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Students' approaches when researching complex geographical conflicts using the internet

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Abstract

Many teachers hesitate to integrate internet research into their lessons as they face major uncertainties concerning their students' competencies in retrieving, evaluating and processing digital information. Understanding complex geographical conflicts using the internet poses special challenges to students, as they need to obtain multi-dimensional, spatial and temporally relevant information to grasp the conflict in its entirety. In order to obtain insights into students' digital researching strategies, a study was conducted in 2018 with 20 German secondary school students, who were asked to form their own opinion on a complex geographical conflict by searching the internet for useful information. The students were instructed to share their thoughts and actions aloud while undertaking the research. All digital activities and accompanying speech were recorded with screen and audio capture technology. The analysis of the transcripts consisted of a combination of qualitative and basic quantitative analysis, which led to the conclusion that students have very different abilities in identifying multi-dimensional information on complex geographical conflicts. The majority of the students neither used maps nor paid attention to publication dates of websites or information. Furthermore, none of the participants questioned the credibility of their retrieved digital information.

Keywords

Complex geographical conflicts; digital literacy; geography education; Germany; information literacy; information retrieval; secondary education

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1. Introduction

The internet and the distribution of mobile devices have irrevocably changed the accessibility of information, as almost limitless amounts of data can be obtained at any place and at any time. However, since the rise of Web 2.0, algorithm-based search engines and viral spreading of fake news, internet users need research and evaluation competencies to find factually correct information and to question the interests of the authors and their representation of facts.

In educational contexts, the large amounts of data on the internet can offer great opportunities for classroom activity design, as information on almost all topics and for all school subjects can be quickly accessed. Searching for information on the internet prepares students for an information-based society, when employed to promote information problem-solving skills (Wisconsin Educational Media Association, 1993, p.3). Student motivation may be increased when searching the internet independently because the researching process requires their responsibility. Students can gain better control over their learning process and can select topics and information that correspond to their interests (Wallace & Kuppermann, 1997, p.2). However,

even though German children between the age of 12 and 19 years old spend more than 200 minutes daily online (Medienpädagogischer Forschungsverband Südwest (MPFS), 2018, p.52), it has been shown that many young people are facing major difficulties when independently searching and evaluating online information (Fraillon et al., 2019, p.77).

Recent research focuses primarily on students' digital information literacy on a general, interdisciplinary level (Eickelmann et al., 2019; Metzger et al., 2015; Stanford History Education Group, 2016). However, every single school subject has its own specific digital research requirements: the challenges of undertaking internet research in modern foreign languages will most likely require different competencies than researching in natural or social sciences. Thus, digital information literacy should not (only) be instructed on a meta level but also be better included in subject-specific, contextual projects (Hapke, 2007, pp.141–143). This suggests that each school subject needs to develop concepts and materials to foster discipline-specific digital information literacy. For geography education, internet research may be an efficient way to fully investigate complex geographical conflicts, as up-to-date data, authentic information presented from different perspectives, maps, web mapping services, pictures and videos expand the possibilities of exploring a geographical conflict in its multiple dimensions and at different scales. Discipline-specific requirements of digital information searches in geography have received little attention thus far, and previous work has failed to address specific requirements of understanding complex geographical conflicts using the internet. In order to gain a better understanding of the students' approaches and difficulties, we observed 20 German secondary school students over the year 2018 when researching a complex geographical conflict on the internet. The research presented here aims to establish preliminary findings on the following research questions:

When searching the internet for complex geographical conflicts:

I. Do secondary school students find the necessary information that enables them to understand the conflict in question?
II. What are the difficulties that secondary school students face when undertaking internet research?
III. Are there certain researching strategies that help secondary school students identify useful information?

We first describe the theoretical requirements that should be fulfilled when researching geographical conflicts. Subsequently we show how participating students met these requirements, what difficulties they faced, and what strategies positively affected their research.

2. Theoretical framework

2.1 Understanding complex geographical conflicts and internet research

Understanding complex geographical conflicts is a particular difficulty in the school subject geography. Complex geographical conflicts are spatial conflicts of interest, consisting of several linked elements that are in a spatiotemporal dynamic (Budke & Müller, 2015, p.177). Various actors are involved in the conflict, pursuing different interests in the matter, e.g. economic, ecological, and social. To give an example, the following question represents a typical complex geographical conflict that could be addressed in geography lessons: should the Amazon rainforest area be further developed? There is no generally valid answer to this question since different ecologic, economic and social interests meet and different interest groups, such as conservationists, agricultural firms or local residents pursue different goals and values. To form a solid argument on the complex geographical conflict, students need to weigh up the advantages and disadvantages for different scales, i.e. on a regional and a global level. Not all aspects of the conflict can be considered equally, as they can have effects in very different

dimensions. Furthermore, individual elements of the conflict cannot be viewed in isolation as many aspects are interlinked. To answer complex geographical conflicts, students need to have an understanding of the interrelations of natural circumstances and social activities, which is deemed to be the main objective of geography education (Deutsche Gesellschaft für Geographie (DGfG), 2014, pp.5–6).

In traditional geography lessons, students are given all the necessary resources to understand a conflict usually either on worksheets or within textbooks. This ensures that all information available to the students is relevant and from credible sources. However, German geography textbooks are not up-to-date and do not comply with current educational standards, as they lack a variety of argumentative tasks and multi-perspective materials (Budke, 2011, p.261). The information available on the internet differs somewhat for complex geographical conflicts, with a wealth of up-to-date, multi-dimensional, and authentic information available to support the different dimensions of a conflict. To assess the credibility of sources and information, students need to critically evaluate the identified data, which includes questioning the intention of the author and weighting the different pieces of information in order to develop a conclusive argument.

On the basis of the current educational standards for geography and considering the special challenges of digital research, we developed a framework supporting the understanding of complex geographical conflicts when using the internet. We found that three approaches appear to be relevant in order to fully understand complex geographical conflicts: (1) the identification of multi-dimensional information; (2) the analysis of spatial information and; (3) the recognition of temporally relevant information (see Figure 1).

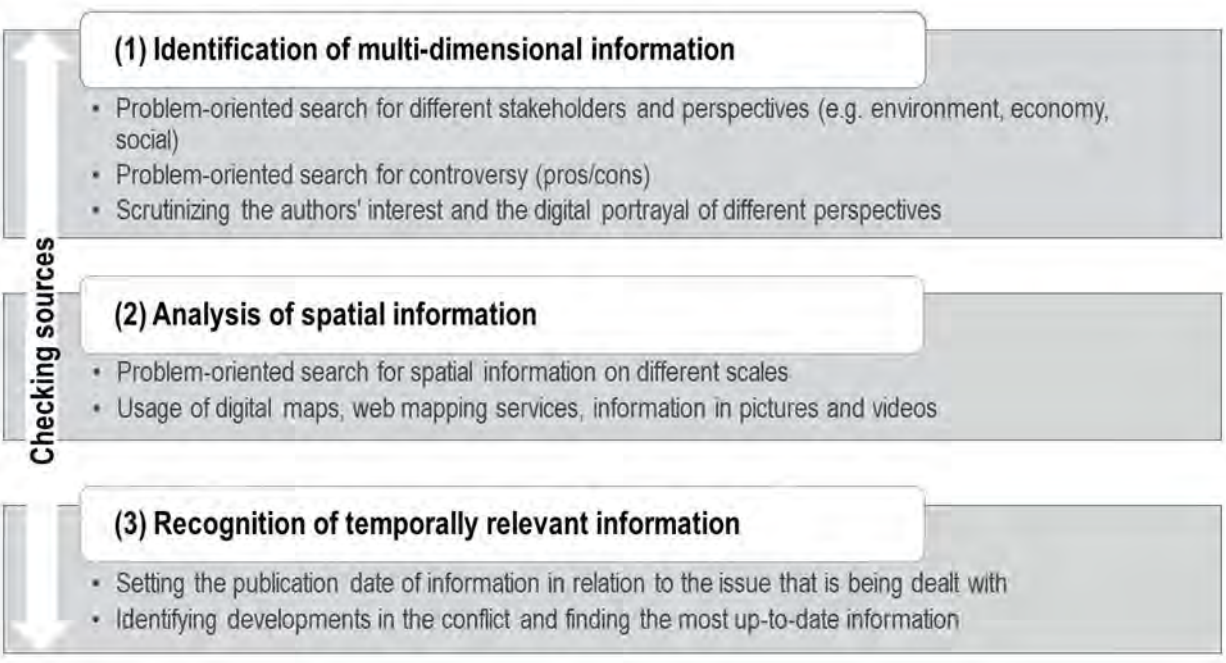

Figure 1: Approaches for understanding complex geographical conflicts using the internet (author's own diagram)

(1) Identification of multi-dimensional information
The concept of 'change of perspective' has been established as a teaching principle in geography education. It is based on the assumption that every geographical conflict can be seen from different perspectives and that this perspective can be changed by the observer (Rhode-Jüchtern, 2013, pp.214–215). As geography is the subject that combines scientific

topics with social problems and thus represents both a natural and a social science (Gebhardt, 2016, p.51), when dealing with complex geographical conflicts, students need to identify the interactions of natural preconditions and human activity, which are usually highly interconnected (DGfG, 2014, p.6). In order for students to be able to assess a geographical conflict and express their position on it with coherent arguments, they need to identify the controversy of the conflict which arises when controversial positions and assessments of the problem are presented by different individuals and groups (Ohl, 2013, p.163). Those controversial positions, which may focus on ecological balance, economic security or social justice are, following the concept of education for sustainable development, interlinked and interdependent (Bahr, 2013, p.18). The students first must understand who represents which position in the conflict, what motives and interests underlie these positions and what power the actors have to enforce their position. In a further analysis, the positions of the actors must be related to each other to gain a complete overview of the conflict. Thus, the identification of multi-dimensional information provides a knowledge base for understanding the complexity of geographical conflicts which has a particular impact on internet research: students' search for information must be flexibly designed since their understanding of the conflict and formation of their arguments will emerge in the course of processing conflict-relevant information found along the way. In terms of evaluation, students must be aware that information does not reach the internet without a reason and, as such, the reader must always scrutinise the interest of the author. There is usually a certain reason for the dissemination of online information, such as an economic or political benefit. Stakeholders involved in a conflict publish information on the internet, which is usually interpreted for their own purposes. In addition, the digital representation of the publishers' arguments needs to be examined critically.

(2) Analysis of spatial information
Geography is the school subject that deals centrally with the category of space. To understand the impact of possible changes on different scales, and thus to fully comprehend complex geographical conflicts, it is necessary to explore spatial conditions and resources - both natural and human (DGfG, 2014, pp.5-6). Important cartographic sources on the internet are web mapping services, photographs, satellite images, digital atlases and geographical information systems. Those sources offer the opportunity to investigate the basic physical conditions of a region and to understand spatial connections. In geography education, maps are used for location purposes on a local and global scale, often as a starting point for explaining spatial relationships and as a basis for communicating planning projects (Gryl, 2016, pp.5–6). The impact of possible developments and changes can also be comprehended using digital maps. Web mapping services are useful not only to find locations, but they are also helpful in problem-based educational environments where the location-based dimension is important (Kerski, 2013, p.13). Research has shown that using geospatial technologies offers great opportunities for positively affecting students' spatial thinking and their understanding of spatial changes (Favier & van der Schee, 2014, p.233; Xiang & Liu, 2017, p.73). In order to properly evaluate spatial information, digital map reading competencies are needed that enable students to analyse maps to find their own conflict-relevant information without having to repeat preformed arguments.

(3) Recognition of temporally relevant information
The human conditions and natural circumstances of a geographical conflict are not static but change over time (Warman, 1946, p.176). This change applies to all geographic processes, from urbanisation processes to volcanic activity (DGfG, 2014, p.11), and current events are linked to long-term developments, e.g. current periods of drought with global climate change (Freytag et al., 2016, p.2). Therefore, the recognition of temporally relevant information is necessary when trying to understand complex geographical conflicts. In geography education, students are usually dealing with ongoing geographical issues, as the integration of current events into geography lessons helps to foster situational learning environment (Kestler, 2015, p.335). To form a valid argument in relation to an ongoing geographical conflict, up-to-date

information and older information help to fully explore a conflict, as they illustrate developments and changes of a geographical situation. If students are dealing with geographical conflicts that occurred in the past, they need to be aware that, even if the conflict has finished, the latest state of knowledge on the subject can still develop further. When searching the internet for information, special caution is required, as once published on the internet information usually remains online. Students need to pay special attention to the publication dates of their sources and of the data given on websites to assess its validity. They need to set the date of the information in relation to the conflict they are researching. This allows them to understand the current state of the conflict and to reconstruct developments.

2.2 Adolescents' digital information literacy

Being able to deal with the challenges of digital research, students need to acquire information literacy, which is the ability to handle information in a 'self-determined, sovereign, responsible and goal-oriented' manner (Ballod, 2015, p.36). Digital information literacy may be considered an important skill for being a responsible citizen, as it can help people to participate in democratic negotiation processes, to act self-determined, and to judge facts on the basis of current research. In order to understand complex geographical conflicts, the vast amounts of available online information must be filtered to identify relevant material. The author's intention must be questioned critically and the credibility of the information must be checked.

An overview of previous studies suggests that young people lack digital information literacy in many respects. The International Computer and Information Literacy Study (ICILS) demonstrated that 30% of all participating German students faced major problems in retrieving and evaluating online information (Eickelmann et al., 2019, p.125). The reasons for their difficulties are diverse but generally students lack knowledge of the way in which search engines function and of the limitations of searching using a single search engine (Deyrup & Bloom, 2012, p.204; Julien & Barker, 2009, p.14). They tend to simply use the first results that appear in a search list (Julien & Barker, 2009, p.15), especially when researching controversial topics (Walhout et al., 2017, p.1457). Their search terms frequently consist of long strings of words written in their natural language (Deyrup & Bloom, 2012, p.205). Many students seem to have little knowledge of how to specify search queries and narrow down search results by using Boolean operators (Deyrup & Bloom, 2012, p.205; Brusilovsky et al., 2010, p.189).

Teenagers, just as most internet users, are often not aware that algorithms determine what information they receive and in which order they obtain it (Lischka & Stöcker, 2017, p.14). Studies in the United States have found that most high school students have not yet developed an awareness of critically questioning information found on websites (Metzger et al. 2015, p.236). Images from unknown sources are often blindly trusted and credible information can often not be distinguished from advertising (Stanford History Education Group, 2016, pp.10–17). Due to convenience, motivation, and time pressure students spend most of their research time searching and scanning information, and very little time on the evaluation and organisation of information (Walraven et al. 2009, p.244). Rather than choosing their sources due to quality and reliability, students seem to prefer online websites that provide large amounts of easily understandable information (Hong & Jo, 2017, pp.181–182).

Although many students do not seem familiar with key assessment criteria for digital information and websites, they show high confidence with their researching skills and over-estimate their own information literacy and research success (Deyrup & Bloom, 2012, p.205; Julien & Barker, 2009, p.15; Spiewak, 2017). A possible explanation for this misjudgement may be that schools make a small contribution to developing their digital information literacy. Students get little feedback on their knowledge and skills (Ihme & Senkbeil, 2017, p.34).

Despite many teachers being aware of their students having major difficulties with the correct usage of online information and how to deal with the wealth of digital data, a case study has

shown that few teachers take steps to promote these shortcomings (Mertes, 2016, p.172). Recent research showed that 28% of German teachers frequently use digital information research in their lessons (Schmid et al., 2017, pp.21–28). When giving students research questions, teachers often choose the safe way out and direct students to specific online resources that they consider to be appropriate (Purcell et al., 2012, p.50), which does not prepare students for independent learning and develop their researching skills.

3. Material and methods

3.1 Participants

This study involved 20 students aged 16-18 years old from four secondary schools ('Gymnasium') in North Rhine-Westphalia, Germany. The group of participants was comprised of an equal number of female and male students, all of which were either in their final or pre-final year. Seven out of these 20 students chose geography as a major field of study and 17 out of 20 participants stated they received very good to satisfactory marks in the subject geography. This relatively old student age group was chosen to ensure that digital information retrieval was part of their private routine and that they all use the internet for information purposes. The intention was to collect data from a group of secondary school students near the end of their school career to gain insights into the internet researching skills of German students just before starting their higher educational studies. Consequently, the results of this research can be relevant also for universities, as the students' digital competencies demonstrated in this study may help to better reflect on the skills of their incoming student cohort. The study was carried out from spring to autumn 2018 until it became apparent that recurring patterns were emerging among the students during their internet research, which thus provided initial insights and conclusions. This limited number of cases also enabled a very in-depth qualitative analysis of the data. Certainly, the insights gained in this process must be verified in studies with higher numbers of participants.

3.2 Study task

The participants were requested to form a reasoned judgement on a complex geographical conflict by searching the internet for useful information. A local conflict was chosen, which is characterised by diverging but interlinking economic, environmental, and social interests. Spatial information and current material needed to be abundant and easily accessible through digital means. The conflict to be resolved needed to be distant from the home of the students so that the students had no prior knowledge.

These requirements were met by focusing on a geographical conflict occurring between the small towns of Neu Darchau and Darchau in Lower Saxony, Germany. The task was to decide whether a bridge should be constructed between the two towns that are separated by the River Elbe (Figure 2). Views vary on whether the bridge should be built between different interest groups due to a number of environmental, social, and economic factors. The convenience of this conflict as a research task for our study lies not only in its geographic relevance; the issue is also widely shared on the internet. A large amount of background information on the conflict, including personal statements with differing views, can be found on a variety of websites that include local and national newspapers, citizen initiatives, private blogs and Wikipedia. Videos from private and journalist sources are available on YouTube, as well as numerous posts on social networks such as Facebook. Of particular note is that common web mapping services – such as Google Maps – also provide useful information on the conflict: the two towns are very differently equipped in terms of infrastructure, such as schools, restaurants and supermarkets. A visible landmark that gives a plausible explanation for the different developments of the two towns, and also provides arguments for a historical and cultural relevance of a bridge, is the former German Democratic Republic (East Germany) border facility watchtower next to the town of Darchau. The inner German border separated the two towns of Darchau and Neu Darchau

until 1990. There is no other bridge over the Elbe nearby, which confirms the dependency on the existing ferry.

An Elbe bridge in Neu Darchau: curse or blessing?

A bridge between Neu Darchau and Darchau over the River Elbe has long been a subject of discussion. The two places are currently connected by a ferry, and there are different opinions and arguments as to whether a bridge should be built.

Task: Should a bridge be built between Darchau and Neu Darchau? Justify your opinion by weighing up the pros and cons of a bridge's construction over the River Elbe.

Figure 2: Study task – An Elbe Bridge in Neu Darchau: curse or blessing?

3.3 Data collection

Before starting the assignment the participating students were asked to fill in a partially standardised questionnaire to collect independent variables such as personal and school data, and information on their internet use at school and in private life. After answering the questionnaire, the students were asked to complete the study task and form a reasoned opinion on the conflict by researching the necessary information on the internet. While researching, students were allowed to take notes, handwritten or using a digital writing tool such as Microsoft Word or PowerPoint. This was optional for the students in order to offer them a working environment that was as natural as possible and the notes gave insights into their thinking and their researching strategies (San Diego et al., 2012, p.864). To provide a descriptive, in-depth insight into the students' strategies for research, participants were also asked to comment aloud on their thoughts and actions during the task. The 'thinking aloud' approach was chosen as it provides insights into cognitive processes while researching (Sandmann, 2014, p.179), usually without affecting the structure and course of the thought process (Ericsson & Simon, 1993, pp.105–106). We ensured that we obtained the consent of both parents and students to participate in the study with recording of screen activity and concurrent verbalisations.

While working on the assignment, we made sure that there was enough privacy so that the students were distracted as little as possible and were not inhibited from thinking aloud. 25% of the students had their own room during the assignment. The remaining 75% of participants sat in classrooms with up to 8 students, in which we secured enough privacy to express their thoughts in an undisturbed environment: the individual workstations were spaced far apart and were separated from each other by divider walls so that the students could not observe each other. The students worked on laptops wearing headsets over which the thinking aloud was recorded and which enabled them to listen to digital audio files and videos without disturbing the other study participants.

A screen and audio recorder was installed to capture all of the participants' digital actions and accompanying speech. Whilst there are technical merits of using a camera and recording device, this type of recording also had advantages with regards to the realism of the study results. The effect of behaving differently when being filmed (Foster, 1996, p.37) was considered to have been minimised using the screen and audio recorder, as there was no visible camera and only the students' on-screen actions and their voices were recorded. Previous research has shown that study participants feel comfortable when their digital actions are recorded with a screen recorder (Imler & Eichelberger, 2011, p.453). It was anticipated – and after conducting the study was confirmed – that, while researching, most students switched between taking notes and commenting verbally on information they found online. The combination of the recorded verbalisations, the recorded digital actions and the students' notes enabled us to gain many insights into their researching approaches.

Following the research task, participants gave their own opinion and their reasoning on the geographical conflict in question. They then filled in a standardised questionnaire in which they evaluated their success in finding information, their satisfaction with their conclusion and their enjoyment of the task on a rating scale from 1 to 5. There was a time limit of approximately 45 minutes for the task, which equals the time slot of a German school lesson. All of the students' thoughts and actions were recorded in an extended transcript, which included not only the transcribed student verbalisations while researching, but also their concurrent digital actions, the notes they took while researching and their justified opinion on the conflict.

Aside from the possible effect on the students whilst being recorded, some further limitations should be taken into account that may have influenced the study results. First, the students' research behaviour could further be affected by their motivation and by their interest in the topic. Second, the method of thinking aloud was unfamiliar to students and may have been uncomfortable or unsettling, which may have caused them not to express all their thoughts. Furthermore, unconscious thoughts or those not uttered cannot be recorded using the method of thinking aloud (Wilson, 1994, p.249). Third, the number of study participants cannot be considered sufficient to provide actual tangible results, and the study has been carried out with German students only. There may be different findings in other countries as the implementation of internet research in geography education may be more elaborate.

3.4 Data analysis

Following the students' approaches for understanding complex geographical conflicts using the internet (Figure 1) we analysed: (1) the students' identification of multi-dimensional information; (2) their analysis of spatial information and; (3) their recognition of temporally relevant information with respect to the three study questions, to determine: (I) whether the secondary school students found the necessary information that enabled them to fully understand the conflict; (II) what difficulties they faced and; (III) whether there were certain strategies that help them identify useful information. To do so, we analysed the extended transcripts of the students' researching process, the screen recordings and the simultaneous thinking aloud to get answers to our study questions. We used QDA software to organise the relevant student statements and Microsoft Excel to record the results of the analysis, to establish connections between the chosen student strategies and the success or failure of the internet research, and to present the findings graphically.

Firstly, to get a picture of the multi-dimensional information that the students identified, we counted the number of relevant pieces of information that were correctly understood by the students. We define 'a relevant piece of information' as any information that could serve as evidence for an argument about the geographical conflict to be dealt with. To give an example, the two following pieces of information on the conflict are both relevant, but in this context are only defined as being one piece of relevant information, since they serve as evidence for the same argument: 'The bridge is very expensive' and 'The bridge costs X amount'. The second information only supports the first one with an exact number. We were then able to identify how many relevant pieces of information the participants had found and classified the participants as performing above-average or below-average within this group, helping to identify researching strategies the above-average performers used. We then analysed the search terms formulated by the students, their choice of websites, and the information they collected with regards to its relevance to the task. We further analysed the extended transcript to determine whether the students explicitly mentioned difficulties they were having when searching for conflict-relevant information. In order to find out which difficulties were more frequently encountered, we used QDA software to organise the students' statements into categories, such as 'difficulties in reading comprehension' or 'difficulties in evaluating digital information'.

Secondly, we were interested in how the students performed in analysing spatial information. As spatial relations are difficult to express in texts it was of special interest to us whether students used cartographic data to locate the place of interest and to find information on the conflict. We were looking to determine the students' difficulties and strategies in obtaining conflict-related spatial information from maps. Therefore, we had to analyse the students' actions when dealing with maps and their accompanying speech. We looked at the students' screen recordings with a focus on their map work to find out whether they used digital maps or map programs at all, whether they located the conflict correctly, whether they used maps to verify the information they found in texts, and whether they analysed the map with regard to the conflict issue. We focused our analysis on the map work and the students' concurrent verbalisations. However, since students do not always express all thoughts, we also paid attention to cursor movements, zooming in and out, and student notes, which might indicate that the map was analysed in terms of the conflict.

Thirdly, we looked for indications as to whether the date of web pages and information was a selection criterion known to the students and whether they used it to identify developments in the conflict. To determine whether the students used the publication dates as a criterion for their information retrieval, we focused our analysis on indications that the students were paying attention to the date of publication or the date of information, either by mentioning it explicitly, by including dates in their notes or their argumentation, or by using the cursor to move over the date. As an example, the following quotes from two participating students were provided whilst they were looking at their search engine result list:

> *So, they are all from 2018, that's a difference to 2015.*
>
> *Let's see what's up to date. [...] So that's something more current than up here.*
>
> (NB all quotes have been translated from German into English)

We further hoped to get an indication of the difficulties and the strategies students used to recognise temporally relevant information, such as having problems finding publication dates on websites or using advanced search options to find up-to-date information on the conflict.
We were also interested as to whether we could find interactions between the identification of multi-dimensional information, the analysis of spatial information and the recognition of temporally relevant information. Using basic quantitative analysis, we wanted to determine whether students who perform comparatively well in identifying multi-dimensional information also paid special attention to publication dates or use maps comparatively often.

4. Results

4.1 The identification of multi-dimensional information

Identification of multi-dimensional information with regards to the geographical conflict is needed to understand the complexity of the conflict and develop an opinion based on the evidence. The observation of the students' digital researching process revealed that their success in retrieving information relevant to the conflict varies considerably. Figure 3 illustrates that the amount varied between 4 and 15 relevant pieces of information the students identified during their research. On average the 20 students identified 7.85 relevant pieces of information. We could not find any correlations between the amount of conflict-relevant information found in the internet research and the students' independent variables: age nor gender, their grade in geography lessons, or how often they conduct internet research in school or private life, did not give any indication for their results. The time required for the research was the same for all students, as was the technical equipment. Therefore, in the following section, we focus on the different search strategies used by students to explain these results.

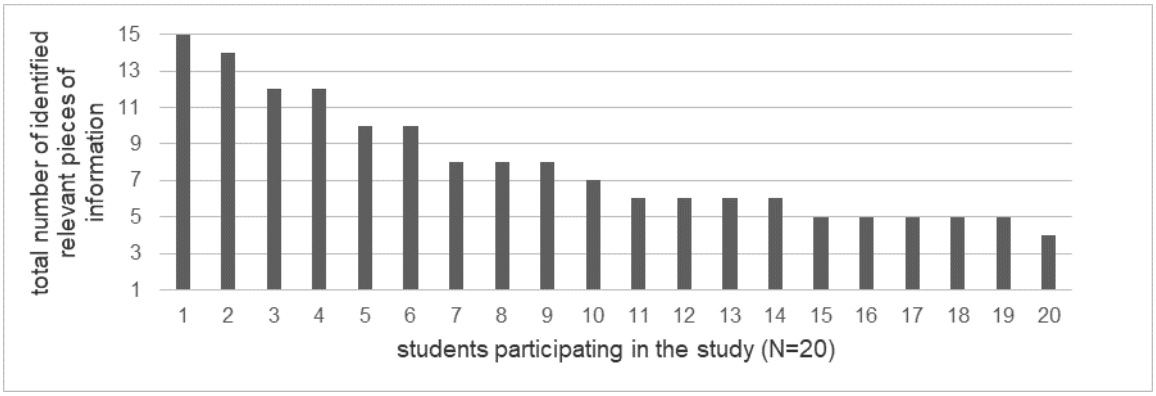

Figure 3: The identification of conflict-relevant information whilst undertaking research using the internet (authors' own diagram)

We observed that 7 out of the 20 students did not open any search results that were beyond the first two results on the result list, and more than half of the participants often spent only a very short period, sometimes less than 3 seconds, looking at the search result lists. As observers, the selection of websites by the students often seemed arbitrary. Only 9 of the 20 students showed obvious signs of reading the results, as they either read the results out loud or we assumed they did because they stayed on the search result page for a sufficient time to read the displayed search results.

To analyse the data in terms of strategies that helped students find conflict-relevant information, we categorised the collected data of the students into two groups: the students who found 8 or more relevant pieces of information were classified as above-average performers within this group (N=9) and the students who identified 7 or less relevant pieces of information were classified as below-average performers (N=11). As shown in Figure 4, the above-average performers changed their search queries on average 6.77 times, whereas the below-average performers modified their queries on average 4.81 times.

Figure 4: The average amount of search queries undertaken and the average amount of websites the students identified conflict-relevant information on (authors' own diagram)

The students used on average 3.55 websites to identify conflict-relevant information in order to form their opinion, with the above-average performers using around 28% more websites than the below-average performers (Figure 4). It was unexpected that 4 out of the 20 participating secondary school students only used one or two websites to extract information whilst researching the geographic conflict. This relatively small number of websites used cannot be explained with a lack of time, as, after finishing their research, the students were asked by the researchers if they had had enough time to complete the task. Only one of the participants said she had needed more time. All of the other participants considered their internet research to be finished. 15 of the 20 students stated in the subsequent questionnaire that it was either 'easy' or

'very easy' to find information on the topic. 5 of the students who found the least information also stated that they were 'very happy' or 'happy' with their research results. Unsurprisingly, the usage of more suitable resources led to the identification of more relevant information to the conflict, as a single source of information usually contains only a limited selection of relevant information. Therefore, the usage of a higher number of sources also increases the probability that different valid pieces of information are included. However, as different sources can contain the same content, not only is the number of used websites is of importance, but also the type of website the students used.

Figure 5 illustrates the types of websites the students used, for example the websites of newspapers or news broadcasters, websites of private action groups or Wikipedia. Websites that we could not assign to any of the named categories were grouped under 'others', such as private blogs. The above-average performers used on average 2.68 different types of websites; the below-average performers used on average 1.81 different types of websites. 36% of the below-average performers used only one type of website – the websites of newspapers – and none of those students found more than 6 relevant pieces of information. It seems that by using only journalist-written articles, the amount of relevant information identified was limited. In particular, this was thought to be because, due to their limited scope, newspaper articles cannot include a large number of relevant pieces of information and the different perspectives involved in the geographical conflict. In contrast, the citizens' initiatives and local political parties use their web presences to describe their concerns comprehensively and present their arguments in a very plausible manner. Overall, a mixture of different types of websites was shown to be the best way to find a high number of multi-dimensional information of a geographic conflict, which was shown by the participating student who identified most information, who used 4 different types of websites, including websites of newspapers, private action groups, towns, and federal state representations.

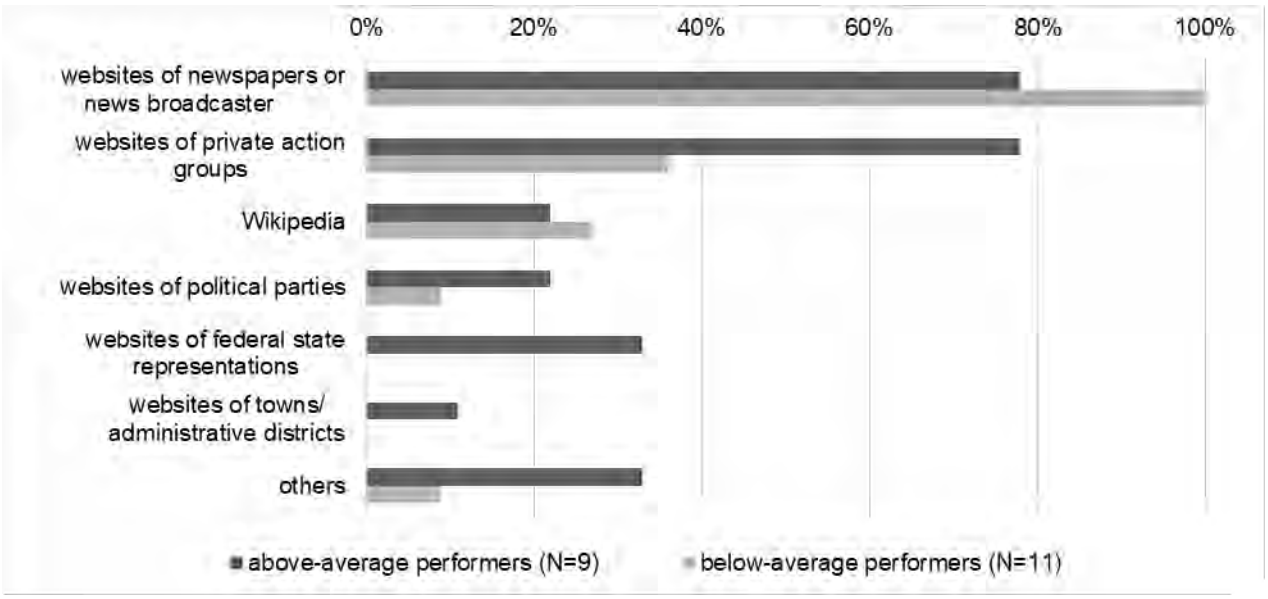

Figure 5: Different types of websites used by students in the research task (authors' own diagram)

As shown in Figure 6, most students took notes while researching, either handwritten or using a digital writing tool, with some students taking notes in both ways. The majority of below-average performers took handwritten notes, with only 2 out of 11 of these students using a digital writing tool. On the contrary, 5 out of the 9 students deemed above-average performers made use of a digital writing tool. Just over half of the students from the below-average group structured their

notes according to argument and assigned them to pros and cons, whereas 78% of the above-average students did so, and one of them assigned the identified pieces of information to the relevant interest groups. These results lead to the assumption that structured notes, either according to controversy or according to interest group, seem to be a strategy that positively affects the identification of conflict-relevant information.

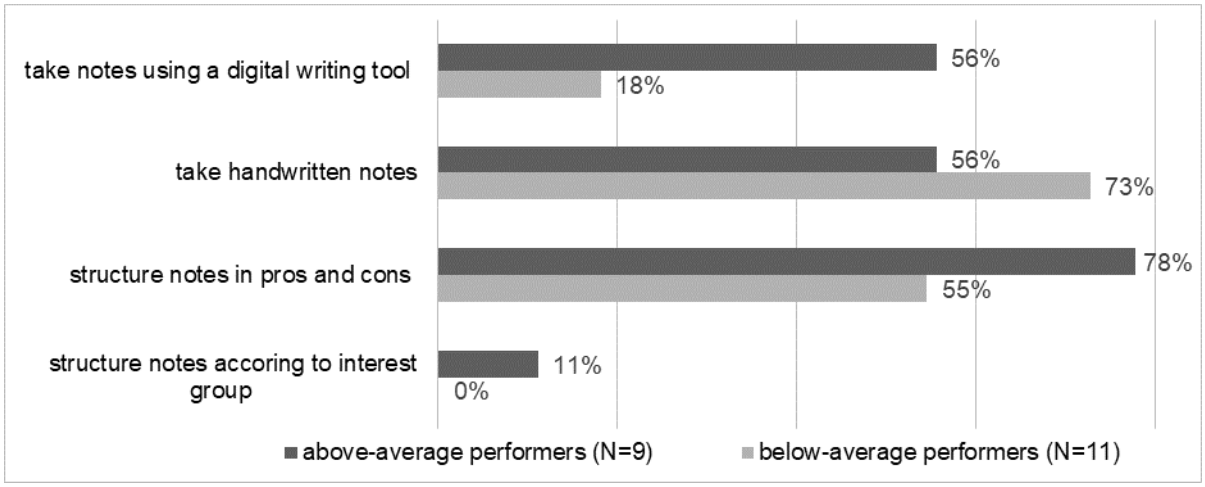

Figure 6: The methods by which students took notes while researching (authors' own diagram; multiple choices are possible)

4.2 The analysis of spatial information

As shown in Figure 7, the majority of the students did not use any maps whilst researching the geographic conflict. If students used maps it was generally at the very beginning of their search, usually intending to locate the conflict. Only one participating student repeatedly used a map in the course of their research and compared the information they read on websites with the cartographic information of online maps.

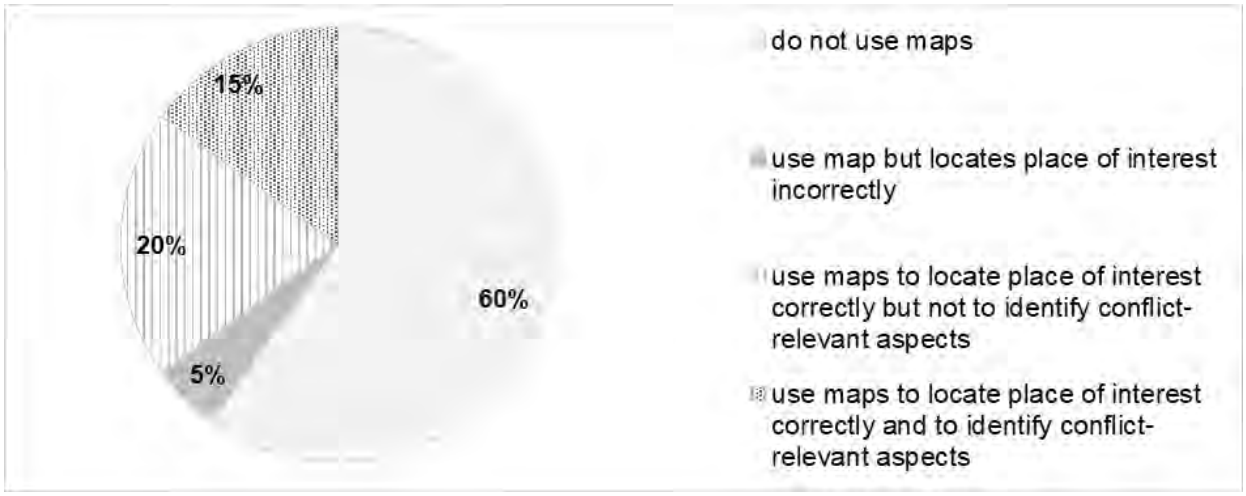

Figure 7: Students using maps while searching the internet (authors' own diagram)

30% of the above-average performers started their search explicitly searching for spatial information and not on the conflict itself. This was demonstrated as their first search terms were, for example, 'Where is Darchau?' or, they mentioned their interest in the location when thinking aloud:

First of all, I google the place to maybe find some information about it.

Only 18% of the below-average performers proceeded in that way. In contrast, 27% of the below-average performers started their information search with the search terms 'Elbe Bridge', and thus did not include the name of the place of interest. All of the above-average performers included the location of the conflict in their first search query.

The majority of the students did not use maps to gain spatial information, but the texts they read often contained information on the place of interest. However, 6 out of the 20 participating students did not indicate that they retrieved any spatial information, neither maps nor in text. Of this set of students, 4 of the 6 students are within the group of below-average performers.

There was no identifiable connection between the number of relevant pieces of information identified and usage of maps or web mapping services. This leads to the assumption that the majority of students blindly took information from the internet and did not obtain basic knowledge of the location in question and did not explore the local conditions. This leaves us in doubt as to whether the students understood all the information they found on the internet. It also raises the question as to whether the pupils are at all able to form an opinion about a conflict where the location and resources are unknown.

4.3 The recognition of temporally relevant information

The prerequisite for recognition of temporally relevant information is the observation of publication dates and the date on which the identified information took place, where relevant. Identifying the age of such information enables us to classify it in terms of time, to reconstruct developments of events and to determine the current status of the conflict.

The geographic conflict the students focused on has been in discussion for a number of decades, but current events have brought up the issue again and new developments in the conflict have taken place. There have been a few more recent developments in the conflict, i.e. that low water levels in summer 2018 have brought ferry traffic in the location of interest to a standstill, and current politicians are responding to these with new proposals for a solution to the conflict. The costs for the construction of a bridge are also considered to be rising.

As shown in Figure 8, 13 of the 20 participants did not show any noticeable signs of paying attention to dates, such as mentioning it aloud explicitly or scrolling with the mouse over the date of publication, a movement that was visible to the observers.

Out of the 7 students who apparently considered dates, only 1 student repeatedly identified publication dates and apparently used it as a criterion in the information search. The remaining 6 students did not seem to continuously evaluate their sources by date and instead only considered publication date once or twice during their research. Additionally, at least 1 of the 7 students who did consider dates did not check the publication date but rather trusted their feelings, as shown in the following quote:

This page looks relatively up-to-date.

None of the students explicitly searched for up-to-date information by including a date in the search terms, or by using advanced search options or Boolean operators to refine their search terms. As none of the students used these search options, and did not mention them whilst thinking aloud, it is thought that the students may not know strategies for refining their queries to specify their search terms.

Similar to the use of maps, we could not identify any links between the students' success in identifying relevant information and whether they considered publication dates. This finding also

casts doubt on the students' ability to distinguish the most recent state of events from earlier developments and thus to understand the conflict.

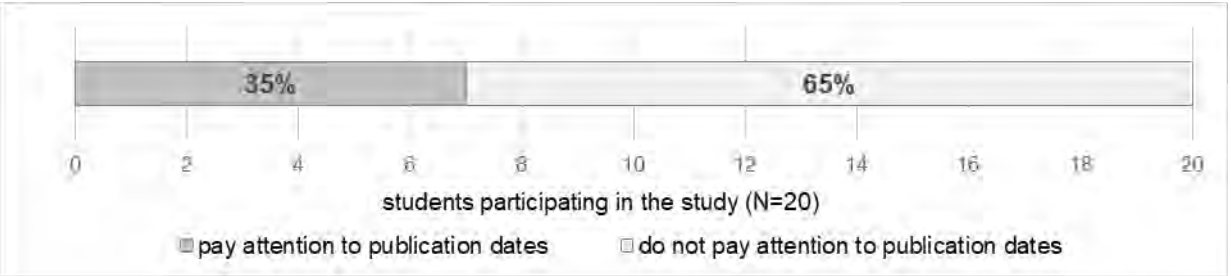

Figure 8: Students who considered publication dates (authors' own diagram)

5. Discussion and conclusion

The aim of this study was to generate initial findings about the research behaviour of secondary school students when trying to understand complex geographical conflicts using the internet. This research has investigated the study questions: (I) whether the students found the necessary information that enabled them to fully understand the conflict; (II) the difficulties students face whilst researching and; (III) if there are certain researching strategies that help the students identify useful information. The results of these questions are summarised below:

I. All students found suitable information during their research to get an overview of some aspects of the conflict. However, to fully understand the conflict students need to identify multi-perspective information, analyse spatial information and recognise temporally relevant information to understand a geographical conflict in its entirety (Figure 1). The main findings of our study revealed that students show very different abilities in finding multi-dimensional information when searching the internet, as the number of identified relevant pieces of information varied greatly between the participants.

   The majority of the participating students did not use maps in order to gain spatial information about the conflict. Only 15% of the participating students analysed a map with regard to the conflict in question. A possible explanation for this finding might be that the vast majority of map work in German geography classes is limited to describing maps and students rarely work on tasks that require map analysis, and map-based argumentations or evaluations are even rarer (Budke et al., 2017, p.11). The analysis of maps would not only have helped the students to identify conflict-relevant information but would also have supported the related texts identified.

   Almost two thirds of the students did not consider publication dates and thus were not in a position to classify the identified information in terms of time relevance, to understand developments of the conflict or to determine the most current state of the conflict. Since the majority of the students did not use maps nor considered dates, we can conclude that they obtained information oblivious to where or when the conflict is taking place. This leaves the quality of the obtained researched information in doubt. It was particularly striking to observe that the student who identified the largest amount of relevant pieces of information neither used maps nor considered publication dates. In contrast, the students who identified the least conflict-relevant information used a map to locate the place of interest and provided the publication dates of the retrieved information.

II. When researching geographical conflicts the participating students showed problems with both the method of researching information effectively and the evaluation of information. Many students had problems with the appropriate use of search engines, dealing with search result pages and evaluating digital information, which supports previous findings (Deyrup & Bloom, 2012; Julien & Barker, 2009; Stanford History Education Group, 2016). It was striking that pupils adopted the arguments of authors of blogs, letters to the editor, and citizens' initiatives without scrutinising them. Such behaviour when researching is particularly critical in the case of geographical conflicts, as there is no clear solution and different arguments must be weighed against each other to develop an argument. The retrieved information must be checked for accuracy to form a reliable judgement on the conflict. The students' missing verification of digital information gives reason to believe that they were not familiar with checking information and might not know any strategies of verifying the identified information. Whenever the students expressed doubts about the seriousness of websites, this seemed to be based on their gut feeling rather than specific criteria, as illustrated by the following student quote:

> *So, there have been quite a few polls done here, but the question is whether these polls are serious or not. But it looks like a study here or some kind of paper. That's why I trust them for now.*

Throughout the study, the only criterion that students knew about in order to determine the seriousness of websites seemed to be website familiarity; when they already knew of a website they considered it as trustworthy. If they were not familiar with a website, students often did not consider them to be trustworthy, even if those were the online presences of regional or national newspapers. This is shown in the following quote by a student, who was reading the links on the search results list after entering his search term:

> *And the first thing I see now is "SVZ Local". I don't know it. I don't know this "HAZ" either. I don't know the "National Newspaper" either. But, actually, I always press on what seems familiar to me. But since I don't know anything here, I just take the first one, because that was probably the most clicked and therefore, um, yes.*

The students' difficulties in finding valuable information when searching the internet may be influenced by a set of additional skills that we have not been able to measure in detail. Empirical studies have shown that students' general skills in information evaluation and organisation seem to positively influence their searching performance (Tsai et al., 2012, p.252), their writing skills and their general course performance tend to positively correlate with their information literacy skills (Lanning & Mallek, 2017; Shao & Purpur, 2016), and their reading comprehension influences their success in finding digital information (Brand-Gruwel et al., 2009, p.1209; Kanniainen et al., 2019, p.2213). Our observations give reason to believe that students' reading comprehension influenced their success in finding conflict-relevant information particularly; 45% of the students within the group of below-average performers explicitly mentioned that they were having comprehension problems. Of this group, 36% of the students misunderstood content on websites and took incorrect notes. Within both groups, many students overlooked valuable information on websites they were dealing with.

III. Strategies that apparently helped the students seemed to be the usage of a higher number of websites, a higher diversity of online resources, and more frequent modification of search terms. Additionally, the usage of digital writing tools to take notes on the identified information, especially when structured according to argument or

interest group, seemed to positively affect the search. A possible explanation for the effectiveness of digital notes may be that pupils can work faster with the help of digital writing tools than when writing with pencil and paper, leaving them more time for their research. Another possible explanation could be that students who do better research also tend to have better computer skills and therefore may be more likely to use digital writing programs. In addition, structured notes – handwritten or digital – give students a better visual overview of what arguments they have already found and whether there may be an imbalance between the proponents or opponents of a conflict issue.

As this study is only aiming to make some initial observations on students' difficulties and strategies when researching complex geographical conflicts, further research in the subject area should be focused on whether the identified connections between students' success in identifying conflict-relevant information and their researching strategies can also be found in larger study groups. In addition, studies should investigate how to improve the digital researching skills of students in geography lessons.

We anticipated that students who use maps to gather spatial information and who pay attention to publications dates to recognise developments in the conflict will be more successful in finding relevant information, so it was unexpected that the analysis of maps and recognition of temporally relevant information did not seem to be connected with students' researching success in identifying multi-dimensional information on the conflict. Follow on work from this study is focusing on the extent to which the students used their digitally retrieved information to form their own justified opinion on the topic. We hope that the analysis of the students' arguments will determine whether the number of identified multi-dimensional information, the analysis of spatial information and the recognition of temporally relevant information influenced the participants' opinions on the conflict and their reasoned argumentation.

Our study was conducted with comparatively advanced, high-performing students. We can assume that younger and weaker students would have even more difficulties researching complex geographical conflicts using the internet. For educational purposes, the findings of this study can provide initial ideas for a concept-based implementation of internet research in geography education. As digital information literacy requires a broad set of skills, regular guidance, practice, and multiple interventions will be necessary to result in a higher level of proficiency in internet-based research (Gross & Latham, 2013, p.189). Our developed model, consisting of three approaches for understanding complex geographical conflicts using the internet (see Figure 1), can be used as a framework for the development of teaching concepts. It appears that support materials such as scaffoldings, tables, or guidelines need to be developed that foster the students' identification of multi-dimensional information, their analysis of spatial information, and their recognition of temporally relevant information to understand the conflict in its entirety. Furthermore, it seems that the lesson design needs to better prepare students for internet research on complex geographical conflicts, to support them during their research in a process-guided manner, and to enable an evaluation of their research results.

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