How and what students read: A study of evaluation and document selection processes in task-oriented reading

Tonje Stenseth

Thesis submitted for the degree of Ph.D.

Department of Teacher Education and School Research
Faculty of Educational Sciences

UNIVERSITY OF OSLO

2018
Acknowledgements

Alongside this doctoral thesis, life has developed and continued in the most literal sense. Amid data collection, analysis, innumerous drafts, abstracts and countless hours of frustration, I became a mother. Twice. As two pregnancies and two babies did not directly assist the progress of the thesis, I would first and foremost like to thank my supervisor, Professor Helge I. Strømsø, for your tireless patience, countless hours of supervision, availability, support and everlasting presence in all phases of the completion of this thesis. I am forever grateful for your wisdom and good spirit, both academically and in life generally. I would also especially like to thank Professor Ivar Bråten for including me in the TextDIM research group, for contributing greatly to the work in this thesis, and for providing meeting points with the greatest, international scholars in the field. To Professor Øistein Anmarkrud. It is your fault that I started working on a doctoral thesis in the first place, and I have spent many sleepless nights blaming you for all my academic distress. Now, at the end of the journey, I feel only thankful and owe you the greatest gratitude for all your academic and non-academic support during the last decade.

Many years of work with the thesis have resulted in many encounters with many great people. First, thanks to my co-authors, Ivar Bråten, Matthew T. McCrudden, and Helge I. Strømsø for the collaboration, help and for teaching me the cycles of academic writing. Thanks to all the members of TextDIM research group for good seminars, nice dinners, and great travels. Especially thanks to Professor Øistein Anmarkrud and Professor emiritus Bodil Stokke Olaussen for all the constructive comments and feedback in different phases of the work with my thesis. Further, I would particularly like to thank four fabulous women; Anette, Emilia, Kristin B. V. and Leila. Thank you for being true motivators and for generously offering a space to complain, ask questions, relax, and laugh. In addition, I am very greatful to all of my PhD-fellows at various times, and to all the fantastic people at the Department of Teacher Education and School Research. Further, I would like to thank the students participating in the studies in the the thesis, and for their teachers allowing them to do so. I am very greatful for your interest in my project, and for welcoming me in your classes.

Thanks to my family and friends for always being interested and for being supportive through these years. Even though it has been hard to grasp the essence of my writings, you have never stopped asking questions and forcing me to transfer theory into practice.
Finally, my dear husband, my best friend, and my greatest supporter. Thank you for being you, and for all your steadiness, calmness, rationality and unconditional belief in me. Thank you for being my handyman, fixing everything that needs to get fixed. I love you more than anything.

To my precious and beautiful girls, Eira and Tiril. Thank you both for being vivid and constant reminders of what life is all about. Being your mother is the greatest privilege of my life.

Tonje Stenseth,
Tønsberg, October 2018
Summary

The infinite availability of written information in our digitalized world often calls for a reading competence that extends comprehension of single texts. A major 21st century educational goal is to develop students’ ability to process several texts and pieces of information regarding the same topic, known as multiple documents reading. Such reading skills are demanding because the individual must identify, evaluate and integrate information within and across documents, often guided by a specific reading task or goal. The overarching aim of the thesis have been to study what readers attend to when selecting documents during task-oriented reading, and how individual differences affect readers’ selection behavior and attitudes towards the current topics. Hence, upper-secondary students’ evaluations and selections of multiple documents have been examined in three supplementary studies;

First, a mixed-methods study was conducted to assess students’ document selections in relation to an assigned task. Evaluations of both content relevance and author expertise were prominent for students when evaluating the usefulness of documents. However, it was found that the salience of author expertise differed between the two topics used in the study. To explain this difference, qualitative follow-up interviews were performed and indicated that students’ familiarity with the topics affected the salience of author expertise.

The processes involved in task-oriented reading and document selection are assumed to be influenced by individual differences. More specifically, the second and quantitative study was designed to investigate students’ topic interest and topic knowledge as potential predictors of attitudes towards the current socioscientific topics. Because enduring attitudes are likely to have consequences for how readers engage with and elaborate on the issue at hand, it is both theoretically and practically crucial to know how such attitudes might come into existence.

Finally, a qualitative interview study investigated students’ own reflections on their document selections. Students’ justifications supplemented findings from the previous papers by demonstrating a breadth of justifications related to content relevance, source features, and topic knowledge. Positive implications of the findings is that students were able to use knowledge about documents’ source features and content relevance when...
engaged in document selections. However, it seems that teachers need to facilitate students’ developments of even more sophisticated evaluation skills to take full advantage of information obtained from the Internet and elsewhere.

Jointly, the three studies emphasizes purposeful interaction with complex documents in the overwhelming information society of the 21st century. Especially, the thesis expands the understanding of document selection processes in reading with multiple documents.
Part I: Extended abstract

1 Background and choice of topic ................................................................. 1
  1.1 Overarching aim .................................................................................. 2
  1.2 Thesis outline ...................................................................................... 3

2 Evaluations of documents’ usefulness in relation to a task ....................... 4
  2.1 Multiple documents reading ................................................................. 4
     2.1.1 The Documents Model ................................................................... 5
     2.1.2 MD-TRACE model ........................................................................ 5
  2.2 Task-oriented reading ........................................................................... 7
     2.2.1 Content relevance ......................................................................... 7
     2.2.2 Author expertise .......................................................................... 8
  2.3 Chapter summary ................................................................................... 9

3 Individual differences .............................................................................. 11
  3.1 Relationships between individual difference variables ......................... 11
     3.1.1 Topic knowledge ........................................................................... 12
     3.1.2 Topic interest ............................................................................... 13
     3.1.3 Topic familiarity ........................................................................... 13
     3.1.4 Attitudes ..................................................................................... 14
  3.2 Chapter summary .................................................................................. 15

4 Presentation of papers and associated research questions ....................... 16
  4.1 Paper I: The effects of topic familiarity, author expertise, and content relevance on Norwegian students’ document selection: A mixed methods study ......................... 16
  4.2 Paper II: Investigating interest and knowledge as predictors of students’ attitudes towards socioscientific issues .................................................................................. 17
  4.3 Paper III: To read or not to read: A qualitative study of students’ justifications for document selection in task-oriented reading ......................................................... 18

5 Methodological considerations .................................................................. 20
  5.1 Materials ............................................................................................. 20
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>Paper I: Assessment of document selection</td>
<td>24</td>
</tr>
<tr>
<td>5.2.1</td>
<td>Sampling in mixed methods research</td>
<td>24</td>
</tr>
<tr>
<td>5.2.2</td>
<td>Integration of data sets and interpretation of results</td>
<td>26</td>
</tr>
<tr>
<td>5.2.3</td>
<td>Value added by mixed methods</td>
<td>28</td>
</tr>
<tr>
<td>5.3</td>
<td>Paper II: Predictors of students’ attitudes</td>
<td>28</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Choice of analysis: paired sample $t$-tests, correlations and hierarchical multiple regression analyses with interaction terms</td>
<td>28</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Validity in quantitative research</td>
<td>29</td>
</tr>
<tr>
<td>5.3.3</td>
<td>Value added by quantitative methods</td>
<td>31</td>
</tr>
<tr>
<td>5.4</td>
<td>Paper III: Students’ justifications for document selection</td>
<td>31</td>
</tr>
<tr>
<td>5.4.1</td>
<td>Thematic and content analysis</td>
<td>32</td>
</tr>
<tr>
<td>5.4.2</td>
<td>Interviewer effects and validity issues</td>
<td>34</td>
</tr>
<tr>
<td>5.4.3</td>
<td>Value added by qualitative orientations</td>
<td>35</td>
</tr>
<tr>
<td>5.5</td>
<td>Ethical considerations</td>
<td>36</td>
</tr>
<tr>
<td>6</td>
<td>Discussion</td>
<td>37</td>
</tr>
<tr>
<td>6.1</td>
<td>Summary of main findings</td>
<td>37</td>
</tr>
<tr>
<td>6.2</td>
<td>Educational implications</td>
<td>41</td>
</tr>
<tr>
<td>6.3</td>
<td>Limitations and future directions</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>References</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Appendices</td>
<td>60</td>
</tr>
<tr>
<td>Appendix I: Information and consent letter</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Appendix II: Demographics questionnaire</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Appendix III: Topic interest measure, nuclear power</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Appendix IV: Topic interest measure, climate change</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Appendix V: Topic knowledge measure, nuclear power</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Appendix VI: Topic knowledge measure, climate change</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Appendix VII: Task instructions</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Appendix VIII: Card selection materials</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Appendix IX: Interview protocol</td>
<td>92</td>
<td></td>
</tr>
</tbody>
</table>
Part II: Papers I - III

Paper I:

Paper II:

Paper III:
1 Background and choice of topic

A distinguished feature of today’s reading context is the easy accessibility to infinite amounts of information on any topic. Consequently, readers have numerous opportunities to revise their knowledge and to acquire new knowledge. However, with these opportunities comes the challenge of deciding which information to attend to and which to ignore. A survey conducted in the U.S. in 2005 unveiled that two-thirds of reported reading episodes involved searching for information in one document or several documents and that general books and literature represented less than 10% of participants’ daily reading materials (White, Chen, & Forsyth, 2010). Although the survey was conducted over a decade ago, these findings may be valid in today’s reading contexts. The findings suggest that reading in the 21st century is mainly task- and goal-oriented and that the reader must be selective to successfully navigate the great diversity of information (Metzger, 2007). Hence, an underlying assumption in the current thesis is that a competent reader is characterized by the ability not merely to read and comprehend written information but additionally, to evaluate and select relevant documents to achieve a reading goal.

The understanding of reading as more sophisticated than the ability to decode and comprehend a text is reflected in both national and international policy documents. For example, an important educational goal from primary school and throughout upper-secondary school in Norway is to develop students’ critical reading skills to prepare students to participate in the information society (Norwegian Ministry of Education and Research, 2012). This account of reading skills in the Norwegian curriculum resembles the OECD’s definition of reading literacy, as set forth in the PISA reading framework:

*Reading literacy is understanding, using, reflecting on and engaging with written texts, in order to achieve one’s goals, develop one’s knowledge and potential, and participate in society* (OECD, 2016).

Thus, the Norwegian national curriculum and the definition of reading literacy places the reader at the center of the reading activity by describing ways of interacting with written texts and reasons for doing so (Norwegian Ministry of Education and Research, 2012; OECD, 2016). Reading is thereby assigned an instrumental value greater than that of the reading activity: it provides opportunities for self-realization and participation in a democratic society. Along with this understanding of the personal and societal importance of reading is the
accessibility to controversial information on socioscientific topics that are consequential for people’s lives. Individuals are expected to be able to comprehend and competently act on such information when making important life decisions related to, for example, health, nutrition or climate issues (Stromso, Bråten, & Stenseth, 2017; Ferguson, 2012; Fox, 2009). Reading about controversial socioscientific issues of potentially great personal or social relevance requires the ability to evaluate the usefulness of what is read (McCrudden, Magliano, & Schraw, 2011) and demonstrate multiple document reading skills (Rouet, 2006).

As a part of understanding the complex processes involved in selective reading with multiple documents, the thesis addresses individual differences assumed to influence how readers read and what they comprehend. Cognitive factors have been commonly given attention when investigating individual differences in multiple document comprehension. However, more recently, the interaction between cognitive and affective factors is receiving increasing attention from researchers aiming to understand the broad array of differences among readers (Afflerbach, 2016). In the current thesis, both cognitive and motivational-affective factors are included to assess the evaluative and selective processes involved in task-oriented reading. Hence, how different readers interpret task instructions, read and evaluate documents’ usefulness are all integral to understanding why different students choose different documents when solving identical tasks.

Considering these aspects together, reading in the 21st century is arguably task- and goal-oriented, with the reader being evaluative and selective when interacting with written text. However, concerns regarding students’ inadequate evaluation and reading skills due to maladjustment to the information literacy landscape in the 21st century have frequently been expressed (Goldman, et al., 2016). For example, both national and international large-scale assessments suggest that students do not progress much beyond basic reading skills (Kjærnsli & Jensen, 2016; OECD, 2013). Echoing these findings, numerous empirical studies imply that most students lack literacy skills such as using evaluation criteria to determine the validity of information located online and elsewhere (Britt & Aglinskas, 2002; Bromme & Goldman, 2014; Kjærnsli & Jensen, 2016; OECD, 2013; Pellegrino & Hilton, 2012).

1.1 Overarching aim

The overarching aim of the thesis is to study what readers attend to when selecting documents during task-oriented reading of texts on socioscientific issues and the extent that individual
differences affect readers’ selection behavior and attitudes towards such issues. The following empirical findings together demonstrate the relevance and importance of this aim. First, reading with multiple documents is demanding both cognitively and motivationally, and most teenagers experience difficulties when using multiple sources of information (e.g., Britt & Aglinskas, 2002; Walraven, Brand - Gruwel, & Boshuizen, 2009). Second, to succeed in multiple documents reading, effective readers evaluate information based on several dimensions such as relevance, trustworthiness and expertise (Bråten et al., In press; McCrudden & Schraw, 2007). Third, individuals’ prior knowledge and interest have been found to impact the ability to make inferences across multiple documents and the comprehension of multiple documents, respectively (Bråten et al., 2014; Strømsø & Bråten, 2009; Gil et al., 2010). Additionally, readers’ attitudes and beliefs towards a topic have been linked to information evaluation and processing (Kardash & Scholes, 1996; Murphy & Alexander, 2004; Kahan, et al., 2012). Less, however, is known concerning how these reading processes and individual difference variables are linked and interact with each other. To reduce this knowledge gap, the research questions are designed to address both text features and individual reader differences that might influence how and what readers evaluate when engaged in document selection during task-oriented reading.

1.2 Thesis outline

The thesis consists of an extended abstract (Part I) and three papers (Part II). The extended abstract includes five chapters in addition to the current introductory chapter:

*Chapter 2* reviews research on reading with multiple documents. The chapter presents two prominent theoretical models in multiple documents reading to focus on the role of both the task and the selection processes. Content relevance and author expertise are highlighted as salient textual features in task-oriented reading processes.

*Chapter 3* addresses individual differences in the reading processes with multiple documents. *Chapter 4* briefly summarizes each paper and presents the associated research questions. *Chapter 5* discusses general methodological considerations with respect to the thesis and the three papers.

Finally, *Chapter 6* discusses the main findings in the thesis and educational implications. The thesis concludes with a discussion of limitations and suggestions for future research.
2 Evaluations of documents’ usefulness in relation to a task

Theories and discussions regarding the nature of reading have called for greater attention to the contexts of reading (e.g., Cerdán, Gilabert, & Vidal-Abarca, 2011; McCrudden & Schraw, 2007; Rouet, 2006; Snow & the RAND reading study group, 2002). Most reading occurs within the context of a task (Britt, Rouet, & Durik, 2018). Specific task instructions, such as adopting a stance on a debated issue or preparing a presentation on a topic, are presumed to more strongly influence the type of information that readers focus on than if reading with a less well-defined purpose (Britt, Rouet & Durik, 2018). Additionally, when assigned specific task instructions, students are often prompted to engage in reading activities that may involve evaluating, selecting and using two or more documents to complete a task, that is, multiple documents reading. Such reading is distinct from single text reading in several ways, and two theoretical models are presented in the current chapter to describe some of the reading processes involved in document evaluation and document selection as they concern the thesis.

2.1 Multiple documents reading

Research on multiple documents reading emerged from seminal studies in the 1990s (Perfetti, Rouet, & Britt, 1999; Rouet et al., 1996; Wineburg, 1991). Originally advanced as a mastery reading skill characterized by the ability to interrelate several documents addressing an issue from different perspectives, multiple documents reading is no longer a reading activity relevant to expert readers only. Due to the large expansion of information availability in our digitalized world, the ability to consult several documents often contradictory in nature and at odds with prior knowledge is crucial for readers in both educational and informal settings. In fact, the ability to use multiple written documents simultaneously has become a core reading skill in our information and Internet era (Saux, et al., 2017), and presents readers with unique possibilities for creating information-rich and nuanced accounts of complex topics (Perfetti et al., 1999; Wiley et al., 2009).

Two theoretical models are presented next to describe the processes involved in multiple documents reading.
2.1.1 The Documents Model

The Documents Model framework (DMF) is dominant in research on multiple documents reading, as it describes how readers integrate information from several documents to build a synoptic outline of the content presented therein (Britt & Rouet, 2012; Perfetti, Rouet, & Britt, 1999; Rouet, 2006). In addition to the text-base, the text-internal meaning of the text, and the situation model, the reader’s interpretation of the situation described in the text, the DMF proposes an additional layer to assess readers’ understanding of the relation between different sources and between sources and content. In this intertext model, inconsistencies between texts are identified, and the unique content of each text is linked to different authors (Britt, et al., 1999; Britt, Rouet, & Braasch, 2013). Establishing links between content and source facilitates the reader’s comprehension by improving recall of the particular claims set forward by each author (Britt & Rouet, 2012). Understanding and attending to source information are crucial in multiple documents reading for differentiating between the documents and identifying their distinct contributions to the integrated representation of the current situation or topic (Bråten et al., 2011).

However, whether a document model is genuinely constructed depends on several factors such as readers’ goals, former experience with similar tasks, expertise and the willingness to make necessary connections between documents and situations (Perfetti, Rouet & Britt, 1999). Students often fail to integrate information across documents because of the cognitively demanding processes required to do so. Consequently, the quality of readers’ document models might vary as a function of individual differences between readers (see chapter 3).

2.1.2 MD-TRACE model

As outlined, researchers agree that reading occurs in contexts where it is guided by readers’ goals (Macedo-Rouet et al., 2013). Purposeful interaction with complex documents necessitates a theoretical framework that describes the processing steps and decisions that underlie the search, evaluation, selection and use of multiple documents (Rouet & Britt, 2011). The Multiple-Document Task-based Relevance Assessment and Content Extraction (MD-TRACE model) extends the DM framework by offering a descriptive model of the resources and processes required for reading tasks involving multiple documents. The resources described in the model are both external (task specifications, a set of documents,
and a set of reader-generated products) and internal (prior knowledge, former task and reading experience, memory skills, understanding of task requirements, and understanding of the documents’ sources and contents), and are involved in five different processing steps. Step 1 involves task model construction, in which the reader interprets task instructions and creates goals to complete the task. McCrudden and Schraw (2007) proposes that reading is always goal-directed because the reader attempts to understand the text with a preconceived goal. In multiple documents reading, the goal might be even more salient, as people are unlikely to engage in such cognitively demanding reading processes without a purpose or instructions. Hence, the task model construction posits that readers develop personal reading goals and criteria to help determine content relevance for current documents. Step 2 concerns a decision point when the reader must assess his or her information needs. For example, to complete a reading task on the topic of nuclear power, the reader might realize that (s)he lacks the necessary prior knowledge to complete the task and thus seeks information elsewhere (external resources). By contrast, if familiar with the topic, the reader might rely on prior knowledge (internal resources). In practice, step 2 might occur several times during the reading process, and these reassessments of information needs can be challenging for students (e.g., Rouet & Coutelet, 2008). Step 3 in the MD-TRACE model is complex and consists of three substeps. In step 3A, the reader assesses item relevance, namely, the extent to which a document contributes to achieving the reader’s goal. In addition to assessing such content relevance, item relevance is assessed, based on evaluations of the trustworthiness of the content, which is generally determined by evaluating source characteristics. The assessments of both content and credibility might be critical factors in readers’ determinations of whether a document is relevant. In step 3B, the reader processes text contents and engages with the document to build a representation of the content. Step 3C is typical of multiple documents reading and involves updating/creating a documents model. Here, the reader must combine the information found in several documents and attach content information to the correct source to remember where the information was found (source-content links). Step 4 is task product construction: the reader uses document information to create a task response. Finally, step 5 concerns assessment of product quality. The reader assesses whether the product in step 4 satisfies the task goals created in step 1. For the current thesis, the relevance of the MD-TRACE model concerns how steps 1 (task model construction) and 2 (assessment of information needs) together influence step 3 (accessing, processing and integration of information) and evaluations of content relevance and author expertise that determine whether a document is selected and used.
2.2 Task-oriented reading

Task-oriented reading with multiple documents involves selecting, evaluating and using at least two documents to complete an assigned task or a self-selected reading goal (Anmarkrud et al., 2013; Cerdán, Marín, & Candel, 2013; Gil et al., 2010; Wineburg, 1991). Specifically, “task-oriented reading refers to situations in which a reader reads one or more texts while knowing in advance that s/he has to perform a task for which the texts are a crucial and available source of information” (Vidal-Abarca, et al., 2011, p. 180). However, even in a class of 30 students who have received the same task and relevance instructions, the result may be 30 various reading goals because the interpretations of task instructions may differ (McCrudden & Schraw, 2007; Britt, Rouet & Durik, 2018). Hence, to advance an understanding of the interaction process involved in task-oriented reading with multiple documents, tasks and instructions must be distinguished from how they are interpreted (Britt, Rouet & Durik, 2018).

After interpreting the task instructions, the reader will have created a perception of how to solve the task and the kind of information required. Only pertinent information is considered, and individuals interact with documents and refer back to the task until they consider the task accomplished (Vidal-Abarca, Mañá, & Gil, 2010). However, identifying documents’ usefulness might not be an issue of “use” or “not use” (Britt, Rouet & Durik, 2018), as documents are likely to contain both task-relevant and task-irrelevant text segments. Therefore, in addition to considering documents’ relevance in evaluating usefulness, the reader should evaluate author expertise, which will provide information regarding the trustworthiness and credibility of the content presented. In the thesis, these evaluation processes are considered additive processes, necessary for judging the usefulness of documents in relation to a task and personal reading goals.

2.2.1 Content relevance

In a task-oriented reading context, content relevance is the perceived instrumental value of text information in relation to a reader’s goal or purpose (Lehman & Schraw, 2002; McCrudden, Magliano, & Schraw, 2010; McCrudden & Schraw, 2007). Consequently, content that is more instrumental to a goal is considered more relevant, whereas content perceived as less instrumental is deemed less relevant (McCrudden, Magliano & Schraw, 2010). Although seemingly inevitable, the ability to distinguish between task relevant and
irrelevant information is crucial, given the massive amount of information available together with individuals’ limited working memory capacity. Hence, efficient and skilled readers can optimize their reading behavior by formulating clear goals and criteria for determining documents’ relevance to achieving those goals (McCrudden, Magliano & Schraw, 2010). Given the importance of goals as directives for the reading activity and relevance evaluations, educators should provide students with explicit task-focusing instructions. However, studies of the role of task instructions in multiple document comprehension have produced inconsistent findings regarding the use of tasks for facilitating readers’ goal formulation and successful processing (Le Bigot & Rouet, 2007; Wiley et al., 2009; Bråten & Strømsø, 2010; Gil et al., 2010).

Evaluations of content relevance might be insufficient when deciding whether to select and use a document in preparing a task response. Additionally, expert readers also appear to consider source information when judging the relevance and usefulness of a document (e.g., Wineburg, 1991).

### 2.2.2 Author expertise

Numerous studies have highlighted the necessity of evaluating author expertise when judging documents’ usefulness for accomplishing a reading task (Goldman, et al., 2012; Mason, Junyent, & Tornatora, 2014; Rouet & Britt, 2011; Mason, Ariasi, & Boldrin, 2011). For example, documents about nuclear power written by a professor of natural science versus a journalist should be evaluated and used differently, even if the reader decides that both documents are useful and relevant. Not only can great differences in these authors’ level of expertise be assumed; their purpose and motive for writing are likely also disparate. In other words, considerations of author expertise enhances evaluations of content relevance, as demonstrated by the following definition of sourcing; “Sourcing is defined as attending to, evaluating and using available information about the sources of documents, such as who authored them and what kinds of documents they are, in predicting and interpreting a document’s content or judging its trustworthiness” (Strømsø, et al., 2013; Bråten, Strømsø, & Britt, 2009).

Students’ knowledge of the benefits of being attentive to sources when evaluating the validity of information and knowledge claims are documented in the literature. A recent study by Paul et al. (2017) demonstrated that 9th graders in two different educational systems (Germany and
France) could name benefits deriving from sourcing. However, the students did not evaluate the source information unless required by the reading context. Further demonstrating young students’ sourcing knowledge, Stadtlér et al. (2014) found that 9th graders could evaluate author expertise in brief written scenarios, and Rouet et al. (2011) found that teenagers could solve short, explicit sourcing tasks without assistance. Many studies also indicate that despite knowledge about sourcing, students often fail to attend to and evaluate source features when engaged in task-oriented reading involving multiple documents (Britt & Aglinskas, 2002; Strømsø, et al., 2013; Stadtlér & Bromme, 2007), and if attending to sources, students have been found to rely on superficial cues such as layout (Iding, et al., 2009) or to adopt a default stance using a general “rule of thumb” (e.g., “I trust documents written by professors and avoid articles written by journalists”) (List & Alexander, 2018). The reason that students infrequently undertake a deeper analysis of author expertise is beyond the scope of the current thesis, but individual differences seem to be related to sourcing activities with prior knowledge (Rouet, et al., 1997; Rouet, et al., 1996; Bråten, Strømsø, & Salmerón, 2011; Strømsø, Bråten, & Britt, 2010; Braasch, et al., 2014), interest (Guthrie, et al., 2007), and prior attitudes towards the current reading topic (Strømsø, Bråten, & Stenseth, 2017; Braasch, et al., 2014; Andreassen & Bråten, 2013; Gottlieb & Wineburg, 2012). These connections are particularly relevant to the studies presented in the current thesis (see section 3.1 for further detail).

2.3 Chapter summary

In educational settings, readers’ purpose for reading is guided mainly by task instructions, for example, to prepare a class presentation on a controversial topic. Hence, the reader interacts with the task and creates a personal reading goal that then determines how (s)he evaluates the documents encountered to solve the task. Often, such task-oriented reading with multiple documents involves relating to documents with potentially conflicting perspectives on the same topic. Two theoretical models were used in the chapter to describe cognitive and procedural approaches to the reading processes involved in document selection. These approaches consider the evaluation of usefulness as a core process. Decisions regarding documents’ usefulness have been theoretically emphasized as involving judgments of both content relevance and author expertise. Notably, studies demonstrate inconsistent results regarding students’ abilities to use such evaluative processes, which might stem from individual differences in cognitive and affective factors. The MD-TRACE model generally
recognizes the importance of individual differences in the processing of multiple documents (i.e., internal resources), yet how these variables interfere with the different processing steps in the model is unclear. The next chapter accordingly addresses current individual reader variables assumed to influence the evaluation and selection processes involved in multiple documents reading.
3 Individual differences

In a review of individual differences in multiple document comprehension, Barzilai and Strømsø (2018) suggest four clusters of variables when assessing the reading processes and what readers grasp from reading multiple documents: cognitive, meta-cognitive, motivational-affective and sociocultural differences. The present study includes three selected cognitive (topic knowledge) and motivational-affective (topic interest and attitudes) variables as potential sources of individual variation in evaluations and selections of multiple documents. For theoretical reasons, my coauthors and I combined topic knowledge and topic interest to form a fourth variable: topic familiarity. For example, readers’ prior knowledge and interest in a topic might increase their reading engagement, whereas less familiarity with a topic and task might result in poor engagement and inadequate reading strategies.

Before providing empirical justifications for the inclusion and relevance of the variables considered in the thesis, how the concepts were used and the theoretical relationships between them are briefly outlined.

3.1 Relationships between individual difference variables

*Topic knowledge* was measured and used to represent the depth of students’ knowledge on a specific topic within a domain. The assumption was that the more topic knowledge a person possesses, the better equipped (s)he is to engage deeply with the topic. Topic knowledge is a cognitive factor that influences both the evaluative processing of multiple documents and the document selection process. *Topic interest* is included in the study as a motivational factor that influences readers’ willingness to assess and engage with the central merits of an issue. Moreover, it is assumed that topic interest helps determine what people choose to learn (Schraw & Lehman, 2001). Consistent with Guthrie and Wigfield’s (2000) engagement perspective on reading development, *topic familiarity* was conceptualized as the combination of topic knowledge and topic interest, thus indicating the extent to which individuals were familiar with the current topics from both a cognitive and a motivational perspective, how this familiarity affected the assessment of information needs and subsequently, document selection. Finally, topic knowledge and topic interest were used as predictor variables for readers’ *attitudes*, understood as relatively enduring evaluative judgments of controversial
topics. Attitudes were included in the study because of their potential influence on readers’ ability to use information that conflicts with their attitudes.

### 3.1.1 Topic knowledge

Researchers widely agree that readers’ prior knowledge is one of the strongest predictors of performance in text-based learning (Stromsø, Bråten, & Samuelstuen, 2008; Alexander & Jetton, 2000; Anmarkrud, 2009; Kintsch, 1998). Prior knowledge, however, is a broad and multidimensional construct. Three forms of the construct are commonly used in the context of reading comprehension, namely, domain knowledge, topic knowledge, and general world knowledge. In the thesis, topic knowledge is used as a subset of domain knowledge and refers to knowledge relevant to a specific discourse (Kendeou & O’Brien, 2016).

Notably, prior knowledge can both facilitate and interfere with knowledge acquisition based on the assumption that individuals interpret new information with preexisting structures in memory (Bransford & Johnson, 1972). For example, according to Kintsch’s CI-model (1988; 1998), learning might be facilitated if new information is linked to existing knowledge schemas stored in the readers’ mind. However, prior knowledge might work unfavorably if the schema includes incorrect knowledge. That is, correct prior knowledge or misconceptions might have a positive or negative cumulative effect on knowledge acquisition, thereby resulting in erroneous learning. Hence, topic knowledge affects reading about complex topics from multiple documents because comprehension is mediated by the interaction between individual differences in prior knowledge and the content of the documents (Kendeou & O’Brien, 2016).

In addition to potentially interfering with the comprehension of multiple documents, prior knowledge might influence the evaluations of content relevance and the validity of knowledge claims before the document selection process. Bromme and Goldman (2014) and Bromme, Thomm and Wolf (2013) explained individual differences in judging the validity of scientific information with first- and second-hand evaluations. In first-hand evaluations, individuals seek to answer the question “what is true?”, which requires relevant personal experience or prior knowledge to judge the validity of knowledge claims presented in the documents (Scharrer et al, 2012; 2014). In second-hand evaluations, the reader recognizes that he or she lacks the relevant experience or prior knowledge and therefore cannot evaluate knowledge claims in the same manner as in first-hand evaluations. Instead, the reader might perform
evaluations of source features such as author expertise to determine the usefulness of the document.

### 3.1.2 Topic interest

Although considered a critical factor in readers’ construction of meaning from text and evaluations of documents’ usefulness, the influence of prior knowledge is irrelevant if the reader does not engage in the reading activity. In general, interest appears to affect the extent to which individuals engage in a deeper processing of the reading material, the use of specific reading strategies, and the allocation of attention (Schiefele, 1996; 1999; Schraw, 1998). Hence, topic interest was included in the current study as a motivational, internal factor indicating readers’ willful engagement with multiple documents. Numerous studies have documented the impact of readers’ interest on multiple document comprehension. For example, a study by Strømsø and Bråten (2009) found that topic interest predicted students’ scores on only the most demanding comprehension task, which required students to integrate content across texts. It did not affect content recall or single text comprehension.

### 3.1.3 Topic familiarity

In the current thesis, readers’ levels of topic knowledge and topic interest were used together as indicators of topic familiarity, consistent with Guthrie and Wigfield’s (2000) engagement perspective on reading development, which suggests that engaged reading includes both motivational and cognitive characteristics of the reader. Guthrie and Wigfield (2000) found that engaged readers demonstrate both greater comprehension and stronger reading outcomes compared to disengaged readers. Hence, students’ degree of familiarity with the two topics in the current study was expected to influence whether they displayed an effortful engagement in the assigned tasks and how they evaluated and selected documents. However, assessments of topic familiarity in reading comprehension research have been ambiguous and are often juxtaposed with prior knowledge. For example, several studies of first and second language (L2) comprehension have examined the effect of topic familiarity on reading, specifically how it facilitates L2 listening comprehension (e.g., Chiang & Dunkel, 1992) or reading comprehension (e.g., Barry & Lazarte, 1995; Carrell, Gajdusek, & Wise, 1998; Chen & Donin, 1997). In these studies, prior knowledge and topic familiarity were used as theoretical concepts to describe similar aspects of a reader’s predispositions. Thus, the motivational aspect of interest was excluded.
3.1.4 Attitudes

Attitudes can be described as people’s general predispositions, whether favorable or unfavorable, towards other people, objects, and issues (Petty, Priester, & Briñol, 2002). Applications of different evaluation standards might occur in the case of attitude-consistent or attitude-inconsistent information. Hence, information consistent with existing viewpoints is more favorably evaluated, whereas information that conflicts with these perspectives are more scrutinized or even ignored (List & Alexander, 2018). In the thesis, attitudes are used to denote readers’ predispositions towards the two reading topics and are assumed to guide how readers interpret the presented information.

Attitudes towards controversial socioscientific issues might have negative consequences if the reader cannot consider information or viewpoints at odds with his or her attitudes, known as the myside bias phenomenon. This phenomenon refers to the fact that people tend to test hypotheses, evaluate and generate evidence biased by their prior attitudes (Stanovich, West, & Toplak, 2013). For example, in a seminal work by Lord et al. (1979), people read and evaluated conflicting research evidence on capital punishment. Those with strong initial beliefs on the topic evaluated evidence that supported their views more positively than they did evidence that opposed their views. Reading conflicting evidence also strengthened their initial beliefs on the topic (Lord et al., 1979). Expanding the findings of this study, Kardash and Scholes (1996) investigated the degree to which people’s preexisting beliefs about the HIV-AIDS relationship was associated with the written conclusions that they reached after reading a text presenting arguments for two opposing positions on the topic (HIV is the sole cause of AIDS vs. HIV does not cause AIDS). The results showed that the stronger the preexisting beliefs students held on the topic, the more certain were the conclusions they drew from the inconclusive text, thus favoring their own initial beliefs about the HIV-AIDS relationship (Kardash & Scholes, 1996). Similarly, Murphy and Alexander (2004) found that students who read three different texts on controversial topics, each presenting arguments and counterarguments for a particular position, strengthened their pre-reading beliefs about the topic discussed in the text. More recently, Kahan and colleagues (2012) found that people’s perceptions of risk related to climate change depended not on their science literacy or technical reasoning capacities, but rather on their preexisting beliefs and cultural values. Together, these studies indicate how preexisting attitudes and beliefs about a controversial topic may affect information evaluation and processing. Both motivational engagement and knowledge-based elaboration, independently or interactively, likely contribute to attitude.
strength (Kunda, 1990). Hence, the present study sought to assess how knowledge and interest predicted students’ attitudes towards climate change and nuclear power.

3.2 Chapter summary

Readers differ considerably in how they evaluate, select and read multiple documents in a task-oriented reading context. The current chapter addressed several potential sources of individual variations that might be grouped into two clusters of variables: cognitive and affective. Specifically, the thesis assumes that readers’ evaluations and selections of documents in task-oriented reading are influenced by topic knowledge and topic interest alongside attitude strength. Additionally, topic knowledge and topic interest together might affect readers’ processing of multiple documents. For example, readers’ level of topic knowledge will likely influence how they evaluate the content of a document and the kind of documents they use to solve a task. Importantly, the reader might not engage in the reading task if they lack interest or motivation. To indicate readers’ level of familiarity with the two topics, measures of topic knowledge and topic interest were used to create the topic familiarity-variable in the current study.
4 Presentation of papers and associated research questions

Jointly, the theory chapters illuminate reading, evaluation and selection processes in task-oriented reading involving multiple documents and how individual factors are crucial for understanding how readers differ in these reading processes. Expanding the understanding of document selection in multiple documents reading offers insight into core reading skills required for the rapid-changing information society of the 21st century. This chapter briefly summarizes each paper and the main findings.

4.1 Paper I: The effects of topic familiarity, author expertise, and content relevance on Norwegian students’ document selection: A mixed methods study

Authors: M. T. McCrudden, T. Stenseth, I. Bråten and H.I. Strømsø

Summary: Theoretically, the ability to locate and select relevant documents that fulfill the task goal and the reader’s threshold for task completion is considered crucial to task-oriented reading with multiple documents (Kammerer, et al., 2013; List & Alexander, 2017; Salmerón, Kammerer, & García-Carrión, 2013). In the current study, students were assigned reading tasks focused on two controversial, socioscientific topics. One pre-assumption was that individual differences in familiarity with the topics (topic knowledge and topic interest) would affect evaluations of content relevance and author expertise in the documents presented and whether the documents were selected to solve the tasks. Hence, the first research question was: To what extent does topic familiarity affect the degree to which individuals consider author expertise when discerning the degree of relevance of documents? The results suggest that reliance on author expertise was a function of topic familiarity. The second research question was created as a qualitative follow-up question to this result to gain a more complete understanding of how students value author expertise for more and less familiar topics: Why was author expertise more salient for the less familiar topic (nuclear power) than for the more familiar topic (climate change)?
Methods: The study adopted a sequential explanatory mixed methods design to examine both quantitative and qualitative aspects of upper-secondary students’ document selection. This two-phase method began with the collection and analysis of quantitative data (document selection task, \( N = 153 \)), followed by the collection and analysis of qualitative data (interviews, \( N = 5 \)). The purpose of the qualitative phase was to help explain the initial results of the quantitative phase.

Main findings: The quantitative results indicated that topic familiarity affected participants’ selection of documents from authors with more or less expertise. When the topic was more familiar (climate change), no difference between participants’ selection of documents from authors with high versus low expertise was found. However, when the topic was less familiar (nuclear power), participants selected more documents from high expertise authors than from low expertise authors. The qualitative findings revealed three themes to explain this difference: (1) participants perceived that scientists possess a greater ability to make correct scientific assertions than do journalists; (2) when an assertion was more familiar, participants perceived less of a necessity to rely on author expertise; and (3) when an assertion was less familiar, participants perceived a greater need to rely on author expertise. The data sets were complementary and indicated that topic familiarity moderates the salience of author expertise, but not content relevance.

4.2 Paper II: Investigating interest and knowledge as predictors of students’ attitudes towards socioscientific issues

Authors: T. Stenseth, I. Bråten and H.I. Strømsø

Summary: Individual factors are assumed to be prominent in mediating differences in multiple documents reading and document selection behavior (Braasch, Bråten, & McCrudden, 2018). Therefore, the second study investigated the relationships between three individual difference variables to illuminate how readers performing the same task may engage in different reading behaviors. Specifically, the aim was to investigate topic interest and topic knowledge as predictors of students’ attitudes, as enduring attitudes are assumed to influence how people address and evaluate controversial issues.
The two research questions in the study were identical except for the corresponding topics they were designed to examine: *To what extent can students’ personal interest in and their knowledge about nuclear power/climate change independently and interactively predict their attitudes towards nuclear power plant risks/human-induced climate change?*

**Methods:** The sample comprised 153 upper-secondary school students. Quantitative analysis was used to investigate topic differences in interest, knowledge and attitudes (paired $t$-tests) and the extent to which attitudes could be predicted by interest and background knowledge (hierarchical multiple regression analysis).

**Main findings:** Attitudes towards nuclear power and climate change were found to be predicted by topic knowledge and topic interest, respectively. When an issue was experienced as relatively “cold”, meaning that it evoked less student involvement and engagement, students relied mainly on their knowledge base when forming an attitude towards it and drew on personal interest when they lacked knowledge about the issue. Given the current students’ greater interest in and knowledge of climate change, they presumably perceived this issue as more comprehensible and less complex than the issue of nuclear power. These perceptions may have in turn increased students’ reliance on subjective judgment grounded in personal interest when evaluating the climate change issue compared to the nuclear power issue.

### 4.3 Paper III: To read or not to read: A qualitative study of students’ justifications for document selection in task-oriented reading

**Authors:** T. Stenseth and H.I. Strømsø

**Summary:** The ability to integrate information into coherent representations (e.g., Britt et al., 1999; Afferbach & Cho, 2009) and to create source-content links to connect content with the source (i.e., who says what) (Britt & Rouet, 2012) are distinguishing features in theoretical models of multiple documents reading. Because students moreover lacked access to the full version of the documents, they had to use source information and surface content information to predict the usefulness of the documents. Based on this theory and the current task material, we assumed that evaluations of content and source features were prominent in students’ evaluation and document selection processes. Students’ evaluation processes in multiple document use have been studied in primarily online contexts and with post-reading
assessments (e.g., Britt & Aglinskas, 2002; Stadtler & Bromme, 2007; Wiley et al., 2009). Therefore, the current study considered students’ own reflections and justifications for document selection.

The first research question was formulated as an open and explorative query: *What types of evaluation criteria appear in students’ justifications for selecting documents?* Given the two different topics in the data material, students’ evaluation criteria were assumed to vary as a function of students’ familiarity with the topics. The key role of the topic in document evaluation and task-oriented reading was examined through the second research question: *Do students’ evaluation criteria vary by topic?*

**Methods:** Based on findings from Paper I, 25 students were purposefully sampled to participate in an interview study to provide a broader understanding of their document selections. Hence, a qualitative approach consisting of individual interviews was used to investigate students’ predictive evaluation processes when selecting documents.

**Main findings:** The interview data facilitated evaluations of different aspects of content relevance for most students. Students’ justifications were related to both topic- and task-relevant information. In addition, evaluations of source features were another prominent justification category, indicating that students may consider source information when prompted to justify their document selections. This finding is important, given the number of studies indicating that students hardly evaluate source information when reading multiple documents (e.g., Britt & Aglinskas, 2002; McCrudden, et al., 2016; Stadtler & Bromme, 2007). The final main category of justification criteria regarded prior topic knowledge and assessment of information needs, which might be related to first- and second-hand evaluations of information in the subsequent step. For the second research question regarding variation of evaluation criteria on the two topics, topic differences appeared in some coding categories. In general, we ascribed this difference to variation in prior topic knowledge and familiarity with the topics.

Together, the three papers contribute to the understanding of what readers attend to when selecting documents in task-oriented reading, including individual differences in this process. The papers move from a broad perspective (paper I, mixed methods study) to quantitative (paper II) and qualitative (paper III) elaborations of the research aim.
5 Methodological considerations

The thesis consists of three methodologically distinct empirical papers. Paper I employs a mixed methods design, while Paper II draws on quantitative analysis, and Paper III uses qualitative interviews as the main source of data. Methodological procedures, data analysis and results are thoroughly described in the three papers and thus are not repeated in the following. Rather, the current section addresses common validity issues arising in the three papers and relevant methodological considerations characteristic of each study. By emphasizing the value added of each methodological approach, I demonstrate that a triangulation of methods helps highlight different aspects of the research objectives. The chapter ends with a presentation of both study-specific and general ethical considerations as they relate to the current research.

5.1 Materials

The three studies draw partly on the same data, which include a short questionnaire for gathering demographic information, measures of topic interest, topic knowledge and attitudes, and the document selection task. To form trustworthy inferences from the data, it is crucial that the validity of the materials is considered (Brinkmann & Kvale, 2014). For example, the use of rigorous procedures when developing data instruments can minimize threats to validity, as they may enhance the development of instruments with sound psychometric properties. Additionally, considerations of self-report measures are particularly relevant to the current set of studies.

Topic knowledge measures

Participants’ topic knowledge of climate change was assessed using a multiple-choice measure of 15 items that has been used and validated in prior work (e.g., Bråten et al., 2009; Bråten et al., 2011; Stroemsø et al., 2010). The measure was designed by three researchers, with key concepts and information selected independently from different texts. However, the items were collaboratively written and agreed upon by all three test constructors. To ensure a satisfying degree of construct validity, an independent climate researcher served as an external auditor, who reviewed an early version of the topic knowledge measure, resulting in minor modifications of a few items (see Bråten et al., 2009 for further detail). For the current study, a parallel 15-item multiple-choice measure for nuclear power was developed. The
procedure used to develop the former topic knowledge measure was used, and an external auditor (a researcher from the Department of Physics in the Faculty of Mathematics and Natural Sciences, University of Oslo) was consulted to ensure construct validity.

Compared to the high reliability scores on the topic interest measures, the Cronbach’s alphas for the topic knowledge measures were lower than desirable. The low alpha values may have resulted from the combination of items testing both scientific and political knowledge. To increase the alphas, items addressing political issues were removed from the measures. However, the removal did not improve the alphas of the remaining items. Because internal consistency reliabilities are likely less appropriate in cases encompassing a diversity of knowledge aspects, test-retest data were collected to verify the stability of scores on these measures. The test-retest reliabilities reported for the two topic knowledge measures (.77 and .72, respectively) indicate acceptable reliability values for both measures (e.g., Kerlinger & Lee, 2000).

**Topic interest measures**

In the current studies, participants’ interest was measured in terms of individual interest, understood as a person’s enduring relationship with a specific content domain as opposed to situated interest in the material. When individually interested, a person has developed a valued domain knowledge (Hidi & Renninger, 2006), and we aimed to assess whether this type of interest affected document selection. Student interest and engagement in the two topics were assessed with two 12-item measures and 10-point Likert scales. Half of the items reflected an interest without active engagement or involvement, whereas the other half focused on active engagement and involvement. Although the measure for climate change was previously used and validated by Bråten, Strømsø, and colleagues (Bråten, et al., 2009; Strømsø, Bråten, & Britt, 2010), the nuclear power measure were developed for the current studies. The Cronbach’s alphas for scores on both topic interest measures were comparatively high (.94 and .89 for climate change and nuclear power, respectively).

**Attitudes**

Participants’ attitudes towards climate change and nuclear power were assessed using three-item measures developed for the current study. High scores on the measures indicated that participants believed climate change was caused by humans and that they judged nuclear power plants to be high-risk. By contrast, low scores indicated a belief that climate change
was not caused by humans and that nuclear power plants are safe. The Cronbach’s alphas for the measures were .90 and .86, respectively.

The measures were used to gauge students’ predispositions towards climate change and nuclear power. It seems reasonable to question whether only three items can capture the breadth of such attitudes. However, the small number of items used to measure each construct is comparable to the number of items used in studies such as Mullis et al. (2003; 2007) in which a 5-item questionnaire was used to measure attitudes towards reading, while Coles and Hall (2002) used only one item. Furthermore, the use of Likert scales ensures sufficient variance in students’ responses, unlike dichotomous agree/disagree or semantic-differential response formats (Crocker & Algina, 2008).

Validity of self-report instruments

Affective constructs such as interest and attitudes are included in the current study because of their assumed greater effect on reading behavior compared with cognitive constructs such as background knowledge. However, the challenge is how to obtain valid measures of these constructs that are typically measured using self-report instruments such as Likert-scales. Self-report measures are sensitive to self-presentation, understood as intentional or unintentional self-deception (Pauls & Crost, 2004). Methods to reduce self-presentation behavior are available (e.g., providing warnings that self-presentation can be detected or using forced-choice item formats). However, as the current data were collected for research in a low-stakes context, the assumed occurrence of self-presentation is less common than in high-stakes contexts (Niessen, Meijer, & Tendeiro, 2017). Hence, notwithstanding the potential weakness of self-report instruments, the validity of the interest- and attitude-measures in the current study are considered satisfactory.

Correlations between the variables

When using statistics, the conclusions drawn from the statistical test results must be accurate and reliable. Statistical validity in the case of the relationship between variables indicates whether the correlation is statistically significant and potentially to how strong it is (Shadish, Cook & Campbell, 2002). In Paper II, a correlation matrix shows the relationship between participants’ topic interest, topic knowledge and attitudes towards the two topics. For example, interest in and knowledge about the two issues are correlated, $r = .63$, $p < .001$, and $r = .56$, $p < .001$, respectively. The strength of these correlation coefficients is moderate to
strong (Cohen, 1988; 1993). Although the correlation coefficients provide no information regarding causal relationships, they furnish information about the covariation of the variables (see Discussion of main findings for more detail).

Two threats to statistical validity should be considered when using correlational data, namely, statistical power and independence. First, small sample sizes generally result in decreased precision of statistical analyses and might result in a value of statistical power that is too low to draw inferences. Researchers disagree about the sample size required for performing Pearson’s $r$ (e.g., David, 1938), but low sample sizes will reduce the power for determining the correlation for a given alpha (typically 0.05). Furthermore, small sample sizes will make it more difficult to recognize possible relevant deviations in the scale of the variables, their linear correlations and normal errors. Although the data will remain valid under the given conditions and context of collection, the validity of the results might not transfer to other contexts, which raises the question of external validity (generalizability) (Shadish, Cook & Campbell, 2002). Given such considerations and the aim to achieve satisfactory statistical validity, obtaining a sufficiently large sample when recruiting participants for the current study was crucial. The current sample size of 153 might be considered satisfactory in the case of statistical power (Bonett & Wright, 2000). Second, independence in the observations is pertinent when assessing statistical validity. The participants in the study are attending the same college preparatory courses, but in two different years. Moreover, the sample is rather homogenous in terms of socioeconomic status. Consequently, compared to randomly selected individuals, the participants are more similar to each other, which might introduce severe bias into the estimation of standard errors and exact effects (Shadish, Cook & Campbell, 2002).

**Reading task**

All participants received identical instructions to prepare a class presentation on two controversial socioscientific topics by using 20 documents assigned to them. The students were instructed to select as many documents as required to solve the task. Hence, the students evaluated the documents’ usefulness based on their interpretations of the task. Thus, issues related to the framing of the task must be considered, as framing might have biased the respondents towards particular choices. For example, the selection of journalistic sources over more scientific sources might be motivated by the desire to include an entertainment value in the writings or “spice up” the presentations, as these sources may have been used to increase engagement. Such motivations may have influenced the results and are linked to the framing
of the task. Additionally, the evaluations of documents’ usefulness and thereby perceived task relevance seemed to develop from goals such as learning more about the topic, achieving a good grade and convincing others of one’s viewpoint with respect to the interpretation of the task instructions. Although data on neither students’ interpretations of the task nor their goal for the reading task were explicitly collected, document selections and justifications indirectly revealed students’ selection strategies.

The reading task was developed for this doctoral thesis. Author expertise was represented as journalists or professors (less expert and more expert authors, respectively), and document content was classified as either relevant or irrelevant. Although author expertise and content relevance were treated as dichotomous categories in the current study, they could clearly differ along various dimensions and with a degree of expertise and relevance rather than “expert versus non-expert” and “relevant versus irrelevant”.

5.2 Paper I: Assessment of document selection

A mixed methods design was used for the first study. In general, a study can be characterized as mixed methods if it combines at least one quantitative and one qualitative component (Bergman, 2008). In the current study, a sequential explanatory mixed methods design\(^1\) was well suited to assess whether author expertise and content relevance were salient for students when selecting documents on two topics differing in familiarity (quantitative phase). In addition, students’ selection criteria for the two topics were studied through analyses of self-reported justifications (qualitative phase).

The current section presents central issues of concern when conducting mixed methods research, focusing on sampling, data integration and interpretations of the results. Together, these elements address the overall validity of the research and the inferences drawn from it.

5.2.1 Sampling in mixed methods research

The quality of inferences in any study depends on the quality of the underlying sampling design, as inferences will lack legitimation if the sampling design is inappropriate (Onwuegbuzie & Collins, 2017). In the current study, 153 upper-secondary school students

\(^1\) Typically, when a researcher starts with quantitative methods and then uses qualitative methods, they are attempting to help explain the initial quantitative results (Creswell, Clark & Garrett, 2008).
were identified and selected as participants through the researcher’s own network. Whether they are representative of upper-secondary school students is open to question, given their homogenous socioeconomic status (i.e., middle class; 82.4% were native-born Norwegians) and high levels of academic performance. Hence, the external validity and generalizability of the results may be restricted. However, for the current study, the generalizations can be considered working hypotheses rather than definitive conclusions, and similar studies that have been performed in other contexts were consulted (Kleven, 2008; Shadish, Cook, & Campbell, 2002). For example, the main conclusion from Paper I was that topic familiarity affected the salience of author expertise, but not of content relevance. The fact that individuals use different strategies to evaluate the validity of scientific information has been found by several empirical studies (Bromme & Goldman, 2014; Bromme, Thomm, & Wolf, 2013; Scharrer et al., 2012; 2014). Hence, the main conclusion matches with results of other studies and thereby indicates external validity (Lund, 2005). The degree of representability of the current sample can be considered subordinate, given the theoretical focus and basic research characteristics of the study.

Ideally, the selection of interviewees should be randomized to ensure all participants have an equal probability of selection. However, randomizing the current sample selection was infeasible for two reasons. First, the sample was not sufficiently large (\(N = 153\)) to ensure that randomization does not produce a biased sample. Second, and more importantly, the purpose of our research design was to further explore the quantitative findings. The qualitative cases were selected with a purposeful sampling strategy that is described in the literature as a nonrandom procedure ensuring that particular categories of cases within a sample are represented in the final sample (Creswell & Plano Clark, 2011). Purposeful sampling was based on findings from the quantitative phase of the study and included participants with certain characteristics pertinent to the research questions and hypotheses. The participants were identified through a two-step selection procedure based on two inclusion criteria (see Paper I for details). Thirty-eight students that satisfied both inclusion criteria were selected, and a convenience sample of five students was also included. The use of only five of 38 students might appear inadequate, given the relative brevity of the interviews (approximately 30 minutes). Nevertheless, the sample sizes in a sequential design may be unequal because of the purpose of qualitative samples, which provide an in-depth understanding of a small group of individuals based on quantitative findings, which are in contrast more general (Creswell, Plano Clark, & Garrett, 2008). Given, additionally, the qualitative research questions in Paper
I, we believe the interview data provided substantive and valuable insight into why author salience differed for more and less familiar topics. A future study could use a different method, such as grounded theory, to plumb the reasons for these differences.

In sum, the purposive and convenience sampling in Paper I were performed to investigate the depth of two specific, quantitative findings (quantitative sample; \(N = 153\), qualitative sample; \(N = 5\)). As the role of sampling designs in mixed methods studies can be considered more complex than in single quantitative and qualitative studies because of the points of interfacing between these two components, the current sampling considerations were holistic. More specifically, we ensured that all sampling decisions were integrated into a process that would yield meta-inferences, i.e., integrating quantitative and qualitative findings so that the sum is greater than the parts, denoted \(1+1=3\) (Fetters & Freshwater, 2015, p. 115).

### 5.2.2 Integration of data sets and interpretation of results

Before discussing the challenges of integrating the quantitative and qualitative data sets, I will briefly describe and justify the types of analyses used in the study.

**Quantitative analysis**

A 2 x 2 within-subject repeated-measures univariate analysis of variance (ANOVA) was conducted to assess the significance of author expertise and content relevance (independent variables) for document selection for each topic (dependent variables). An ANOVA was chosen as a way to investigate how the independent variables affect the dependent variable in combination (Brace, Kemp, & Snelgar, 2012). However, we could not explain topic differences in students’ selection criteria by examining the quantitative results in isolation.

**Qualitative analysis**

The interviews were coded using a five-step procedure (Braun & Clarke, 2006; Shank, 2006), which entailed 1) familiarizing ourselves with the interviews, 2) extracting all relevant phrases from the transcripts, 3) generating initial codes, 4) developing categories from the codes by aggregating similar codes and 5) identifying themes. The steps in the analytic process are similar to the coding process conducted in Paper III; however, the latter paper is based on a more detailed, nuanced and extensive coding of a larger sample.

*Integrating quantitative and qualitative data*
To draw valid inferences from dual data sets in a mixed method study, the results must be integrated to achieve methodological rigor (Teddlie & Tashakkori, 2009). Recognizing possible barriers in integrating quantitative and qualitative research, Bryman (2007) presents several difficulties that might impede the integration of findings, among which the structure of the research project and the role of timelines are particularly relevant to the current study. First, when designing the mixed methods study, the quantitative section was planned in a structured way by using a survey. The challenge of integrating the findings arises when findings from the survey guide the qualitative component such that the latter provides the main orientation (Bryman, 2007). In the absence of attentiveness to the rationale of conducting the mixed method study, integrating the quantitative and qualitative findings might be difficult. Second, the different timelines of quantitative and qualitative data might pose difficulties to integrating the data. For example, data collection and analysis are often completed sooner and more quickly with quantitative data than with qualitative data, resulting in the two data sets being out of phase with each other. As a team of researchers writing the current paper, we were able to delegate data analysis and writing among us.

Specifically, the results from the first study were integrated by connecting and merging the data. Hence, the quantitative data set was used to inform qualitative data collection (connecting data), and a joint display was used to combine quantitative and qualitative findings (merging data) (Johnson, Grove, & Clarke, 2017).

**Issues in interpretation**

When interpreting the results, we drew meta-inferences at the end of the study, which included broader interpretations than those formed after the quantitative or qualitative phase alone. Given the nature of sequential explanatory design in which the quantitative data must be analyzed prior to participant selection, a validity issue concerning the qualitative data is noteworthy. In the study, the interviews occurred three weeks after the document selection task. This timing might have affected the interview responses, diminishing the validity of the subsequent qualitative data because participants may not have remembered the first phase of data collection. Thus, direct comparisons between the participants may have not been as robust as possible.
5.2.3 Value added by mixed methods

Considered a complex and time-consuming research method posing several methodological pitfalls (Bergman, 2008; Bryman, 2007; Erzberger & Kelle, 2003), mixed methods research may nonetheless offer advantages and valuable features that makes it “worth the effort”. Hence, the potential value added from using mixed methods approaches might compensate for the many methodological considerations required.

From a practical perspective, the choice of mixed methods enabled the creation of quantitative instruments for assessing the constructs of primary interest (topic knowledge, topic interest, author expertise and content relevance), facilitated the return to the participants for a second phase of qualitative data collection, and provided time to conduct the research in two phases (Creswell & Plano Clark, 2011). From a theoretical perspective, the study in Paper I demonstrates the value of a mixed methods design in theoretically motivated psychological research. The design and combination of quantitative and qualitative methods advanced the overall research aim of the thesis by offering insight into what readers attend to when selecting documents in task-oriented reading. Specifically, the mixed methods design produced a more comprehensive account of how topic familiarity affects document selection.

5.3 Paper II: Predictors of students’ attitudes

The current paper investigated how topic knowledge and topic interest predicts readers’ attitudes with respect to socioscientific issues. Paper II used participants’ scores on measures of topic knowledge, topic interest and attitudes regarding climate change and nuclear power as the data sources. Gender and self-reported natural science grade were also included as potential predictors of attitudes towards the current topics.

Note that the sample in Paper II is identical to the quantitative sample in Paper I. Hence, sampling considerations are not repeated in the current section.

5.3.1 Choice of analysis: paired sample t-tests, correlations and hierarchical multiple regression analyses with interaction terms

In Paper II, t-tests, correlations and hierarchical multiple regression analyses were used. Paired sample t-tests were used to investigate whether the participants were significantly more interested in and more knowledgeable about one topic compared to the other and whether they
exhibited stronger attitudes towards one of the topics. Paired $t$-tests enabled a comparison of the mean scores of two sets of observations for the same individual (mean scores for topic interest, topic knowledge and attitudes on climate change were compared to mean scores for topic interest, topic knowledge and attitudes on nuclear power). A parametric test of correlation (Pearson’s $r$) were used to assess the degree and strength of the relationship between the current variables, yielding insight into how individual characteristics were associated with each other before fitting hierarchical regression models to the data and testing the hypothesis (Field, 2013) (see section 5.1, Correlation between the variables or Paper II for further detail).

Finally, to directly address the research questions posed in Paper II, two hierarchical regression analyses were conducted to discern the distinct contribution of each predictor variable on students’ attitudes towards the two socioscientific topics. Hierarchical regression analyses were conducted because we had an empirical and theoretical rationale to decide the order of how the predictors were inputted into the models. To analyze the potential effect of the interaction between the two independent variables, topic interest and topic knowledge, interaction terms were created (see Paper II, page 277 for details).

5.3.2 Validity in quantitative research

In general, validity is a rational discussion of alternative interpretations of research (Kleven, 2008). In contrast to qualitative research, however, quantitative research requires certain statistical procedures to increase the quality and validity of inferences. In Paper II, diagnostic statistics were used to assess how the models fitted the sampled data and to establish the validity of the models. Hence, potential concerns regarding violated assumptions of the statistical tests were investigated before interpreting the results of the multiple regression analysis, particularly inaccurate inferences regarding covariation (Shadish, Cook & Campbell, 2002). The independent variables were examined using Cook’s distance, the Durbin-Watson scores, collinearity and the variance inflation factor (VIF) for both multiple regression models.

Cook’s distance

Before interpreting the results, we checked whether certain cases exert undue influence over the other model parameters (Field, 2013). This kind of analysis can help determine whether the regression model is stable across the sample or conversely, whether it is biased by a few
influential cases. Hence, Cook’s distance considers the effect of a single case on the entire model. Cook and Weisberg (1982) suggested that values greater than 1 may be cause for concern.

For the first regression analysis with *attitudes towards climate change* as the dependent variable, the residuals statistics showed a Cook’s distance of .007 ($M$, $SD = .018$. For the second regression analysis with *attitudes towards nuclear power plants* as the dependent variable, the Cook’s distance was .006 ($M$, $SD = .008$. Clearly, both values are acceptable.

**Durbin-Watson test**

For any two observations, the residual terms should be uncorrelated (independent). If this assumption of independence is violated, then the confidence intervals and significance tests are invalid. The Durbin-Watson test tests for serial correlations between errors. The test statistics can vary between 0 and 4, with a value of 2 indicating that the residuals are uncorrelated.

For the first regression analysis with *attitudes towards climate change* as the dependent variable, the Durbin-Watson score was 1.832, and for the second analysis, the score was 1.813. Both values are close to 2 and are thereby acceptable.

**Collinearity**

Another concern when including more than one predictor in a multiple regression model is collinearity, which exists in the case of a strong correlation between two or more predictors. A strong collinearity between predictors makes unique estimates of the regression coefficients impossible to obtain (Field, 2013). SPSS produces various collinearity diagnostics, one of which is the variance inflation factor (VIF). The VIF indicates whether a predictor has a strong linear relationship with the other predictors. Values greater than 5 are cause for concern.

The VIF for the first regression analysis (*attitudes towards climate change* as the dependent variable) yielded the following values: 1.302 (*topic knowledge*), 1.221 (*interest*), 1.153 (*science grade*), and 1.204 (*gender*). The VIF values for the regression analysis with *attitudes towards nuclear power plants* as the dependent variable were 1.374 (*topic knowledge*), 1.157 (*topic interest*), 1.203 (*science grade*), and 1.150 (*gender*). All these values are less than the critical value of 5.
Related to VIF is the tolerance statistic: a tolerance level below .20 indicates a potential problem. The tolerance of the final model in the first regression analysis (attitudes climate change as the dependent variable) yielded the following values: .768 (prior knowledge), .819 (prior interest), .867 (science grade), and .831 (gender). For the final model in the second analysis, the values are as follows: .728 (prior knowledge), .864 (prior interest), .831 (science grade), and .870 (gender). All these values are greater than the critical value of .20.

In sum, all scores and values were acceptable, so the models sufficiently fitted the data. However, the use of correlational data collected at a single time point does not support conclusions regarding causality, though the theoretical assumptions regarding topic knowledge and topic interest as predictors of attitudes were consistent with the empirical findings. As Shadish, Cook and Campbell (2002) acknowledge, many factors are typically required to generate an effect, but we rarely know them all and how they relate to each other. For example, as highlighted in Paper II, we are aware that other individual difference variables than the ones included in the current study might predict students’ attitudes towards socioscientific topics (Bizer, Barden, & Petty, 2003). In this respect, addressing the question of causality as probabilistic rather than deterministic may be more functional and expedient.

5.3.3 Value added by quantitative methods

The second paper added value in terms of how topic knowledge and topic interest relate to readers’ attitudes towards socioscientific issues. More specifically, this paper aimed to investigate topic interest and topic knowledge as predictors of such attitudes, including the potential interaction between personal interest and topic knowledge. Multiple regression analysis was conducted to study how each independent variable included in the regression related to students’ attitudes. In sum, the quantitative regression analysis provided insight into how interest and knowledge predict students’ attitudes.

5.4 Paper III: Students’ justifications for document selection

A qualitative research interview aims to understand the world from the subjects’ viewpoint (Kvale & Brinkmann, 2009), and the method thus seemed suitable for the aim of the final paper in the thesis, namely, to assess participants’ justifications for selecting documents in task-oriented reading. Paper I used interview data to gain insight into the quantitative
findings. By contrast, the interview data was used in Paper III to provide an exhaustive account of students’ justifications of their document selections.

The coding and interpretation of interview data are of great importance when considering the quality and validity of the inferences being drawn. A detailed description of the coding process is provided in this paper. Due to space limitations, several reflections on the different stages of the coding process have been omitted. Hence, the current section focuses on the reflections and decisions made during the coding process, thereby increasing the methodological transparency of the study.

5.4.1 Thematic and content analysis

Thematic and content analysis are widely used in qualitative research and can be classified as descriptive approaches to data analysis that include meaning construction and categorizing as prominent features (Kvale, 2007; Braun & Clarke, 2006; Vaismoradi, Turunen, & Bondas, 2013; Madill & Gough, 2008). Additionally, coding meaning to text units and aggregating those codes into categories enables quantifying the frequency of specific themes and ascertaining the importance of a theme in a qualitative data set (Kvale, 2007). For the current study, the quantification facilitated the assessment of whether certain justifications for document selections were more frequently used than others. Notably, the study and the analysis are qualitative. Thus, the percentages reported in the paper are included to better illustrate the appearance of the evaluation criteria in the participants’ justifications and the variation in the use of evaluation criteria across topics.

Purposeful sampling

A purposeful sampling procedure was used to capture the variation of justifications in document selection (details of the sample procedure are described in Paper III). Twenty-five students were identified and selected to participate in the interview study, which is considered a satisfactory sample size, given the aim of the study and the practical issues regarding time and feasibility (Kvale, 2007).

Coding

Due to the lack of a one-way process of coding in qualitative analysis, the different coding steps were completed cyclically (Kvale, 2007). The coding cycles of the study are described in detail in Paper III, which includes a table showing examples of how students’ justifications
were coded. The description of the different coding cycles in the paper are transparent and should be replicable by other researchers. Thus, the following section will describe several of the decisions that were pertinent prior to and during the elementary coding process with reference to NVivo 10, as this software package was used to accomplish the first management of the interview data. For example, basic decisions were made regarding what should qualify as a theme and what “size” it should be and whether the analysis should provide a rich thematic description of the entire data set or a more detailed and nuanced account of a group of themes within the data (Boyatzis, 1998). The following description of the coding process in NVivo 10 explains the choices made concerning this and other issues.

Organizing the data. In this first step, the data were organized in a new project in NVivo. All audio files were imported, and 25 student cases were created. Several interviews had been transcribed outside NVivo and were therefore imported and linked to the correct audio file within the computer program. The remaining interviews were transcribed directly in NVivo.

Reading and make notes. After completing the transcription process, I read through all the transcripts to form an impression of the entire data set. After reading the interviews, I skimmed through all the interviews again and created memos for each interview case. A memo is a document for recording ideas, insights, interpretations and an evolving understanding of the data. Additionally, I created short summaries in the memos to make it easier and more time-efficient to return to an interview and capture the essence of its content without re-reading the entire interview.

Classifying data into codes and themes. Coding in NVivo involves connecting each meaning unit in the participants’ responses to a node. The node represents more than a name or a label; it is a way of connecting a theoretical concept or idea with passages of text that exemplify that idea (Gibbs, 2002). Thus, the nodes created in the coding process had definitions attached to them. This process can be conducted both within-case and across-case analysis in NVivo. The first approach seeks to understand each case separately to obtain a holistic understanding of each participant’s perspective, whereas the latter approach seeks common themes across cases. Both approaches were useful for the interview study. First, we coded the transcripts across-case, using the predefined nodes content relevance, source and topic knowledge. Consistent with the coding process described by Gibbs (2002), we connected these theoretical concepts to passages of texts that exemplified the current concepts (e.g., the following statement was coded source: [...] this is a source I believe I can trust because it is written by a professor). Second, we coded the transcripts within-case, which is a more detailed and fine-
grained coding of one transcript at the time. Here, the coding was expanded in terms of identifying nuances in participants’ verbalizations. For example, *source* contained considerations of the source’s credibility and was mentioned frequently by the participants. However, the data also contained explicit utterances related to the authors’ credentials and affiliations (as in the previous example), considerations of the author’s motive and whether the author was considered an expert in the current field and able to write a comprehensible text on the topic. These codes were organized into a hierarchy of codes, with “source” as the main category and “credentials and affiliations”, “motives” and “expertise and comprehensibility” as subcategories. Because we used *in vivo* codes, which are based on the participants’ own wording, we generated several codes that described identical concepts, as participants’ wording often differed when describing the same phenomena. As the coding process continued, the list of nodes grew, making the nodes difficult to manage. Hence, several free nodes were connected to each other, as they addressed similar meaning units in the participants’ utterances. To address this disorderly list of nodes, we started arranging the nodes hierarchically and clarifying their definitions. This step was conducted twice during the coding process. Organizing free nodes into hierarchal nodes is important for both data reduction and categorization in the analytical process. This stage of the analysis is used to test out interpretations of the data and is known as theoretical elaboration (Gibbs, 2002).

*Interpreting the data.* After reducing the codes into meaningful categories and broader themes, differences and similarities across the interviews were identified. We read through the interviews again, looking systematically for differences, similarities and patterns. This process was time-consuming, but memo links and annotations created during the coding were very helpful. We also used both the matrix coding query and the cluster analysis in NVivo frequently, as these functions allowed us to discover and visualize the data.

### 5.4.2 Interviewer effects and validity issues

Compared with quantitative research, the researcher in qualitative research is more accustomed to playing an intersubjective role in knowledge construction. When interviewing, the researcher is present and available to the participant and might consciously or unknowingly affect responses from the interviewees because of their theoretical predisposition. Furthermore, the interpretation and coding of the interview data might be noticeably affected by the researcher’s confirmation bias, which is a type of cognitive bias that refers to favoring information that confirms preexisting beliefs and opinions. Objectivity,
understood as freedom from bias, refers to whether knowledge is reliable (Kvale, 2007). In the current study, issues of reliability were addressed through dialogical intersubjectivity between the two authors involved in Paper III and intrarater reliability involving comparisons of coded transcripts after 1, 8 and 12 months (see Paper III for further detail).

Reactivity may arise when interpreting findings from the interview data. Here, an assumption is that people being observed or interviewed tend to behave differently or in accordance with what they believe the observer/interviewer wants, also known as the looping-effect (Hacking, 1995) or the Hawthorn-effect (McCarney, et al., 2007). In the current context, the interview questions might have guided students’ focus towards reflections they did not attend to when actually performing the reading task. This possibility is a shortcoming of delayed retrospective reporting, as the latter is more susceptible to post hoc rationalizations (see also Paper I, which addresses the same validity issue in relation to the qualitative part of that study) (Nisbett & Wilson, 1977), and of self-reported data that might reflect intentions rather than practices (McNamara, 2011). This threat to validity was mitigated by note-taking during the document selection task, as these notes served as contextual cues during the interviews.

5.4.3 Value added by qualitative orientations

Research interviews provide a unique opportunity to explore participants’ experiences and understanding of an issue through conversation and interaction (Kvale, 2007). Hence, the interview constitutes a powerful method of producing knowledge. The interview data in the current study added valuable insight into what the students attended to when selecting documents in task-oriented reading and why their evaluation criteria varied by the topic. For example, when given the opportunity to justify their strategies for document selection, the students provided responses ranging from brief answers with no reflection on the evaluation and selection process to elaborative answers demonstrating impressive insight into considerations of relevance, sources and production of knowledge claims. Hence, the interview data added pertinent nuances to students’ justifications for document selection that would otherwise have been remained hidden.

Triangulation of research methods

All research methods have distinguishing strengths and weaknesses that are generally related to an evaluation of pros and cons of the quality and overall value of the research. In the
previous section, I highlighted and discussed potential benefits and limitations of the three studies in the doctoral thesis. Despite their shortcomings, I believe that together, the studies contribute valuably to the investigation of the overall research aim of the thesis through the triangulation of research methods (see section 6, Discussion of main findings).

5.5 Ethical considerations

Regarding ethical considerations of the present thesis, the project was reported to the Norwegian Social Science Data Services (NSD), where it was evaluated for issues related to anonymity and the processing of sensitive information. Permission to conduct the research project without the need for notification was obtained. Consequently, all materials, texts and procedures were approved without suggestions for improvement. Given the age of the students (\(M = 17.4\)), the choice of topics were assumed to not be stigmatizing, and following the decision from NSD, informed consent for participation was obtained directly from the students. An additional informational letter about the study was also provided to the guardians. With respect to the protection of individuals’ rights, the students were informed about the right to decide whether to participate in the study and their right to withdraw from it at any time without an explanation.

When using qualitative data, the researcher must approach the issue of anonymization conscientiously in both data collection and analysis. Participants for the interviews were recruited after quantitative data collection and were identified by their respective classroom teachers based on student ID (five last digits in their phone number). The teachers contacted the current students and asked them to participate in a volunteer follow-up interview, and all the selected students agreed to participate. The teacher made appointments with the students and gave the list of appointments to me. Hence, I was not involved in identifying the students, and they remained anonymous to me throughout the process. Before the interviews, the teachers and I repeatedly communicated the voluntary nature of participation to the students. The students were also informed that they could withdraw from the interview at any time without consequences. Furthermore, the dataset was treated and coded to make identifying participants impossible. The objective of this approach was to report essential information from the responses, not identifying information.
6 Discussion

The underlying assumption of the doctoral thesis is that competent readers are characterized by not merely the ability to read and comprehend written information but additionally, to evaluate and select relevant documents in relation to a task or reading goal. This assumption was actualized through three distinct, yet related theoretical areas of investigation: evaluations of documents’ usefulness in task-oriented reading, multiple documents reading processes, and individual difference variables as sources of variation in document selection. These areas can be summarized through the overarching aim of the thesis:

To study what readers attend to when selecting documents in task-oriented reading of texts on socioscientific issues and the extent to which individual differences are related to readers’ selection behavior and attitudes towards such issues.

6.1 Summary of main findings

Theoretically, it is acknowledged that purposeful interaction with complex documents requires different processing steps. Individual differences are known to be significant for facilitating this processing, yet their precise role is unknown. Together, the papers in this thesis have provided an empirical contribution to this theoretical perspective by offering insight into document selection processes, individual differences in these selections, and individuals’ justifications for their selective reading behavior. By combining a focus on both text features and individual differences, the thesis reinforces the importance of understanding and assessing this relationship, as what individuals bring to the reading task seems to be decisive for how and what they read. The main findings of the papers can be summarized in four points:

1. In general, the students evaluated both content relevance and author expertise when judging the usefulness of documents. However, the degree to which students valued author expertise differed between the topics. This variation in students’ evaluations and document selections seemed to depend on context and students’ familiarity with the topics (cf. research question 1, Paper I). To explain this difference, qualitative findings revealed that scientists were assumed as more capable of making correct scientific assertions than lower-expertise authors (journalists). Accordingly, when more familiar with the topic, students relied less on author expertise (cf. research
question 2, Paper I). Together, the data sets suggested that topic familiarity moderates the salience of author expertise, but not content relevance.

2. Individuals’ attitudes towards debated issues are assumed to affect how they evaluate information about such issues. Cognitive and motivational factors were found to predict students’ attitudes towards the topics, with the extent of predictability varying between the topics. For example, topic knowledge was a better predictor of attitudes towards nuclear power, whereas topic interest was a better predictor of attitudes towards climate change. Furthermore, students’ personal interest and topic knowledge interacted, with the relationship between interest and attitude depending on the level of topic knowledge (cf. research questions in Paper II). The findings highlight the context-specificity of individual reader variables involved in attitude formation. Specifically, the findings suggest that both cognitive and affective-motivational traits are important for assessing readers’ attitudes and consequently, the documents students choose to read.

3. When prompted to justify their document selections, the students reflected on several different aspects related to content relevance, source features and prior topic knowledge (cf. research question 1, Paper III).

4. Although similar evaluation criteria for the document selection were used for both topics, differences in some coding categories arose and were ascribed to variations in the reading context and topics. For example, the interview data indicated that students selected documents supporting their need for knowledge on the nuclear power topic, whereas for climate change, they selected documents that confirmed what they already knew (confirming findings from Paper I). This selection and justification pattern might be based on the perceived awareness of text comprehensibility and the level of students’ prior knowledge. Specifically, the students demonstrated increased trust in their decisions and a decreased need to consult an expert on climate change, whereas the opposite was found for the nuclear power topic (cf. research question 2, Paper III).

The Documents Model and the MD-TRACE framework were used in Chapter 2 to describe the processes involved in task-oriented reading with multiple documents. Of particular relevance to the current thesis are readers’ evaluation and integration of content and source features and the decision-based nature of reading, including the importance of individual
differences in these decision processes (Britt, Rouet, & Durik, 2018a). Combining findings from the three papers in the thesis might contribute an understanding of how and to what extent readers attend to content and source evaluations in the document selection process and how individual differences interfere with such evaluations.

To select a set of documents that provides a variety of viewpoints and perspectives, students should attend to both content and source evaluations when selecting documents and use source features to judge whether content should be emphasized or questioned (Britt et al., 1999; Brante & Strømsø, 2017). The document selection data (Paper I) and justifications for the selections (Paper III) support the assumption that participants evaluate source features and content relevance as two distinct, yet related constructs. Although several participants undertook both types of evaluations when determining documents’ usefulness, some students tended to engage in either content evaluations or evaluations of source features. Previous reading experiences may have taught the participants that content relevance and author expertise can be easily evaluated separately, consistent with the findings of Paul and colleagues (2017). In that study, students embedded in two different educational systems (France and Germany) demonstrated source knowledge and awareness of the potential benefits of sourcing. However, the students did not apply their sourcing knowledge unless the reading condition explicitly instructed them to do so (Paul, et al., 2017). When asked why they otherwise refrained from applying this knowledge, the students provided answers that resemble the patterns for document selection and the justifications for the selections in the current thesis. For example, the focus on content relevance seems linked to default reading strategies, with attention to source information first arising from a direct prompt, whether intrinsically or externally motivated, or when lacking knowledge and familiarity with the current topic. However, failing to consider both concepts when deciding the usefulness of documents might indicate incomplete processing. For example, selecting presumably relevant documents not written by trustworthy authors might impose an extra challenge on the reader in terms of performing validity judgments of the content presented. Conversely, selecting documents based exclusively on evaluations of author expertise might generate an incoherent set of documents. That is, selecting documents based on evaluating author expertise might be a superficial strategy for judging validity claims across multiple documents. However, considering the text material used in the current thesis, which consisted of three sentences describing the content accompanied by a clearly displayed line of source information, evaluations of both content and source features might have been facilitated to a greater extent.
than if text materials consisting of full-version documents had been used. Thus, the high frequency of content and source evaluations might have been due to a lower cognitive load as a function of small amounts of text in each document. On the other hand, it might be unrealistic to expect that all participants would evaluate both content and source features in the current, fictive reading and research setting. For example, Britt and colleagues (1999) assumed that readers do not create mental representations of both content and source features in every reading situation they encounter. Instead, readers might create so-called *mush models* where only content information is made conscious, particularly if no prompt is provided to attend to sources (Kammerer, Meier, & Stahl, 2016; Britt et al., 1999) or if readers are not motivated to do so (Paul et al., 2017). Given the findings on differences in the evaluations of content relevance or source features based on topic, an emphasis on content relevance when selecting documents on climate change might result from overinvesting in prior knowledge, which can compromise the evaluations of source features and the links between the content and the source (“who says what”).

The interview data in Paper III suggest that certain students used their current knowledge to validate the knowledge claims advanced by the different documents used in the study. Existing knowledge was used as a criterion for selecting documents, and evaluations of the content was a distinguishing feature. Similarly, the interview data showed that students also acknowledged their lack of knowledge on the least familiar topic, making evaluations of source features more important when deciding which documents to select and include in the task solution. Given the rapidly changing nature of information in the knowledge society, it is profoundly important that readers can acknowledge the boundaries of their preexisting knowledge schema, thereby reducing reliance on their own knowledge and increasing reliance on textual information when necessary (Kendeou & O'Brien, 2016). Additionally, individual interest might be considered a powerful reader variable, potentially guiding reading strategies when reading multiple documents and defining how readers approach the documents (Britt, Rouet, & Durik, 2018b). The findings reported in Paper II show that students’ personal interest and engagement differed for the two socioscientific topics, which bears implications for the role of prior knowledge in evaluating documents and knowledge claims presented in the documents. For example, greater interest in a topic can increase the reliance on subjective judgments of the presented content, echoing the findings of Scharrer and colleagues (2012; 2014). Consequently, interest and engagement in a topic can “replace” and be considered more important than actual knowledge in evaluating socioscientific information.
Both the DMF and the MD-TRACE model lack so-called warm perspectives, meaning how individuals affectively engage in the processing of multiple documents (List and Alexander, 2018). Paper II offers useful perspectives in this regard by focusing on students’ attitudes towards the topics, how these attitudes might be predicted by readers’ topic knowledge and interest, and how differences in personal engagement with topics involves different mechanisms in attitude formation. Given students’ document selections and justifications based on prior knowledge or interest (Paper I and III), students should be taught to adjust their attitudes regarding controversially debated issues towards scientific evidence, as personal convictions might affect reading behavior and what is learned from the texts. An indication of the ability to assess information at odds with preexisting attitudes might be selecting documents representing diverse perspectives, as highlighted in the preceding paragraph. As demonstrated by the findings discussed in Paper III, several participants showed an ability to include multiple perspectives on both topics, particularly on the topic with which they seemed less familiar (nuclear power). If considering reading as a problem-solving and purposeful activity (Britt, Rouet, & Durik, 2018b), this finding can be interpreted as highly promising in terms of readers’ flexibility in processing different kinds of texts in order to solve a reading task.

### 6.2 Educational implications

Using multiple documents to solve a task is a complex reading activity that requires basic reading processes necessary to comprehend single pieces of information and additional processes such as evaluating and selecting relevant and trustworthy information amid an overwhelming volume of written artifacts. Hence, this aspect of reading competence merits greater attention in the classroom and might improve students’ reading comprehension of multiple documents (Wiley, et al., 2009; Sparks & Rapp, 2011; Braasch, et al., 2013; Mason, et al., 2014). For example, in an intervention study targeting secondary school students’ source evaluation strategies, a “contrasting-cases” intervention of only 60 minutes produced promising results concerning the promotion of source feature considerations (Braasch et al, 2013). After the intervention, the participants were instructed to compare and contrast two fictive students’ reading strategies to distinguish what good readers do differently from less sophisticated readers when reading to learn from information retrieved from the Internet. The results suggested that participating students included scientific concepts from more useful documents to a greater extent than did fellow students who received typical classroom
instructions. Moreover, the participants offered more critical evaluations of the source features and considered the trustworthiness of the sources more often than did the control students (Braasch, et al, 2013). Relatedly, a short-term instructional intervention by Mason and colleagues (2014) showed that students in the intervention condition outperformed the other students by demonstrating more appropriate navigation behavior, greater source evaluation, and deeper comprehension of the accessed information. These short intervention-studies suggest that increasing students’ awareness and prompting reading strategies when working with multiple documents might help students strike an adaptive balance between evaluations of author expertise and content relevance and adapt a critical stance in this evaluation process. When students select and integrate information from various documents, it is furthermore crucial that they discern the reliability and validity of the information contained in the documents. This discernment can affect the basis of their understanding of a topic and their metacognitive judgments of whether greater effort is required to develop their understanding and if so, what documents to access and how to evaluate them. However, before students can engage in effortful document evaluations strategies, they should be taught why these reading strategies are crucial for reading in the 21st century. They should also experience the distinctive value of these strategies analogously to that of other basic skills outlined in the national curriculum (Norwegian Ministry of Education and Research, 2012).

Finally, the easy access to and overload of information provided by electronic information technologies might bear implications for the role of the teacher and require a redefinition of knowledge. Some researchers argue that the primary aim of teaching is no longer knowledge transmission, but rather, teaching students how to construct their own knowledge, search and process information and combine this information with their prior knowledge (Brand-Gruwel, Wopereis, & Vermetten, 2005). From this perspective, constructing meaning from different texts implies a view of knowledge as compound and dynamic rather than procedural and universally applicable. Hence, well-justified document selections are pivotal.

*Theoretically important or practically relevant?*

In educational research, the transfer value from theoretically important processes and concepts to practical relevance is a recurring and common discussion, and reading research is no exception. For example, it is theoretically assumed that attending to source information and establishing connections between source and documents are core processes in reading with multiple documents. Additionally, findings from empirical studies suggest that students
possess knowledge on both how to source and how sourcing can benefit the reading process (Rouet, et al., 2011; Stadtler, et al., 2015; Paul et al., 2017). Importantly, empirical studies also demonstrate that students often fail to apply source evaluations when completing reading tasks with multiple documents (e.g., Stromsø, et al., 2013; Britt & Aglinskas, 2002; Braasch, et al., 2013). Source evaluations do not seem to be a default strategy used by readers when encountering texts. Without specific prompts or external incentives, readers appear to forgo evaluations of source information, despite knowing how and the benefits of doing so. Studies indicate that theoretically important reading activities such as “sourcing” seldom occur in practice. Based on previous and current findings, the answer might be multifaceted and consider how readers create representations of the reading context through tasks and requests and how individual reader differences affect reading processes. Hence, any theory of reading aiming to have transfer value for addressing the rapidly changing and volatile attention span of reading situations that characterize the contemporary information society, should consider readers’ interpretations of tasks, as these interpretations will direct what individuals do and attend to when reading.

6.3 Limitations and future directions

In addition to several methodological concerns addressed in the previous chapter, some limitations of the current research and future directions are noteworthy. First, the theoretical framework used to account for the reading processes involved in multiple documents reading is limited in several aspects. The MD-TRACE model fails to represent decisions as more tentative than “yes” or “no”, for example, decisions regarding relevance. In real life, we are often faced with documents containing both relevant and irrelevant information. Depending on our reading goal, we must deliberately locate and select the information we require and omit information not useful to us. Clearly, deciding whether a document is relevant might not involve a dichotomous decision process, as indicated in contrast by the theoretical MD-TRACE framework. Furthermore, the processing steps in the model are represented too linearly and do not consider how reading goals, strategies and effort may change when encountering new resources and text material during the reading process (Britt, Rouet, & Durik, 2018b). Finally, the model fails to directly address reading situations in which the reader encounters obstacles. The Reading as Problem SOLVing model (RESOLV) of reading comprehension was developed partly to extend the MD-TRACE model (Britt, Rouet, & Durik, 2018b) and address the abovementioned limitations of this model. Future studies might
draw more extensively on this reading comprehension framework to obtain an improved approximation to reading situations characterized by problem-solving and purposeful reading activities in real life.

Second, what and how people read are strongly influenced by contextual factors, with the interpretation of the task being a critical determinant of the comprehension of multiple documents (Britt, Rouet, & Durik, 2018b; Wiley, Jaeger, & Griffin, 2018). Theoretically, when presented with specific task instructions, readers use the instructions to define their reading goals to a greater extent than if the task instructions were more general (McCrudden, Magliano, & Schraw, 2010). With specific instructions, the reading goal is narrowed, which might result in spending less time reading irrelevant information (McCrudden, et al., 2010; McCrudden & Schraw, 2010) and improved memory of task-relevant information (Anmarkrud, et al., 2013). The task instructions in the thesis were developed to comply with specific instructions, the assumption being that students would develop somewhat similar reading goals. However, without measures of students’ interpretations of the task instructions, it can be assumed neither that students perceived the instructions identically nor that they developed identical reading goals. In fact, students’ document selection patterns and justifications suggest that a range of factors affected evaluations of both content relevance and source features, possibly indicating different constructions of task models and reading goals. Thus, future studies should assess and compare how readers form their task models, as this formation might result in either surface-level or deep-level processing of a document and affect the ability to take appropriate actions to complete a task. Based on the findings of the current study, readers’ different task models appear to be mediated by not only task instructions, context, and the depth of processing but also differences in background knowledge, interest and attitudes concerning the topics.

Third, the current research is likely not capturing the variance of individual variables that might have affected students’ evaluations and selection processes. Notwithstanding that other individual difference variables could shed additional light on the reading processes investigated in the thesis (e.g., working memory, epistemological beliefs, self-efficacy), the inclusion of the current cognitive, motivational and affective variables seems well founded (see section 3.1 and 5.1). Additionally, the coding of qualitative data undeniably was limited by the concepts of interest that were established as a starting point for the doctoral study.
Fourth, in a review of interventions targeting sourcing skills in text comprehension, Brante and Strømsø (2017) found that most studies did not explicitly address motivational aspects. Additionally, List and Alexander (2017a) developed CAEM as a response to the lack of attention to motivational and affective variables in models describing the processes involved in the reading with multiple documents. Given the participants’ low to average scores on the two interest-measures and the nature of the task and the context (a fictive task in a research-context), it seems reasonable to question participants’ motivation for engaging in the current reading tasks. For example, some students stated that they only attended to source information if their teacher told them to do so or if their academic work was graded, indicating a dependence on extrinsic motivation. Given the potentially large influence of the reading context on task engagement, it would have been useful to include a measure of the students’ task interpretations and strive to create reading contexts in which students are motivated to participate. How readers understand externally prompted reading instructions and how they establish goals to comply with these instructions are underresearched facets of the reading process and should be addressed in future studies (McCrudden, Magliano, & Schraw, 2011). Given this theoretical recognition of motivation as substantially influencing reading behavior and the implications based on the current empirical material, future studies should include motivation variables to a greater extent. Assessments of the function of motivational and affective reader variables when interpreting reading instructions and forming relevant goals should also be more thoroughly investigated.
References


Bråten, I., Ferguson, L. E., Anmarkrud, Ø., Strømsø, H. I., & Brandmo, C. (2014). Modeling relations between students' justification for knowing beliefs in science, motivation for


Stadtler, M., Babiel, S., Rouet, J.-F., & Bromme, R. (2014, April). Ninth-grade students possess good sourcing skills, but do not apply them spontaneously while reading. Philadelphia, USA.


Appendices

Appendix I: Information and consent letter

Department of Teacher Education and School Research
PB 1099, Blindern
N-0317 Oslo

Visiting address:
Sem Sælandsvei 4, Fysikkbygningen, 2. et.
Department, tlf: + 47 22 84 44 75
UV faculty, student information, tlf: + 47 22 84 44 45

Reading of science texts

We are contacting you in relation to a research project about reading that is happening at your school. Researchers from the Department of Teacher Education and School Research and Department of Educational Research at the University of Oslo are carrying out the project.

The main goal of the project is to look at how students in upper-secondary school read science texts. Students often meet several different sources of information in their day-to-day lives, both at school and in other contexts. For example, many students use both textbooks and different Internet sites for schoolwork. Reading texts from several sources can be challenging for many students when they try to gain an integrated understanding of what the texts are about. At the same time, reading several texts on the same topic might be positive as students have the opportunity to get a deeper understanding of the topic.

The study will look at several aspects that can influence how students work with texts. As well as reading texts on a computer screen, participants will answer some questions before and after reading. Students’ names or other personal information will not be registered. It will not be possible to identify who answers what, and the results will only be used for research purposes. It is our hope that the results can contribute to gaining a better understanding of students’ reading habits and ways of working in upper-secondary school.

The study will take place within one class period. We hope that you would like to participate in this important project, and we ask that both you and your guardian sign the attached consent form.

The project is registered with the data protection agency for research, Norwegian Social Science Data Services. Participation is voluntary and it will be possible to withdraw from the project at any time, without having to provide a reason for this. The researchers that are involved in the project have a duty of confidentiality and all data will remain confidential.
You are welcome to contact the sender of this letter if you have any questions about the research project.

Best regards,

Tonje Stenseth (Ph.D student), Department of Teacher Education and School Research, University of Oslo.

tonje.stenseth@ils.uio.no

40 45 59 62

Participation in research project: Reading of science texts in upper-secondary school

Pupil’s name

☐ The above person consents to participating in the project

Date          Place

Pupil’s signature

Guardian’s signature

Please return this response sheet to your teacher.
Appendix II: Demographics questionnaire

Some questions about you

1. Gender:
   Male ☐    Female ☐

2. Age (in whole years): ____________ years

3. Which language did your parents use when talking to you during your childhood?
   Norwegian ☐    Other language ☐
   If you answered «other language»: Which other language did they speak?
   ____________________

4. Which programme area do you attend within specialization in general studies?
   ☐ Natural sciences
   ☐ Language, social sciences and economics

5. What was your final grade in science class last summer?
   6 ☐  5 ☐  4 ☐  3 ☐  2 ☐  1 ☐
Appendix III: Topic interest measure, nuclear power

With the aid of the following statements we wish to learn about your level of interest and engagement in energy issues. If you think that the statement is very true for you, draw a circle around 10. If the statement is not at all true for you, circle 1. If the statement is more or less true for you, circle the number between 1 and 10 that best describes your interest and engagement.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Not at all true</th>
<th>Very true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I’m interested in energy policy................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I’m interested in issues concerning the safety of nuclear power plants ...................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I think that more people should become actively involved in efforts to develop alternative forms of energy...............</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I participate in discussions on the use of nuclear power plants ..................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I’m interested in conditions that influence how safe it is to use nuclear power plants .................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I can imagine being a member of an organization working with issues concerning the use of nuclear power..................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The safety of nuclear power is of interest to me..............</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I’m concerned with how I can influence energy policy ........</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I try to convince others that the use of nuclear power plants can involve a risk ........................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I’m interested in issues concerning nuclear power ..........</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I support organizations working to get rid of nuclear power plants ..........................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I like to keep updated on issues concerning nuclear power plants ...........................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
Appendix IV: Topic interest measure, climate change

With the following statements we want to know to what extent you are interested and engaged in natural and environmental issues. If you think the statement is very true of you, circle 10; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, circle the number between 1 and 10 that best describes your interest and engagement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all true</th>
<th>Very true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am interested in international environmental policy....................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>2. I am interested in issues concerning the earth’s climate..............</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>3. I think that more people should be actively engaged in protecting the environment....................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>4. I participate in discussions about natural and environmental issues....................................................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>5. I am interested in what conditions influence the earth’s climate....................................................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>6. I can imagine being a member of an organization that works with natural and environmental issues........................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>7. Global warming is a topic that interests me...................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>8. I am concerned with how I myself can contribute to the reduction of environmental pollution..............................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>9. I try to convince others that we must reduce the discharges of climate gases.................................................................</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>10.</td>
<td>I am interested in issues concerning air pollution..................</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I support organizations that work to reduce global warming....</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>I like to keep myself updated on issues concerning climate change........................................................................................................</td>
<td></td>
</tr>
</tbody>
</table>
Appendix V: Topic knowledge measure, nuclear power

Below you will find some tasks with different statements about nuclear power. Put a cross next to the statement that you think is correct in each case.

Use only one cross for each task.

1. **Uranium is…**
   - a radioactive carbon material
   - a chemical compound
   - a gaseous element
   - a radioactive element

2. **Nuclear fission is …**
   - merging of atomic nuclei
   - enrichment of heavy water
   - splitting of uranium
   - merging of radium and uranium

3. **Radioactive waste from nuclear power plants is …**
   - spent radon
   - spent uranium fuel
   - spent bio-fuel
   - spent nuclear power

4. **An accident in a nuclear power plant can occur when …**
   - the core of a nuclear reactor melts
   - the nuclear reactor cools down
   - there is too little uranium fuel
   - radium and uranium merge too quickly

5. **The responsibility for ensuring that nuclear power is used for peaceful purposes is held by …**
   - The OECD’s Atomic Energy Institute
   - The International Atomic Energy Agency
   - The UN Panel on Climate Change
   - The International Renewable Energy Agency

6. **Radioactivity is measured in …**
   - Amperes
   - Ohms
   - Parsecs
   - Becquerels

7. **Nuclear power is …**
   - the power stored in the center of atoms
   - conversion of heavy water to atomic nuclei
   - energy liberated by the transformation of atomic nuclei
   - energy generated when uranium is dissolved in heavy water
8. **Radioactive waste must be stored safely for …**
- at least 600 years
- at least 50 years
- at least 300 years
- at least 100 years

9. **A radioactive element …**
- has unstable atomic nuclei
- has stable atomic nuclei
- is among the lightest elements
- emits visible radiation

10. **In 2011, the largest accident at a nuclear power plant since Chernobyl occurred in …**
- Russia
- USA
- Japan
- Brazil

11. **Radioactive radiation …**
- is emitted by electrochemical cells
- is emitted by carbon atoms
- is emitted by natural iodine nuclei
- is emitted by atomic nuclei

12. **Nuclear power plants produce …**
- bio-energy
- coal energy
- electrical energy
- hydro-energy

13. **The safest way to store radioactive waste is …**
- to freeze it to -1000 °C
- to store it deep inside rock
- to deposit it in the ocean at a depth of several thousand meters
- to insulate it with the aid of nano-materials

14. **Radioactivity occurs …**
- naturally in soil and air
- only in nuclear power plants
- in heavy water
- in all of the elements

15. **The most dangerous type of radioactive radiation is …**
- gamma radiation
- beta radiation
- omega radiation
- alpha radiation
Appendix VI: Topic knowledge measure, climate change

Below are some tasks with different statements about central topics concerning natural and environmental issues. Please circle the statement that you believe is correct in each task.

1. The Kyoto Protocol deals with
   a) trade agreements between rich and poor countries
   b) reduction in the discharge of climate gases
   c) the pollution of the Pacific Ocean
   d) protection of the ozone layer
   e) limitations on international whaling

2. The greenhouse effect is due to
   a) holes in the ozone layer
   b) increased use of nuclear energy
   c) increased occurrence of acidic precipitation
   d) streams of heat that do not get out of the atmosphere
   e) the pollution of the oceans

3. Mankind’s discharges of carbon dioxide (CO₂) are due to the use of
   a) propellants (chlorofluorocarbon) in spray cans
   b) fertilizers in farming
   c) phosphatic detergents
   d) fossil fuels
   e) atomic energy

4. Research indicates that the earth’s average temperature
   a) has risen by more than 5 °C in the last 100 years
   b) has risen by more than 5 °C in the last 10 years
   c) has risen by less than 1 °C in the last 100 years
   d) has risen by more than 10 °C in the last 100 years
   e) is in the process of becoming stabilized

5. Some of the most important climate gases are
   a) chlorine and hydrogen
   b) oxygen and propane
   c) nitrogen oxides and butane
   d) propellants and aerosols
   e) water vapour and laughing-gas
6. The earth’s climate has changed
   a) due to astronomical conditions
   b) due to changes in the earth’s circumference at the equator
   c) primarily due to increased discharges of ozone gas
   d) due to reduced discharges of ozone gas
   e) because the ocean currents have increased in intensity

7. The concentration of carbon dioxide (CO\textsubscript{2}) in the atmosphere
   a) varies between high and low degrees of longitude
   b) varies very little from place to place
   c) is greatest in industrialized parts of the world
   d) is greatest in the polar regions
   e) varies a lot from place to place

8. The greenhouse effect is
   a) primarily a natural process
   b) manmade
   c) a relatively new phenomenon
   d) greatest in the stratosphere
   e) strongest in industrialized parts of the world

9. Global climate change can
   a) lead to a lowering of ocean levels
   b) lead to less extreme weather on the entire earth
   c) influence ocean currents
   d) lead to increased volcanic activity
   e) lead to more solar energy escaping from the atmosphere

10. Climate gases
    a) do not occur naturally in the atmosphere
    b) are necessary for much of the life on the earth
    c) did not exist in pre-industrial times
    d) are exclusively synthetic combinations
    e) can cause legionnaires’ disease

11. Mankind’s discharges of carbon dioxide (CO\textsubscript{2})
    a) can lead to an increase in the ozone layer
    b) are substantially reduced through international environmental initiatives
    c) are necessary for the life on the earth
    d) can change the heat balance of the earth
    e) introduce into the atmosphere the largest part of the climate gases
12. The Kyoto Protocol is
   a) a binding agreement between USA and EU
   b) a binding agreement managed by the World Trade Organization (WTO)
   c) a binding international agreement managed by the UN
   d) still not ratified by a sufficient number of countries
   e) an important agreement about the storing of radioactive waste

13. Human activities
   a) form the basis of the greenhouse effect
   b) strengthen the greenhouse effect
   c) have increased the amount of ozone in the ozone layer
   d) have made the earth resemble a greenhouse
   e) can influence the radiation from the sun

14. The earth’s average temperature increases
   a) because of a rise in temperature in the core of the earth
   b) because of changes in the moon’s reflection of the sunlight
   c) because of less clouds in the atmosphere
   d) because of increased discharges of climate gases
   e) because the radiation of heat from the sun penetrates more easily down to the surface of the earth

15. The greenhouse effect is strengthened by
   a) increased use of fossil fuels
   b) radiation of heat from the sun
   c) holes in the ozone layer
   d) increased planting in tropical regions
   e) more growth of gene modified plants
Appendix VII: Task instructions

Instructions – nuclear power plants

The safety of nuclear power plants is a current and widely discussed topic. Nuclear power plants produce energy by splitting uranium. Uranium is a radioactive element, and in addition to energy, nuclear power plants produce radioactive waste. Today, it is being discussed whether nuclear power plants are a safe method for producing energy, or whether the risk of accidents and problems associated with radioactive waste indicate that nuclear power plants should be shut down.

Imagine that you will hold a presentation to your class on this topic. We have found 20 web pages. On the 20 cards in this envelope we have given the name of the author and a summary of the content of each web page.

Read the text on each card. Remember that each card refers to a web page with more information. Select the web pages you want to read carefully to prepare your presentation. State the reason on each card that you select, and put it in the colored envelope. You can select as many cards as you want.

Instructions – climate change

Climate change is a current and widely discussed topic. The Earth’s climate has changed through the ages. Climate change can have natural causes, such as variations in the strength of the sun, changes in the Earth’s orbit around the sun, and volcanic eruptions. Today, there is a discussion about the extent to which humans themselves contribute to such climate change.

Imagine that you will hold a presentation to your class on this topic. We have found 20 web pages. On the 20 cards in this envelope we have given the name of the author and a summary of the content of each web page.

Read the text on each card. Remember that each card refers to a web page with more information. Select the web pages you want to read carefully to prepare your presentation. State the reason on each card that you select, and put it in the colored envelope. You can select as many cards as you want.
Appendix VIII: Card selection materials

Author:
Professor Svein Strand, Faculty of Natural Sciences, University of Agder.

Content:
When we use oil, CO$_2$ is generated. This is a greenhouse gas. Many think that an increase in CO$_2$ causes global warming.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Professor Thomas Solberg, Faculty of Natural Sciences, University of Stavanger

Content:
When plankton decomposes, oil is formed. Plankton are small organisms that live in the sea. Some plankton are luminous at night.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

<table>
<thead>
<tr>
<th>Author:</th>
<th>Professor Kari Lunde, Faculty of Natural Sciences, University of Stavanger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content:</td>
<td>The sun has a surface temperature of approx. 6000 °C. Without the sun, the Earth would be uninhabitable. Even small changes in the sun’s radiation will influence the climate.</td>
</tr>
</tbody>
</table>

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

<table>
<thead>
<tr>
<th>Author:</th>
<th>Professor Katrine Amundsen, Faculty of Natural Sciences, University of Agder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content:</td>
<td>The sun is at least 4.5 billion years and approximately halfway through its lifespan. It is a gas sphere with no solid surface. The sun is the largest body in our solar system.</td>
</tr>
</tbody>
</table>

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Some of the gases in the atmosphere are called climate gases. The most important are water vapour, carbon dioxide, and methane. The climate gases affect the Earth’s temperature.

The atmosphere is the layer of air surrounding the Earth. It has no defined upper boundary. High up in the atmosphere, air pressure is very low.
Heat from the sun penetrates the atmosphere. Most of this heat cannot escape out again. This creates a greenhouse effect.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Modern greenhouses are often made of iron or aluminium and glass. In some cases, plastic is used instead of glass. In nearly half of the greenhouses, houseplants are grown.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Author:
Professor Ole Martinsen, Faculty of Natural Sciences, University of Tromsø

Content:
The temperature at the North Pole is rising faster than anywhere else on the planet. The ice is melting more rapidly than before. This leads to a higher sea level.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Professor Frode Knutsen, Faculty of Natural Sciences, University of Trondheim (NTNU)

Content:
The ocean surrounding the North Pole is called the Arctic Ocean. It is one of the world’s five oceans. Parts of the Arctic Ocean belong to Norway.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

76
Coal, oil, and gas have been stored in the ground for millions of years. When they are extracted and burned, the CO₂ level in the atmosphere rises. CO₂ is an important climate gas.

Coal is a type of rock formed by remnants of plants. In Norway there is little coal. Today, we have only one coal mine in operation on Svalbard.
Can climate change cause more hurricanes? Climate researchers are trying to answer this question. A larger number of strong and devastating hurricanes may possibly occur.

Author: Professor Linda Bakke, Faculty of Natural Sciences, University of Trondheim (NTNU)

Content:
The term “hurricane” stems from a South American deity: Huracan. In the Indian Ocean such winds are called cyclones. In 1979 it was decided to give hurricanes a woman’s or a man’s name.

Briefly state your reason why you want to read this web page carefully:
Storage of CO\textsubscript{2} under the seabed began in the 1990s. Such a technology can reduce climate gas emissions. This can counteract global warming.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

70% of the Earth’s surface is covered by oceans. The Pacific is the world’s deepest ocean. At depths beyond 3,000 meters, the temperature is below 3\degree C.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Author: Professor Anders Kristoffersen, Faculty of Natural Sciences, University of Bergen

Content:
Much carbon is stored in the rainforest. By preserving the rainforest, we can prevent liberation of CO$_2$. This may effectively prevent global warming.

Briefly state your reason why you want to read this web page carefully:
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author: Professor Inger Rasmussen, Faculty of Natural Sciences, University of Bergen

Content:
The rainforest grows near the equator. All rainforests are home to indigenous peoples. More than 50% of all the world’s species of plants and animals live in the rainforests.

Briefly state your reason why you want to read this web page carefully:
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

80
The UN Climate Convention is an agreement on climate gas emissions. The goal is to reduce global warming. The agreement places a special responsibility on rich countries.

The UN was established in 1945. Its first leader was Trygve Lie from Norway. The UN headquarters is located in New York.
Author: 
Professor Geir Johnsen, Faculty of Natural Sciences, University of Agder

Content: 
Several accidents have occurred in nuclear power plants. The worst accident happened in Chernobyl, Ukraine, in 1986. Several hundred people perished.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author: 
Professor Rune Pettersen, Faculty of Natural Sciences, University of Stavanger

Content: 
Ukraine derives energy from nuclear power, hydropower, and fossil fuels. Ukraine is Europe’s second largest country. Its capital city is Kiev.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

82
Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Professor Hilde Dahl, Faculty of Natural Sciences, University of Stavanger

Content:
In nuclear power plants, uranium is split. If this splitting gets out of control, an explosion may occur. Harmful radioactive dust may then spread to the environment.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Professor Hege Jørgensen, Faculty of Natural Sciences, University of Agder

Content:
Natural radioactivity was discovered in 1896. The discoverer was French and called Henri Becquerel. Today, the unit of measurement for radioactive radiation is called “becquerel”.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Author:
Journalist Per Haugen, News Section, NRK TV

Content:
Earthquakes can damage nuclear power plants. If the earthquake destroys the supply of electricity, overheating can occur. This can cause a meltdown of uranium.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Journalist Morten Hagen, News Section, NRK Radio

Content:
Earthquakes are measured on the Richter scale. They occur because of movements in the Earth’s crust. An earthquake in China in 1556 is considered to be the worst natural disaster ever.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Author:
Journalist Hilde Jakobsen, News Section, NRK Radio

Content:
Construction of nuclear power plants must comply with international agreements on safety. The International Atomic Energy Agency is responsible for inspections of nuclear power plants. This is intended to prevent serious accidents.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Journalist Nina Sørensen, News Section, NRK TV

Content:
The International Atomic Energy Agency was established in 1957. It is an independent organization with its headquarter in Vienna. The agency’s first two leaders were Swedish.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Author:  
Professor Bjørn Eriksen, Faculty of Natural Sciences, University of Tromsø  

Content:  
New technology makes nuclear power plants safer. Now, nuclear power plants that will shut down by themselves no matter what goes wrong are being built. Such power plants are under construction in China and Finland.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:  
Professor Lars Berg, Faculty of Natural Sciences, University of Trondheim (NTNU)  

Content:  
China is now the world’s largest manufacturer of industrial goods. Much of the technology stems from foreign enterprises. The Chinese are now making great efforts to develop new technology themselves.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Radioactive waste is a problem. The waste represents a serious health risk if not stored properly. The waste consists of spent uranium fuel.

Increased household spending leads to more waste. In 2011, every Norwegian produced an average of 438 kg household waste. Most of it is recycled for environmental reasons.
Author:
Professor Anita Lund, Faculty of Natural Sciences, University of Trondheim (NTNU)

Content:
Some radioactive waste can remain dangerous for 100,000 years. Such waste must therefore be stored under safe conditions, for example in mine shafts or in specially constructed tunnels. Good storage sites are hard to find.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Author:
Professor Monica Henriksen, Faculty of Natural Sciences, University of Tromsø

Content:
Electronic waste must not be deposited with other waste. This is because electronic waste contains materials that are harmful to our health and environment. The EU has decided that electronics manufacturers must take back this waste.

Briefly state your reason why you want to read this web page carefully:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Many countries want to close down their nuclear power plants. When nuclear power plants are demolished, much radioactive waste must be cleared. This is a difficult and hazardous job.

Author:
Journalist Kristin Iversen, News Section, TV2.no

Content:
Asbestos was previously used in construction materials. When old houses are demolished, much hazardous asbestos must be cleared. Working with asbestos requires protective equipment.

Author:
Journalist Tone Moen, News Section, TV2
Author: 
Professor Jan Karlsen, Faculty of Natural Sciences, University of Bergen

Content: 
The nuclear power plants of the future will produce less radioactive waste. This is because the waste can be used over and over again as fuel. Thereby, the problem of safe long-term storage can be solved.

Briefly state your reason why you want to read this web page carefully:

Author: 
Professor Anne Halvorsen, Faculty of Natural Sciences, University of Bergen

Content: 
In the future, wood will play a more important role as a fuel in Norway. Wood fuel includes, for example, firewood, bark, sawdust and pellets. Ashes from wood fuel can be reused as fertilizer.

Briefly state your reason why you want to read this web page carefully:
Author: Journalist Marianne Gundersen, News Section, NRK.no
Content: Sellafield is a recycling facility for radioactive waste. The facility is located on the coast of Great Britain. In Norway, there are concerns that the old tanks in which the waste is stored are insufficiently safe.

Briefly state your reason why you want to read this web page carefully:

Author: Journalist Trond Johannessen, News Department, NRK.no
Content: From 2001 to 2010 Great Britain reduced its volume of household waste by 12%. Over the same period, they succeeded in recycling a considerably larger proportion of the waste. Many European countries have difficulties recycling their household waste.

Briefly state your reason why you want to read this web page carefully:
Appendix IX: Interview protocol

Manual for test leader

We asked you to select documents that you would use to prepare a class presentation on the topic of climate change/nuclear energy. We like to ask you some questions about the documents you selected to help us understand why people chose some documents, but not others. This will help us understand what people think is important when they make decisions about information.

(During the interview, give students the actual documents they selected)

These are the basic question prompts:

Use these prompts when you want information about why the student selected a specific card or set of cards:

1. “You selected this card. Why did you select this card?”
2. “You selected these cards. Why did you select these cards?”
   - For example, a student may select 4 HR_HT cards.

Use these prompts when you want information about why the student did not select a specific card or cards:

3. “You did not select this card. Why didn’t you select this card?”
   - For example, a student may select 4 HR_HT cards; why didn’t the person select all 5 of these cards?)
4. “You did not select these cards. Why didn’t you select any of these cards?”
   - For example, a student may select 2 HR_HT cards; why didn’t the person select the other 3 cards?)

*Do not use this for every card that they did not select; just use it for cards of interest.

Use this prompt to get the participant to explicitly explain why he/she chose one card (or set of cards) but not another card (or set of cards):

5. Why did you select this card, but not that card?

For example, a student may select 4 HR_HT cards. Try to find out why the student selected these cards but did not select the other HR_HT card.

You will need to ask for card selection decisions both within and across topics. You don’t want the interviews to last too long, but you need to make sure that you 1) get people to explain in their own words why they chose some cards, but not other cards, and 2) their selection criteria within and between topics.
Part II:
Papers I - III

Paper I:

Paper II:

Paper III:
Paper II:
Investigating interest and knowledge as predictors of students’ attitudes towards socio-scientific issues☆

Tonje Stenseth, Ivar Bråten *, Helge I. Strømsø

University of Oslo, Norway

A R T I C L E  I N F O

Article history:
Received 14 April 2015
Received in revised form 6 October 2015
Accepted 27 February 2016

Keywords:
Topic interest
Topic knowledge
Attitudes
Socio-scientific issues

A B S T R A C T

The present study investigated the extent to which topic interest and topic knowledge, independently and interactively, predicted attitudes towards two socio-scientific issues: the potential risk associated with nuclear power plants and human-induced climate change. In a sample of 153 Norwegian upper-secondary school students, topic knowledge was found to be a better predictor of attitudes towards nuclear power plants than was topic interest, whereas topic interest was found to be a better predictor of attitudes towards climate change than was topic knowledge. Thus, more knowledgeable students seemed less likely to be concerned about the potential risk of nuclear power plants than were less knowledgeable students, and more interested and engaged students seemed more likely to judge climate change to be human-induced than were less interested students. Moreover, for both issues, students’ interest in the topic and their topic knowledge interacted, with the relationship between interest and attitude depending on students’ level of topic knowledge. This interaction differed between the two issues, with a stronger relationship between interest and attitudes observed at lower than at higher levels of knowledge for the nuclear power issue and a stronger relationship between interest and attitudes observed at higher than at lower levels of knowledge for the climate change issue. Theoretical and educational implications of the findings are discussed.

© 2016 Elsevier Inc. All rights reserved.

1. Introduction

In democratic societies, socio-scientific issues are often publicly debated (Bromme & Goldman, 2014; Sinatra, Kienhues, & Hofer, 2014). Participation in such discourse reflects people’s attitudes towards the issues, understood as their relatively enduring evaluative judgments about them (Bizer, Barden, & Petty, 2003). The myside bias phenomenon implies that when dealing with controversial issues, people tend to evaluate and generate evidence, as well as test hypotheses, biased by their prior attitudes (Stanovich, West, & Toplak, 2013). Empirical research corroborates this view, with information consistent with people’s prior attitudes more likely to be recalled, evaluated positively, and included in mental representations of situations and issues than attitude-inconsistent information (Andiliou, Ramsay, Murphy, & Fast, 2012; Kahan et al., 2012; Kardash & Scholes, 1996; Lord, Ross, & Lepper, 1979; Maier & Richter, 2013, 2014; McCrudden & Sparks, 2014; Murphy & Alexander, 2004; Strømsø, Bråten, & Stenseth, 2015; van Strien, Brand-Gruwel, & Boshuizen, 2014; Wiley, 2005).

Given the potentially wide-ranging, negative consequences of people’s prior attitudes towards socio-scientific issues for an open-minded and constructive democratic discourse on how to understand and solve them (Sinatra et al., 2014), it is important to understand the psychological antecedents of such attitudes (Critchley, 2008; Sinatra et al., 2014). In an educational context, this seems particularly pertinent because those antecedents may be targeted through instruction to promote attitudes more conducive to decisions and actions informed by scientific evidence. So far, however, educational psychologists seem to have paid less attention to the antecedents than to the consequences of such attitudes. According to Bizer et al. (2003), motivational as well as cognitive factors may contribute to making people’s attitudes weaker or stronger. Consistent with this view, we set out to investigate personal interest and topic knowledge as predictors of high school students’ attitudes towards two publicly debated and essential socio-scientific issues: potential risk associated with nuclear power plants and anthropogenic (i.e., human-induced) climate change.

1.1. Theoretical assumptions and prior research

According to the Elaboration Likelihood Model (ELM) of Petty and colleagues (Petty & Briñol, 2012; Petty & Wegener, 1999), relatively...
enduring attitudes likely to have consequences for behavior are formed through a “central” processing route involving higher degrees of engagement with and elaboration of the issue at hand. Among the individual difference variables that can be assumed to determine attitude formation is how motivated individuals are to assess the central merits of an issue, with personal involvement in an issue being integral to this motivational construct (Petty & Briñol, 2012). Likewise, topic knowledge that allows people to assess issue-relevant information in relation to that knowledge can be assumed to play an important role in arriving at a reasoned attitude (Petty & Briñol, 2012; Petty & Wegener, 1999).

The role of topic knowledge may increase when the issue is more complex because it then requires more background to understand it (Petty & The role of topic knowledge may increase when the issue is more complex because it then requires more background to understand it (Petty & Briñol, 2012). Likewise, topic knowledge, were different from the possible interaction between motivation and knowledge described by Petty and Wegener (1999) and Murphy (2001) (see above), which may be more pertinent when issues are considered less important by participants (Petty & Wegener, 1999).

1. To what extent can students’ personal interest in and their knowledge about human-induced climate change be uniquely predicted by their personal interest in the issues and their knowledge about them, as well as by interactions between these two variables. There are differences between the two issues that may highlight the context-specificity of psychological mechanisms involved in attitude formation regarding socio-scientific issues. Whereas the UN Intergovernmental Panel on Climate Change (2008) has established scientific, if not public, consensus on the issue, stating that it is “virtually certain” that global temperatures will increase in the future and extremely likely that human activities are responsible for this increase, the UN International Atomic Energy Agency (2012) presents safety data documenting that the operational level of nuclear power plant safety around the world “remains high” despite public debate and opposition in several countries. By having students rate the degree to which they considered climate change to be anthropogenic, we thus assessed how well their attitudes accorded with scientific consensus on the issue. However, by asking them to rate the degree to which they considered nuclear power plants to be generally high risk, we assessed the strength of attitudes that were not supported by scientific evidence. Of note is also that nuclear power plants are not in use in Norway, making it likely that our participants would be less personally involved in that issue than in the issue of climate change, which is highly pertinent in northern regions of the world.

In summary, we addressed the following questions:

1. To what extent can students’ personal interest in and their knowledge about nuclear power, independently and interactively, predict their attitudes towards nuclear power plant risk?

2. To what extent can students’ personal interest in and their knowledge about climate change, independently and interactively, predict their attitudes towards human-induced climate change?

Regarding the first question, we expected that topic knowledge would negatively predict attitudes not supported by scientific evidence, with the role of personal interest being less pronounced in this context because students would not consider this issue very relevant given the lack of nuclear power plants in the country. However, we also expected that the relationship between students’ personal interest and their attitudes would depend on their level of topic knowledge, with a stronger relationship observed at lower than at higher levels of topic knowledge.

---

1. Alternatively, less enduring attitudes that are unlikely to predict behavior are formed through a “peripheral” knowledge involving less engagement and elaboration of the issue.
This possibility is consistent with Petty and Wegener’s (1999) idea that when issues are considered less important or relevant, higher knowledge may decrease the role of motivation in attitude formation, as well as with Murphy’s (2001) suggestion that students with less knowledge are more likely to draw on their personal involvement when taking a stance on an issue, even at odds with scientific knowledge.

Regarding the second question, we expected both personal interest and topic knowledge to be positively related to attitudes consistent with scientific consensus on the issue (Lombardi et al., 2014; Sinatra et al., 2012), with interest being a stronger predictor than topic knowledge because students would probably form attitudes towards this more engaging issue on the basis of interests and values shared with their cultural group (Kahan et al., 2012). Again, we expected an interaction between personal interest and topic knowledge, assuming that a stronger relationship between personal interest and attitudes towards human-induced climate change would be observed at higher than at lower levels of topic knowledge (Gauchat, 2012; Kahan et al., 2012). Given that the issue probably was considered more important and personally relevant by our participants, higher knowledge might better equip them to argue and forge a position consistent with their personal interests and engagement (Kahan et al., 2012).

In addressing these two questions, we included gender in our analyses. Because females tend to express higher levels of concerns about technology and the environment than do males (e.g., Davidson & Freudenburg, 1996; Fischer, Morgan, Fischhoff, Nair, & Lave, 1991; McCright, 2010; Zelezy, Chua, & Aldrich, 2000), possibly because of a stronger “other value orientation” (Zelezny et al., 2000, p. 446), we expected that female students would display stronger attitudes towards both risk issues (i.e., nuclear power plants and climate change). Finally, we included students’ science achievement as a control variable because it may be related to all the other predictors (i.e., gender, personal interest, and topic knowledge).

2. Method

2.1. Participants

Participants were 153 students (Mage = 17.4, SD = .61; 59.5% female) from six classes at a public upper secondary school in southeast Norway. The majority of the participants (82.4%) were native-born Norwegians who learned Norwegian as their first language, and the sample was relatively homogeneous (i.e., middle class) in regard to socioeconomic status. All participants were attending college preparatory courses.

2.2. Materials

2.2.1. Attitude measures

The three-item attitude measure concerning climate change asked participants to rate their agreement with statements about human-induced climate change (sample item: I believe that climate change is caused by human activities) on a 10-point scale ranging from 1 (not at all true of me) to 10 (very true of me). The three-item attitude measure concerning nuclear power plants (sample item: I think that nuclear power plants are an environmental hazard) on an identical 10-point scale. High scores on the climate change attitude measure indicated that students held climate change to be caused by humans and low scores indicated that they did not endorse the idea of human causes. On the nuclear power attitude measure, high scores represented that students judged nuclear power plants to be high-risk and low scores indicated that they considered nuclear power plants to be safe. Reliabilities (Cronbach’s α) were .90 (climate change) and .86 (nuclear power). The items of both measures are included in Appendix A.

2.2.2. Topic interest measures

Regarding climate change, we used a 12-item measure validated in prior research (McCrudden, Stenseth, Bråten, & Strømsø, 2016; Strømsø, Bråten, & Britt, 2010). Participants indicated their level of interest or engagement by rating each item on a 10-point scale ranging from 1 (not at all true of me) to 10 (very true of me). Half of the items allowed participants to express their interest without reporting any active engagement or involvement in addressing the problem of climate change (sample item: I am interested in international climate issues). The other half focused more on active engagement and involvement, reflecting participants’ willingness to act for the benefit of the Earth’s climate (sample item: I try to convince others that we should reduce the discharge of greenhouse gases). Cronbach’s α was .94.

We developed a parallel 12-item measure using an identical 10-point scale for nuclear power. While half of the items just asked participants to rate their interest in energy issues and, particularly, in issues concerning nuclear power (sample item: I am interested in issues concerning the safety of nuclear power plants), the other half focused more on active engagement and involvement (sample item: I can imagine being a member of an organization working with issues concerning the use of nuclear power). Cronbach’s α was .89. More sample items for both topic interest measures are included in Appendix B.

2.2.3. Topic knowledge measures

For climate change, we used a 15-item multiple-choice measure validated in much prior work (e.g., Bråten, Strømsø, & Britt, 2009; Bråten, Strømsø, & Salmerón, 2011). Taken together, the 15 items assessed both conceptual understanding and factual information and covered diverse aspects of the topic, with items referring to both scientific (e.g., the greenhouse effect) and political (e.g., the Kyoto Protocol) aspects of climate change. Cronbach’s α was .64. Test–retest reliability was computed in an independent sample of first-year education undergraduates (n = 56), with two weeks between the test and the retest, yielding a reliability estimate (Pearson’s r) of .77.

We developed a parallel 15-item multiple-choice measure concerning nuclear power. In designing this measure, the authors read extensively on the topic in textbooks and reference works, as well as on the Internet, to ensure that the concepts and information included in the measure were central to the issue of nuclear power, and together wrote items to cover the concepts and information agreed upon by all test constructors (e.g., nuclear fission, nuclear power plants, radioactive waste, and the International Atomic Energy Agency). Again, the 15 items assessed both conceptual understanding and factual information and covered scientific (e.g., nuclear fission) as well as political (e.g., the International Atomic Energy Agency) aspects of the topic. The measure was reviewed by a nuclear physicist at the University of Oslo, who carefully checked the response alternatives (i.e., the correct choice and the distractors) for each item. Cronbach’s α was .67. Test–retest reliability was computed in an independent sample of third-year upper-secondary students (n = 82), with two weeks between the test and the retest, yielding a reliability estimate (Pearson’s r) of .72. Sample items for both measures are included in Appendix C.

2.2.4. Achievement in the domain

Achievement in the domain was assessed by means of semester natural science grades. Based on the grading system, ranging from 1 (not good) to 6 (excellent), a 6-point scale was used.

2.3. Procedure

Participants were group-administered the attitude, topic interest, and topic knowledge measures in that order for one of the topics and then for the other, with the order of the topics counterbalanced.
Participants self-reported in writing the last semester grade they had received in natural science. Self-reported school grades have been found to be highly correlated (approx. .90) with grades provided by teachers (Dickhäuser & Plenter, 2005; Frucot & Cook, 1994; Hofer, Kuhle, Kilian, & Fries, 2012).

3. Results

Descriptive data are presented in Table 1. Paired-sample t-tests with Bonferroni adjustment showed that participants were statistically significantly more interested in climate change (M = 5.83, SD = 1.85) than in nuclear power (M = 4.27, SD = 1.69), t(152) = 12.64, p = .000, Cohen’s d = 0.88, and were also statistically significantly more knowledgeable about the former (M = 9.26, SD = 2.35) than the latter topic (M = 8.65, SD = 2.66), t(152) = 3.19, p = .002, Cohen’s d = 0.24. Moreover, participants displayed statistically significantly stronger attitudes about climate change (M = 8.27, SD = 1.73) than about nuclear power (M = 6.68, SD = 2.08), t(152) = 8.57, p = .000, Cohen’s d = 0.84. This indicates that participants were more involved in and had stronger attitudes about climate change than about nuclear power.

Intercorrelations are shown in Table 2, with gender (male = 1, female = 2) also included in the correlation matrix. For nuclear power, there was a statistically significant negative correlation between topic knowledge (r = −.39, p < .001) and attitudes, while there was no statistically significant relationship between topic interest (r = −.06, ns) and attitudes. For climate change, there was a statistically significant positive relationship between topic interest (r = .41, p < .001) and attitudes, while topic knowledge (r = .12, ns) was not statistically significantly related to their attitudes. Gender was positively and statistically significantly related to scores on both attitude measures (r = .36, p < .001, for nuclear power; r = .17, p < .05, for climate change), and science achievement was positively and statistically significantly related to interest in nuclear power (r = .21, p < .01) and knowledge about both issues (r = .32, p < .001, for nuclear power; r = .28, p < .001, for climate change). Finally, interest in the two issues was positively correlated (r = .63, p < .001), as was knowledge about them (r = .56, p < .001).

To directly address our two research questions, we performed two forced-order hierarchical multiple regression analyses, one with attitudes towards nuclear power plant risk as the dependent variable and one with attitudes towards human-induced climate change as the dependent variable. In both analyses, gender and science achievement were entered into the equation in step one together with topic interest and topic knowledge. In step two of each analysis, we included a variable representing the cross-product multiplicative term between topic interest and topic knowledge. To prevent multicollinearity among the first-order and the interaction terms, the interaction terms were created and the regression analyses performed after centering the topic interest and the topic knowledge variables (Cohen, Cohen, West, & Aiken, 2003).

The results for the analysis predicting attitudes towards nuclear power are shown in Table 3. After step one, $R^2 = .23, F_{\text{change}}(4, 148) = 11.27, p = .000$. In this step, both gender ($β = .29, p = .000$) and topic knowledge ($β = -.31, p = .000$) were unique predictors of attitudes, indicating that females were more likely to judge nuclear power plants to be high-risk than were males and that more knowledgeable students were more likely than less knowledgeable students to consider nuclear power plants a safe way of producing energy. The addition of the interaction term in step two resulted in a statistically significant 3% increment in explained variance, with $R^2 = .26, F_{\text{change}}(1, 147) = 5.24, p = .024$, after step two. In this step, both gender ($β = .30, p = .000$) and topic knowledge ($β = -.30, p = .000$) remained unique (viz. positive and negative) predictors of attitudes, with the interaction between topic interest and topic knowledge also becoming a unique predictor, with $β = -.16, p = .024$. Following Aiken and West (1991) and Dawson (2014), we graphed the interaction between topic interest and topic knowledge. Fig. 1 indicates that the relation between topic interest and attitude towards nuclear power depends on students’ level of topic knowledge, with, as expected, a stronger relationship observed at lower than at higher levels of topic knowledge. Accordingly, a simple slope analysis showed that at a level of one standard deviation below the mean of the centered topic knowledge variable, $b = .29, t = 2.62, p = .025$, at a level of one standard deviation above the mean of the centered topic knowledge variable, $b = -.09, t = -.17, p = .45$. According to Cohen’s (1988) rule of thumb, 26% explained variance (Cohen’s $f^2 = .35$) considered a large effect in multiple regression analysis.

The results for the analysis predicting attitudes towards human-induced climate change are also shown in Table 3. After step one, $R^2 = .17, F_{\text{change}}(4, 148) = 7.94, p = .000$. In this step, only topic interest ($β = .38, p = .000$) was a unique predictor of attitudes, indicating that the stronger personal interest students had in the topic, the more likely they were to endorse the view that climate change is caused by human activities. Again, the addition of the interaction term in step two resulted in a statistically significant 3% increment in explained variance, with $R^2 = .20, F_{\text{change}}(1, 147) = 4.84, p = .029$, after step two. In this step, topic interest ($β = .39, p = .000$) remained a unique positive predictor of students’ attitudes and the interaction between topic interest and topic knowledge became a unique predictor, with $β = .17, p = .029$. When this interaction was graphed, the relation between topic interest and attitude towards climate change was found to depend on students’ level of topic knowledge (see Fig. 2). As expected, a stronger relationship emerged between topic interest and attitude at higher than at lower levels of topic knowledge. Accordingly, a simple slope analysis showed that at a level of one standard deviation above the mean of the centered topic knowledge variable, $b = .49, t = 5.00, p = .000$; at a level of one standard deviation below the mean of the centered topic knowledge variable, $b = .23, t = 2.52, p = .013$. That gender did not uniquely predict attitudes towards climate change although it had a positive zero-order correlation with attitudes, may be due to its positive correlation with topic interest, which emerged as a much better predictor of attitudes than gender and, presumably, accounted for some of the same variance that gender shared with attitudes towards climate change. According to Cohen’s (1988) rule of thumb, 20% explained variance (Cohen’s $f^2 = .25$) is considered a medium to large effect in multiple regression analysis.

4. Discussion

As expected, topic knowledge was a better predictor of attitudes towards nuclear power plants than was topic interest, whereas topic interest was a better predictor of attitudes towards climate change than was topic knowledge. Thus, more knowledgeable students seemed less likely to be concerned about the potential risk of nuclear power plants than were less knowledgeable students, and more interested and engaged students seemed more likely to judge climate change to be human-induced than were less interested students. Even more important than the predictability of these first-order terms, however, were the finding that for both issues, students’ personal interest and topic knowledge interacted, with the relationship between interest and the attitude in question depending on students’ level of background knowledge about the issue. Also as expected, this interaction differed...
between the two issues, with a stronger relationship between interest and attitudes observed at lower than at higher levels of knowledge for the nuclear power issue and with a stronger relationship between interest and attitudes observed at higher than at lower levels of knowledge for the climate change issue.

Consistent with theoretical frameworks explaining the roles of motivation and cognition in forming an attitude or a stance on a particular issue (Dole & Sinatra, 1998; Petty & Briñol, 2012), as well as with current models on the roles of interest and knowledge in learning and comprehension (Alexander, 2005; Guthrie & Wigfield, 2000), these findings indicate that both personal interest and topic knowledge may predict students’ attitudes towards socio-scientific issues. At the same time, however, these findings highlight the context-specificity of psychological mechanisms involved in attitude formation regarding socio-scientific issues, with issues differing with respect to personal involvement and relevance seemingly involving different mechanisms. More specifically, when an issue is experienced as relatively “cold” in the sense that it evokes less involvement and engagement among students, they mainly seem to rely on their knowledge base when forming an attitude about it, with personal interest first coming into play when students essentially lack knowledge about the issue (Murphy, 2001). Importantly, in those instances, students’ personal interest may well predict attitudes not supported by scientific evidence, such as with attitudes towards nuclear power plants in this study. When an issue is experienced as more “hot” in the sense that it evokes more involvement and engagement among students, however, they mainly seem to rely on their personal interest in it, with the relationship between interest and attitudes becoming even stronger at higher levels of topic knowledge. In those instances, personal interest and topic knowledge may sometimes work together in supporting attitudes consistent with scientific evidence, such as with attitudes towards human-induced climate change in this study. However, depending on the personal interests that individuals bring to bear on “hot” socio-scientific issues, personal interests and topic knowledge may presumably also work together in supporting attitudes inconsistent with scientific evidence because more knowledgeable individuals may be better equipped to argue and form a position based on their personal interests irrespective of the nature of those interests (Kahan et al., 2012).

Of note is also that participants, given their higher interest in and knowledge of climate change, presumably perceived this issue as more comprehensible and less complex than the issue of nuclear power. In turn, these perceptions may have increased their reliance on subjective judgment grounded in personal interest for the climate change issue compared to the nuclear power issue (Scharrer, Bromme, Britt, & Stadtlar, 2012; Scharrer, Stadtlar, & Bromme, 2014).

Consistent with much research on gender differences in environmental attitudes (e.g., McCright, 2010; Zelezy et al., 2000), female students were likely to hold stronger attitudes towards both issues than were male students, with the relationship between gender and attitudes being especially pronounced in the case of nuclear power plants, where gender also survived as a unique predictor in the regression equation. The varying consistency with scientific evidence notwithstanding, both these attitudes can be interpreted as pro-environmental and may, as such, signal “higher levels of socialization to be other oriented and socially responsible” among females (Zelezy et al., 2000, p. 443). Such gender differences among secondary school students may be particularly interesting in a Norwegian (and Nordic) cultural context where efforts and progress towards gender equality, in general, have been remarkable (Statistics Norway, 2014).

One limitation of this study is the use of correlational data gathered at one single time point, which does not allow conclusions regarding causality. Thus, although we, based on theory, assumed that students’ topic interest and topic knowledge might be causal predictors of their attitudes and observed relationships between variables consistent with this assumption, firmer causal statements about those relationships must await further longitudinal or, preferably, experimental work.

Table 2
Zero-order correlations for all variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gender</td>
<td>.15</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2. Achievement natural science</td>
<td>.26*</td>
<td>.15</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3. Topic interest climate change</td>
<td>.27**</td>
<td>.32***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4. Topic interest nuclear power</td>
<td>– .03</td>
<td>.23**</td>
<td>.63***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5. Topic knowledge climate change</td>
<td>– .27**</td>
<td>.28***</td>
<td>.40***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6. Topic knowledge nuclear power</td>
<td>– .26**</td>
<td>.32***</td>
<td>.14</td>
<td>.35***</td>
<td>.56***</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7. Attitude climate change</td>
<td>.17</td>
<td>.08</td>
<td>.41**</td>
<td>.16*</td>
<td>.12</td>
<td>.14</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8. Attitude nuclear power</td>
<td>.36***</td>
<td>– .12</td>
<td>.11</td>
<td>– .06</td>
<td>– .26**</td>
<td>– .39***</td>
<td>– .28**</td>
<td>–</td>
</tr>
</tbody>
</table>

* p < .05.
** p < .001.
*** p < .0001.

Table 3
Results of hierarchical regression analyses for variables predicting attitudes towards nuclear power plants and climate change.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Nuclear power plants</th>
<th>Climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>SE B β</td>
<td>B</td>
</tr>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>1.23 .33 .20***</td>
<td>0.32 .30 .09</td>
</tr>
<tr>
<td>Achievement natural science</td>
<td>– .21 .20 .08</td>
<td>– .02 .17 .01</td>
</tr>
<tr>
<td>Topic interest</td>
<td>.09 .10 .07</td>
<td>.35 .08 .38**</td>
</tr>
<tr>
<td>Topic knowledge</td>
<td>– .25 .07 .31***</td>
<td>.04 .06 .05</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>1.27 .32 .30***</td>
<td>.29 .30 .09</td>
</tr>
<tr>
<td>Achievement natural science</td>
<td>– .25 .20 .10</td>
<td>.01 .17 .01</td>
</tr>
<tr>
<td>Topic interest</td>
<td>.10 .09 .08</td>
<td>.36 .08 .39***</td>
</tr>
<tr>
<td>Topic knowledge</td>
<td>– .24 .07 .30**</td>
<td>.05 .06 .07</td>
</tr>
</tbody>
</table>

Note. For nuclear power plants R² = .23 for step 1 (p = .000), ΔR² = .03 for step 2 (p = .024); for climate change R² = .17 for step 1 (p = .000), ΔR² = .03 for step 2 (p = .029).
* p < .05.
** p < .001.
Another limitation is that the generalizability of our findings is open to question. Thus, the participating high school students might not be representative of this population and other relationships between variables might be observed with other socio-scientific issues. Of note is also that particular socio-scientific issues are likely to be perceived differently in different cultural contexts, which means that relationships between variables observed in one cultural context may not be generalizable to another one. For example, because the psychological temperature (i.e., the “coldness” and “hotness”) of particular issues may vary across cultures, so would probably the predictability of interest, knowledge, and their interaction for people’s attitudes towards the issues. Future work therefore needs to include other students and target other socio-scientific issues, with cross-cultural work being of particular interest in this area.

Finally, we acknowledge that other individual difference variables than the ones focused in this study may also predict students’ attitudes towards socio-scientific issues, with multiple affective, cognitive, and behavioral sources of information considered to provide input for attitude formation (Bizer et al., 2003). Thus, although we sincerely think that our choice of predictors was well justified (see Section 1.1), future work might include more control variables to see whether personal interest and topic knowledge, as well as their interaction, would still survive as unique predictors of students’ attitudes.

Despite the limitations, our findings may have educational relevance in addition to the theoretical implications discussed above. In science class, an important aim is to facilitate the formation of attitudes towards controversially discussed issues that are consistent with scientific evidence (Norwegian Ministry of Education and Research, 2006). While learning scientific content knowledge may certainly play an important role in this regard, teachers should also be aware that sometimes students’ interest and engagement in an issue may be more important than their knowledge and that in some instances, higher knowledge about an issue may even be used as a vehicle for furthering interests and values that are basically unscientific. The teaching of science should therefore not be viewed as an exclusively cold cognitive enterprise. Because students’ interests, values, and engagement may be equally important for how they conceive of socio-scientific issues and for whether they, eventually, will support or contribute to scientifically based solutions, science class should also be a context for heated discussions with the aim of promoting attitudes commensurable with scientific evidence in most students.

Appendix A

Items for the attitude measures

Nuclear power
I believe that nuclear power plants are a dangerous way to produce energy.
I think that nuclear power plants are an environmental hazard.
I believe that nuclear power plants can have harmful effects.

Climate change
I believe that climate change is caused by human activities.
I think that human emissions of climate gases lead to global warming.
I believe that humans themselves are responsible for climate change.

Appendix B

Sample items for the topic interest measures

Nuclear power
I’m interested in conditions that influence how safe it is to use nuclear power plants.
The safety of nuclear power is of interest to me.
I like to keep updated on issues concerning nuclear power plants.
Climate change
I am interested in what conditions influence the earth’s climate.
Global warming is a topic that interests me.
I like to keep myself updated on issues concerning climate change.

Appendix C

Sample items for the topic knowledge measures (correct answers are in italics)

Nuclear power
3. Radioactive waste from nuclear power plants is ...
   a) spent radon
   b) spent uranium fuel
   c) spent bio-fuel
   d) spent nuclear power

5. The responsibility for ensuring that nuclear power is used for peaceful purposes is held by ...
   a) The OECD’s Atomic Energy Institute
   b) The International Atomic Energy Agency
   c) The UN Panel on Climate Change
   d) The International Renewable Energy Agency

9. A radioactive element ...
   a) has unstable atomic nuclei
   b) has stable atomic nuclei
   c) is among the lightest elements
   d) emits visible radiation

Climate change
2. The greenhouse effect is due to...
   a) holes in the ozone layer
   b) increased use of nuclear energy
   c) increased occurrence of acidic precipitation
   d) streams of heat that do not get out of the atmosphere
   e) the pollution of the oceans

5. Some of the most important climate gases are...
   a) chlorine and hydrogen
   b) oxygen and propane
   c) nitrogen oxides and butane
   d) propellants and aerosols
   e) water vapor and laughing-gas

13. The Kyoto Protocol is...
   a) a binding agreement between USA and EU
   b) a binding agreement managed by the World Trade Organization (WTO)
   c) a binding international agreement managed by the UN
References


