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The Dramatic Arc in the Development of Argumentation Skills of Upper Secondary School Students in Geography Education

Kimmo Härmä [1,*], Sirpa Kärkkäinen [1] and Eila Jeronen [2,3,4]

[1] School of Applied Educational Science and Teacher Education, Philosophical Faculty, University of Eastern Finland, Yliopistokatu 7, FI-80100 Joensuu, Finland; sirpa.a.karkkainen@uef.fi
[2] Faculty of Education, University of Oulu, FI-90014 Oulu, Finland; ejeronen@gmail.com
[3] Faculty of Educational Sciences, University of Helsinki, FI-00014 Helsinki, Finland
[4] Faculty of Education, University of Lapland, FI-96101 Rovaniemi, Finland
* Correspondence: kharma@uef.fi

Abstract: Geography education can facilitate learners' critical thinking and argumentation skills to make well-reasoned decisions on social and environmental issues. This study reports on a geography course consisting of 18 lessons, each of them 75 min, designed to afford intensive practice in argumentation to upper secondary school students (n = 21) and following the dramatic arc. The study produces examples of different developmental pathways of upper secondary school students' argumentation during the geography course. In this qualitative case study, the data were collected from learning diaries and analyzed using content analysis following ARRA-analysis (Analysis of Reasoning, Rhetorics and Argumentation), which is based on Toulmin's argumentation model. The results indicated that most of the students developed justified arguments and composed clear claims and relevant rhetorical modes such as qualifications, rhetorical questions and rebuttals. Justification categories that were mainly used were backings, grounds and warrants. However, some students had difficulties in recognizing the main claim and arguments. The students developed their argumentation skills following the dramatic arc. They possessed the prerequisites for argumentative reasoning and writing but needed further practice in analytical and critical writing.

Keywords: dramatic arc; argumentation; geography education; ARRA analysis

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1. Introduction

Informed citizens need to be able to make decisions. Therefore, it is important that they learn to present evidence-based arguments. In recent years, research on argumentation in school education has increased sharply [1–6]. The term argumentation refers to the process of creating a considered or reasoned opinion on an issue or problem, based on relevant information: individual or group perception of the issue or problem and personal or social values. It includes drawing conclusions through logical reasoning.

According to Toulmin [7], the basic unit of argumentation is an argument. The aim of an argument is to convince the other party of the matter at hand [8]. Key components in argumentation are a person's claim, grounds to support this claim, and backing the grounds with a warrant [7]. Three additional elements include a backing, rebuttal and qualifier [9] related to the quality of the structure of the argumentation chain [10]. In the context of classroom-based teaching and learning, 'argument' often refers to reasoning used in a discussion or debate. In this study, the focus is on how the arguments presented are justified by sufficiently quantitative and qualitatively valid data that together form reliable chains of argumentation [7,11,12].

Research has shown the usefulness of argumentation in teaching and learning, especially in cross-disciplinary approaches such as education for sustainable development and global citizenship [13]. Cross-disciplinarity is also at the heart of geography due to the holistic, global and regional nature of the field [14,15]. Environmental and social issues

and phenomena increasingly intersect due to advances in science and technology [16]. Particularly, according to the Finnish upper secondary school curriculum, the teaching of environmental and social issues is linked to, among other things, building a sustainable future, living in a sustainable way, and promoting sustainable innovations [15]. These are the goals of education and teaching further defined in the Education 2030 Agenda published in 2017 by the United Nations Educational, Scientific and Cultural Organization [17]. Geography provides a good context for studying secondary school students' argumentation skills and their development during teaching and learning processes concerning environmental and social issues.

Previous studies have shown that argumentation skills are challenging to study, but also challenging to teach [2,18,19]. The teaching of argumentation skills has been seen to take up too much time and space from subject knowledge teaching, and thus has also been perceived as a resource issue. In Finland, the upper secondary school geography course, which is named "Common world", involves several cross-disciplinary topics in which social- and science-based issues intertwine. These issues are, for example, climate change and overpopulation, sources of livelihood and natural resources, welfare and development. The topics of the course touch every individual and can evoke emotions. Therefore, the structure of the course was chosen to follow the "dramatic arc". A "dramatic arc" is a literary term for the path a story follows, in this study it is a teaching approach. It provides a backbone by providing a clear beginning, middle, and end of the story [20,21]. With the help of the dramatic arc, such basic elements of drama such as roles, metaphors, tensions and conflicts, as well as time and space [22], combine to integrate the content of teaching into the student's own context. Teaching is expected to support the development of students' argumentation skills. Based on the ideas outlined above, using the dramatic arc framework and an argumentation approach, we explored what the secondary school students' argumentation skills are and how they develop in a geography course on environmental and social issues following a dramatic arc.

2. Theoretical Framework

Argumentation education has many benefits. It can increase learning motivation when students are free to share their thoughts without the limiting questions posed by the teacher [23]. Students' engagement in argumentation can motivate listening to other students' ideas, foster interest in them, and lead to a discussion about which ideas are best justified [24]. Argumentation can also support students' learning of subject knowledge, for example, when they are involved in shaping ideas and defining concepts [25]. During the argumentation process, students come to understand the issues they are studying more deeply as they consider the veracity or credibility of the arguments made by other students [26]. In addition, practicing argumentation makes information visible, facilitates exchange or perspective-sharing activities, develops information searching, increases self-reflection, creates a culture of community discourse with respectful objections and finally creates new knowledge [27,28]. The benefits of argumentation education are presented in Figure 1.

Argumentation has often seen to be challenging. Previous studies have shown that individuals of all ages perform poorly in assessments of both production and evaluation of arguments [29,30]. Students have several problems in producing arguments, paraphrasing and utilizing knowledge from different sources [31–34]. They have problems in constructing written texts [35,36], formulating arguments and combining theory and argument-related evidence, i.e., constructing arguments [2,37,38]. They also lack the competences to cite properly [39]. The use of, and reference to, student information sources has generated a debate about plagiarism [40]. Students may repeat the things presented in the sources instead of presenting their own ideas [41]. Reasons for these problems are insufficient participation of students in classroom discourse [2] and teachers' limited pedagogical skills in organizing activities supporting argumentation discourse [42].

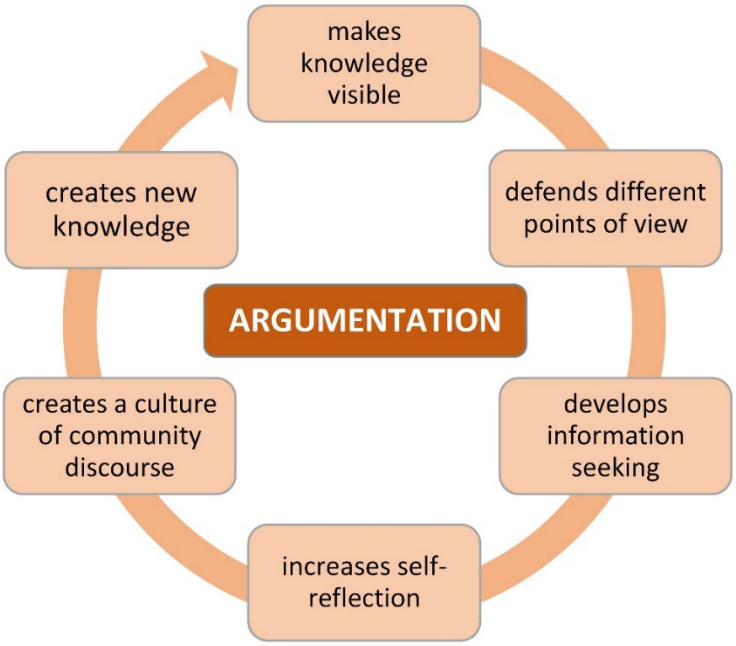


Figure 1. The benefits of practicing argumentation (own creation).

Argumentation skills have been studied quite extensively and the research has also focused on secondary school students and subjects with environmental topics [19,43] in which argumentation is practiced more concretely as part of the subject content knowledge. Argumentation skills are important skills in critical thinking [44]. They are needed in expressing perceptions, justifying them, and solving problems. Extensive, difficult and complex topics require diverse and critical thinking. According to many studies, there is a close relationship between argumentation skills and the development of reflexive skills and students' development of critical reasoning [45–48]. The development of argumentation skills is frequently associated with the promotion of a learning culture characterized by a deep understanding of the relationship between theory and practice [48]. The use of information and communication technology has been found to support the development of argumentation skills [49–51].

One of the best-known methods for examining the quality of argumentation and its development is Toulmin's argumentation pattern (TAP) [7], which has been used in many educational studies [1,11,12,52]. The categories of TAP include the claims, the warrant for their use and the backing of justification. Toulmin also classifies the qualitative attributes that emphasize the conditionality of argumentation, as well as the exceptions and rebuttal conditions. Qualitative attributes are different expressions such as "likely" or "supposedly" and exceptions and rebuttals are various additional options such as "yes unless . . . " or "on the other hand". In general, the idea of classifying argumentation to the TAP categories is that the more different categories of argumentation are included, the better the argumentation skills are [7,11,12].

In geography education, in addition to teaching biogeographical topics, the focus is also on social issues. Geography education plays a crucial role as it is concerned with supporting students to deepen their understanding of problematic issues such as climate change, water management, food security and energy choices [53]. Geography education involves identifying tensions (e.g., conflicting perceptions of sustainable development), understanding cause-and-effect relationships (e.g., the development of phenomena and things), generating and testing hypotheses (e.g., issues concerning local weather), arguing about geographical concepts (e.g., globalization, climate change), understanding contributions and impacts (e.g., wind power and total energy production) and comparison of things (e.g., sources of livelihood in different countries) [54]. It thus encompasses an engagement with real-world issues. When students explore real things and phenomena and argue

about them, they become familiar with complex inter-relationships and connections. In this case, argumentation can support their learning process [13]. Geography education has thus the potential "to connect people more closely with their surroundings and give greater meaning to their lives" [55]. This perspective is crucial when developing students' knowledge, skills and attitudes [17,56] related to the commitment to and advocacy for the environment.

This study aims to answer the following research questions:

Research Question 1 (RQ1). *What are the argumentation skills of Finnish upper secondary school students in the context of geographical issues?*

Research Question 2 (RQ2). *How do argumentation skills concerning environmental and social issues develop in a geography course following a dramatic arc?*

3. Materials and Methods

3.1. Participants, Context and Data Collection

The participants of the study were 21 upper secondary school students (aged 17–18) who completed the geography course "Common World". The selected student group was one of the seven groups of similar courses, which contained approximately 200 students from four different Finnish upper secondary schools. The data were collected from students' learning diaries. The use of learning diaries is a suitable method for learning difficult cross-disciplinary subjects, because students need to reflect on their learning and understanding. Learning diaries offer a good platform for students' own views of the topics [57]. The instructions for writing learning diaries were semi-structured, which gave the students freedom to create their own learning diaries [57,58]. The most important instruction was that the students should produce their own critical thinking, claims and argumentation from the main topics of the lesson. The instructions also emphasized that the learning diary should be written after each lesson, pointing out the value for learning and the fact that the diary would affect the evaluation of the course. In this study, the word *text* is conceptualized to mean one text, that a student has written for one lesson. The essential freedoms were that the students were able to choose certain specific areas of the lesson's main topics and they were free to choose the time and place to write the learning diary. The appropriate length of one text was defined as about half to one page. Learning diaries were uploaded on an O365 portal and the teacher had access to read the texts. The teacher commented on individual students' texts weekly during the course, and also provided help with writing tips if needed.

The learning diaries were just one working method in the course and there were also many others involved, for example group discussions and panels, media analysis assignments from different types of sources, short presentations on some of the smaller themes, and of course a teacher-led review of the most difficult details. In addition, there was a final exam on the most important phenomena and concepts of the course, but the course grade also consisted of other course work, such as the evaluation of study diaries.

3.2. The Dramatic Arc as a Basis of a Geography Course

The structure of the geography course was conformed to the dramatic arc (known also as narrative arc or story arc), with the rising action, the climax, and the falling action [59]. In this study, the structure of the dramatic arc has been applied so that it has four parts (acts): starting hook, rising action, climax, and conclusion [60]. These parts were separated into eight smaller sections and each section handled the main topics of the course including two or three lessons (Figure 2). The starting hook included topic 1 "What is culture and what is my cultural identity" and topic 2 "Development cooperation and measures of the development". The purpose of these topics is to arouse interest in the content of the course and increase students' self-reflection skills [27].

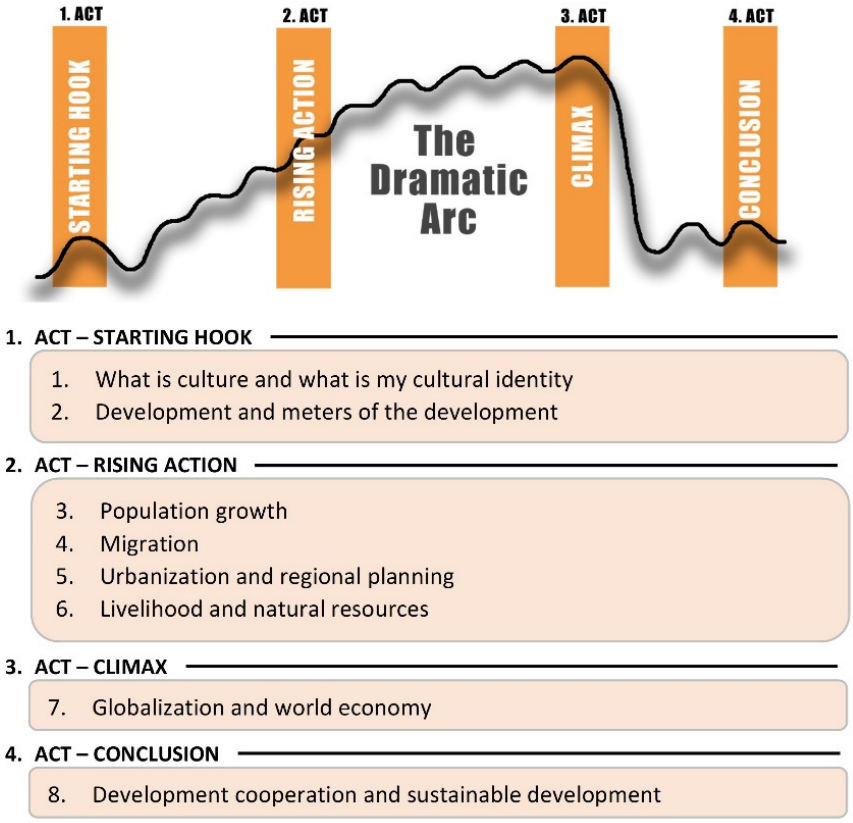


Figure 2. The structure of the dramatic arc, containing four different acts. The acts are separated into eight main topics of the upper secondary school geography course "Common World".

The rising action included more topics than the other acts: 3 "Population growth", 4 "Migration", 5 "Urbanization and regional planning" and 6 "Livelihood and natural resources". In these topics, student's knowledge and understanding of the course content grows and the connections between the different topics become clearer. This extensive and multidisciplinary act also develops information seeking. Topic 7 "Globalization and world economy" is the climax act, where the previous topics intertwine and form a coherent whole. In this act, new knowledge that is created during the course is constructed from many different points of view which are justified with multiple arguments. Topic 8 "Development cooperation and sustainable development" is the conclusion. This final act creates an understanding of the importance of a community dialogue culture in solving common challenges and provides the final solutions to the challenging topics of the course (cf. Figure 1).

3.3. Data Analysis

The study was a qualitative case study [61,62] and the analysis was based on ARRA-analysis (Analysis of Reasoning, Rhetorics and Argumentation) [63,64]. ARRA analysis [63,64] is a tool for identifying the components of argumentation. It is based on Toulmin's Argumentation Pattern (TAP) [7] and has been used especially for educational research and written material [64–66]. Parts of the argument form an argumentation chain and the main parts are claims, justifications and rhetorical modes [7,11,63,64]. In ARRA analysis these parts are separated into more detailed categories. Justification, which is focused on claim (C), is separated into offer ground or evidence (ground [G]), abstract concepts such as a theory or common knowledge (backing [B]) and more concrete justification (warrant [W]), such as sense observations, book texts, speeches, something which can be checked or touched. Rhetorical modes are links between justifications and claims. These expressions glue the parts of the argumentation chain together and make the ar-

gumentation process more reliable and understandable. Rhetorical modes categories are expressions of confidence, probability and likelihood (qualification [Q]), rebuttal expressions, which introduce reservations and the limits of the argumentation (rebuttal [R]), emotional expressions (e), proper questions (pq) and rhetorical questions (rq). Good and high-quality argumentation includes several justifications and rhetorical modes (Figure 3). The whole argumentation process may also contain several shorter argumentation chains with multiple claims [7,11,63,64].

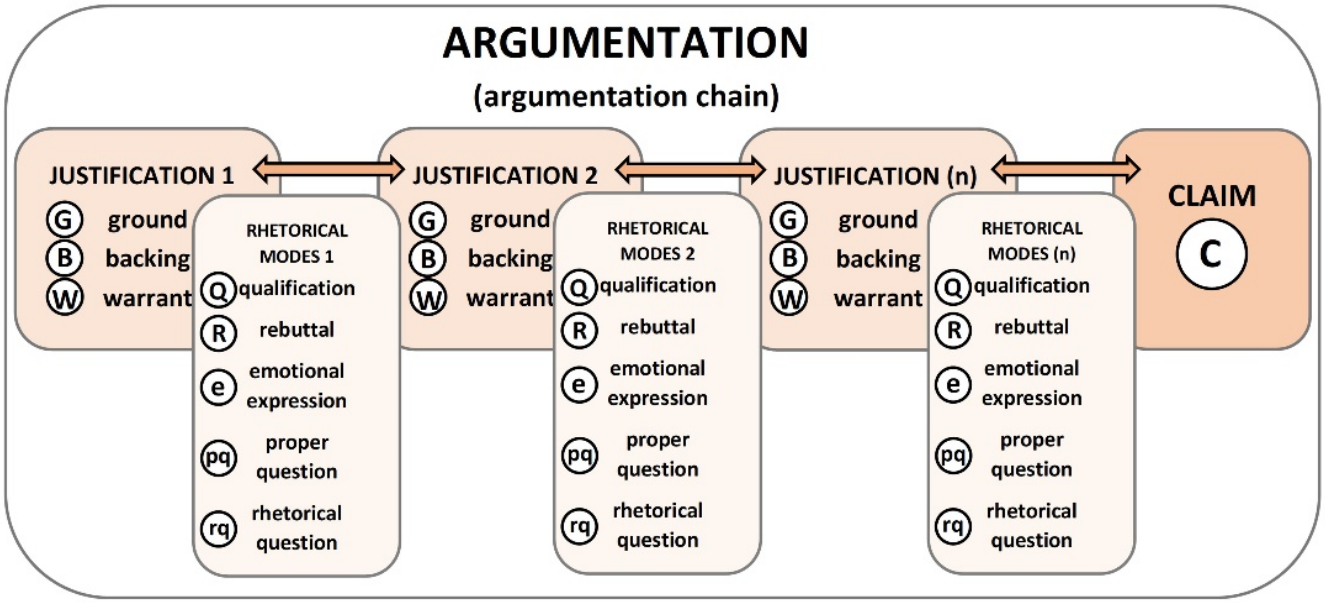


Figure 3. Components of the argumentation chain (own creation).

Data were analyzed text by text and argumentation category codes were marked to the margin of the text. Part of the data was analyzed by two researchers and the results were compared. This researcher triangulation was performed to improve the reliability of the study. All the students were anonymized and given codes in random order (S1, S2, S3, etc.). The code also includes the main topic of the course (1, 2, 3, etc.) which the text deals with. There were several lessons on each main topic, so different texts from the same main topic are also mentioned in codes (a, b, c, etc.). For example, code (S9:3a) means that the text is written by anonymized student 9 and it is the first text on topic 3 "Development and meters of the development". The following text (Figure 4) shows an example of the analysis. In this text, the student has six claims (C1–C6). There also appear categories from justification (G1–G3, B1, B2 and B3) and rhetorical modes (Q1, Q2, e1 and pq1).

In addition to the general analysis described above, the development of argumentation skills was also examined at the individual level of students. Individual students' argumentation was compared to the average results of the student group using SOLO (The structure of the observed learning outcome) taxonomy [67–69]. Students who did not approach the topic in an appropriate way were included in (1) Prestructural level, corresponding to the SOLO taxonomy for describing students' skill levels. These students used tautology, or just repeated the content of the lesson. They had not understood the points of the issues. In the second level (2) Unistructural, students had some relevant views of the topic but there was no connection between claims and argumentation. Understanding was minimal and below the average. In the level (3) Multistructural, students had several relevant views of the topic, independent claims, and the topic was understood serially, but there were unclear connections between the argumentation. In the level (4) Relational, students had relevant views of the topic, independent claims and argumentation, which was integrated into an overall coherent structure, was above the average. In the level (5) Extended abstract,

were students who argued the coherent whole, and re-conceptualized to a higher level of understanding the issue. Argumentation was clearly well above the average of the group.

In this lesson, we addressed topics that bother me quite often. **Population growth is the**	**C1**
greatest threat to the human species, i.e. man. I am **often annoyed when I look at**	**e1, Q1**
rubbish thrown on the ground, young people boasting on their mopeds or otherwise	**G1, G2**
people with a carefree attitude when it comes to responsible consumption. As people	**G3**
like this continue on the same path as the population grows, it's no wonder that "the	**B1**
earth's resources ran out this year." So I **often** wonder, then, **why is population growth**	**C2, Q2, pq1**
not being properly addressed? I know that things like this are far from simple, but the	**C3, B2**
later you wake up, the harder it is to react. Things like this must be reacted, because if	**C4, B3**
there is no change in direction, wars over natural resources will begin and the greatest	**C5**
threat to the human race will truly be unleashed. This cannot be the future we want for	**C6**
our children. (S9:3a)	

Figure 4. An example of one text and analysis from the text by student 9, which deals with topic 3 "Population growth". Claims (C) are colored red, justifications (G and B) shades of brown and rhetorical modes (Q, pq and e) shades of blue.

Argumentation chains show how the argumentation develops and what kinds of connections there are between the different argumentation categories. These chains were created for different example students to reflect on how students' argumentation skills develop in different ways. Figure 5 describes the argumentation chain of the previous example text (S9:3a) (Figure 4). This is an apt example of how students construct the argumentation, and one style of expressing claims, justifications and rhetorical modes. In this example, student (S9) builds a strong base for argumentation in the beginning. The first claim (C1) is justified with multiple justifications (G1, G2, G3 and B1) and rhetorical modes (Q1 and e1). The second claim (C2) is focused on two rhetorical modes (pq1 and Q1), the third claim receives one justification (B2), the fourth claim (C4) complements the previous, the fifth claim (C5) is focused on the last justification (B3) and the last, sixth claim (C6) closes the chain.

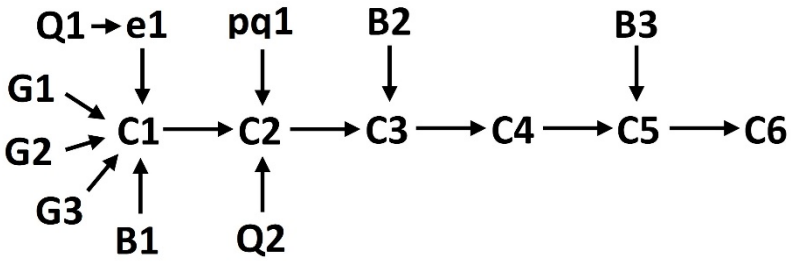


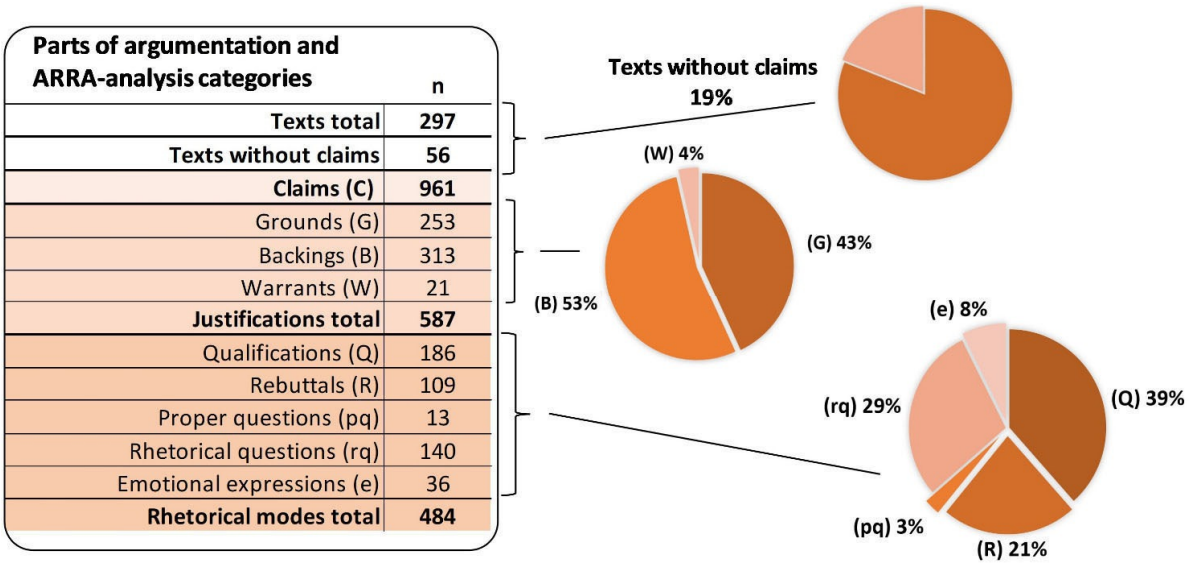
Figure 5. An example of one argumentation chain from the text by student 9, which deals with topic 3 "Development and meters of the development". ARRA-analysis revealed six different claims (C1–C6), six justifications (G1–G3 and B1–B3) and four rhetorical modes (Q1, Q2, e1 and pq1).

4. Results

4.1. Students' Argumentation Development

The students (n = 21) wrote 297 texts in learning diaries focusing on the content of the lessons (n = 18). They did not write a diary text for all lessons. In addition, there were 56 texts without any claims. All ARRA analysis categories [63,64] were found. There were 961 claims, corresponding approximately to three claims per text. In total, 586 justifications

were found, divided into grounds (G) 253, backings (B) 313 and warrants (W) 21. Not all the claims were justified. In rhetoric modes there appeared qualifications (Q) 186, rebuttals (R) 109, proper questions (pq) 13, rhetorical questions (rq) 140 and emotional expressions (e) 36. In total, rhetorical modes amounted to 484. Argumentation categories which were found in the diary texts are shown in Figure 6.



Parts of argumentation and ARRA-analysis categories	n
Texts total	297
Texts without claims	56
Claims (C)	**961**
Grounds (G)	253
Backings (B)	313
Warrants (W)	21
Justifications total	**587**
Qualifications (Q)	186
Rebuttals (R)	109
Proper questions (pq)	13
Rhetorical questions (rq)	140
Emotional expressions (e)	36
Rhetorical modes total	**484**

Figure 6. Appearance of argumentation categories in upper secondary school students' learning diaries. The table shows the number of ARRA-categories and the pie charts show relative and percentage distributions of categories.

Claims are the most important parts of an argument; without claims there can be no justification for them. The students' claims were qualitatively different. In some cases, the student made several claims but there was no clear link between the claims: "Finnish cities are multi-core models and peripheral cities. (C1) The parties are basically divided according to city models (C2). Different parties try to get the best possible conditions everywhere in Finland (C3). It would also be good if this could be the way all over the world (C4)." (S13:5c.)

There are four claims (C1–C4) which handle the same topic but different issues, without any connection. The following example also has four claims (C1–C4), although in this case the claims are connected and they support each other: "Religions, cultures and different languages are spreading around the globe and the world is constantly changing (C1). English, which has become the dominant language, is conquering, and becoming more and more common (C2). Whether you go to America, Africa or Asia, you will do well with English (C3). I think it is good that there is a language on earth that the majority understands (C4)." (S18:1c.)

Justifications provided basis for the arguments: "If there was a restriction in Finland that there should be only one child in a family, then I would be an only child (G1). I think that would be weird (C1) because my little siblings are most important to me (G2)." (S21:3a.) In addition to one argument (C1), one student wrote two grounds (G1 and G2) which were based on the student's own life and observation. In the next example the way of argumentation is similar to that in the previous case, but justification is made with more common views and abstract backing (B1): "Many children from a poor family feel happy (C1) even if they only have a family and nothing else (B1). They do not need a television, a smartphone, or a Chanel bag to be happy (C2)." (S18:1b.) In the diary of student S11, concrete warrants (W1 and W2) bring more reliability to justification for abstract backings or one's own grounds (G1): "The media war between Ukraine and Russia reminded me of how different information they tell about it (G1). Russian news (W1) reports that 200,000

people have been killed there (due to Ukraine, of course) and Finland (W2) reports that 2000?" (S11:2b.)

Rhetorical modes add quality attributes to argumentation and link parts together more strongly. The previous example continues: "That is what I have heard (Q1). I do not understand (R1) why so much propaganda is fed to the people in Russia and everyone believes it (C1)." (S11:2b.) In this example the student first presents a quality attribute (Q1) for the justification. Then comes the sentence that contains the final claim (C1) and critical thinking about rebuttal (R1) of the claim. In the diary of student S12, proper questions were something that had to be answered and a rhetorical question was more similar to wondering. In some cases, a rhetorical question (rq1) acted as an answer to a proper question (pq1): "Why does one product need raw materials from so many different countries (pq1)? Couldn't the product be so simple that everything that it needs could be found in one country (rq1)?" (S12:6b.) Some emotional expressions were also presented in rhetorical question form: "Where is humanity (e1)?" (S9:5c.) or "Is there any sense in life (e1)?" (S17:7b.) Typical emotional expression was some frustrating expression such as the previous, or for example: "In my opinion, it is sad that . . . (e1)" (S9:5c.)

Claims and justification categories indicate that students' argumentation skills improved during the course, although the number of claims and justifications collapsed in the last two main topics of the course (Figure 7). Students' argumentation activity follows the dramatic arc of the course with the rising action, the climax, and the falling action. The number of claims (C) and justification (grounds [G] and backings [B]) clearly increases up to topic 5, where the amount of argumentation reaches a peak. The same phenomenon is also partly observed in rhetorical modes, the appearance being more fragmented than in justifications, which are more important parts for argumentation quality. The exception in the development of justification was the category warrant (W). Students used only few warrants in all topics throughout the course. Diary texts of the first two topics (topic 1 "What is culture and what is my cultural identity" and topic 2 "Development cooperation and meters of the development") were short and seldom argued. After that (in topics 3 "Population growth" and 4 "Migration"), the diversity and number of argumentation categories increased and were highest in topics after the middle of the course (in topic 5 "Urbanization and regional planning" and topic 6 "Livelihood and natural resources"). In the sixth topic (6 "Livelihood and natural resources), argumentation decreased and was lowest in the last topic (8 "Development cooperation and sustainable development").

4.2. Individual Students' Argumentation Development

The students were grouped into three main groups based on their argumentation skills. In first group, students (n = 11) had a weak start, and then developed in argumentation during the course. These students represent the levels 'Prestructural' or 'Unistructural' in SOLO taxonomy [68,69]. In the prestructural level the student did not consider the topic in an appropriate way. He/she used tautology, or just repeated the content of the lesson. The student had not understood the points of the issues. In the unistructural level, students presented some relevant views of the topic, but no connection between claims and argumentation was found. Understanding was minimal.

In the second group, students (n = 9) were on a good level of argumentation in the beginning, but they did not clearly improve their argumentation during the course. They were in the *Multistructural level in SOLO taxonomy*. They were able to present several relevant views on the topic, as well as independent claims, and the topic was understood. The connections between the argumentation categories were however unclear. Some of the students were on a *Relational* level. They had relevant views on the topic, they presented independent claims and their argumentation was coherent. The third group contained students who were good at the beginning and developed to become excellent during the course. This student level in the SOLO taxonomy is *Extended abstract*. He/she argued coherently and re-conceptualized to a deeper understanding and learning.

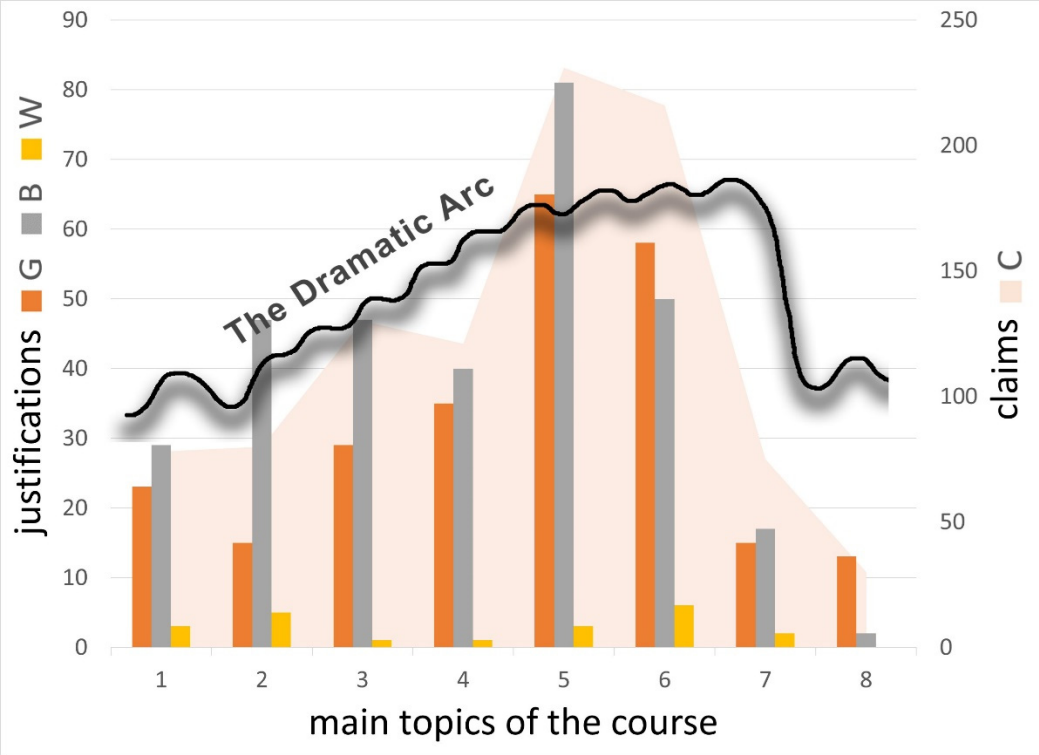


Figure 7. Justifications and claims in the main topics. The right vertical axis shows the number of claims and the left vertical axis the number of justification categories ground (G), backing (B) and warrant (W). The horizontal axis shows the chronological progress and the main topics of the course which are topic 1 "What is culture and what is my cultural identity", topic 2 "Development cooperation and meters of the development", topic 3 "Population growth", topic 4 "Migration", topic 5 "Urbanization and regional planning", topic 6 "Livelihood and natural resources", topic 7 "Globalization and world economy" and topic 8 "Development cooperation and sustainable development". The line describes the form of a theoretical Dramatic Arc.

Figure 8 describes one student's (S10) argumentation. He/she had a weak start and clearly developed during the course. The total amount of argumentation (claims (n = 37) and justification categories G (n = 10), B (n = 5) and W (n = 1)) in the learning diary was low, although there was a clear peak on topics 5 and 6. There was a clear rising action from topic 2 to topic 6, which was the climax, and then a falling action to topic 8. There was also a recognizable starting hook on topic 1. This development follows the development of the student group and the shape of the dramatic arc.

Figure 9 presents argumentation chains of student S10 showing the rising development during the course. The argumentation chain from the first diary text (S10:1a) deals with topic 1 "What is culture and what is my cultural identity". It contains two claims (C1 and C2), one justification (B1) and two rhetorical modes (R1 and Q1). The student presented most claims in the text of topic 5 "Urbanization and regional planning" (S10:5b). The argumentation chain of this text is much longer and more multidisciplinary than in the first text. There are eight claims (C1–C8), five justification (G1, G2, G3, B1 and B2) and three rhetorical modes (pq1, pq2 and rq1). The quality of argumentation has increased. On topic 1 the student writes: "Unfortunately, it is very (Q1) possible (R1) that the Sámi will experience marginalization (C1, B1). To prevent this, they would have to hold on to old customs and traditions and pass them on to future generations (C2)."

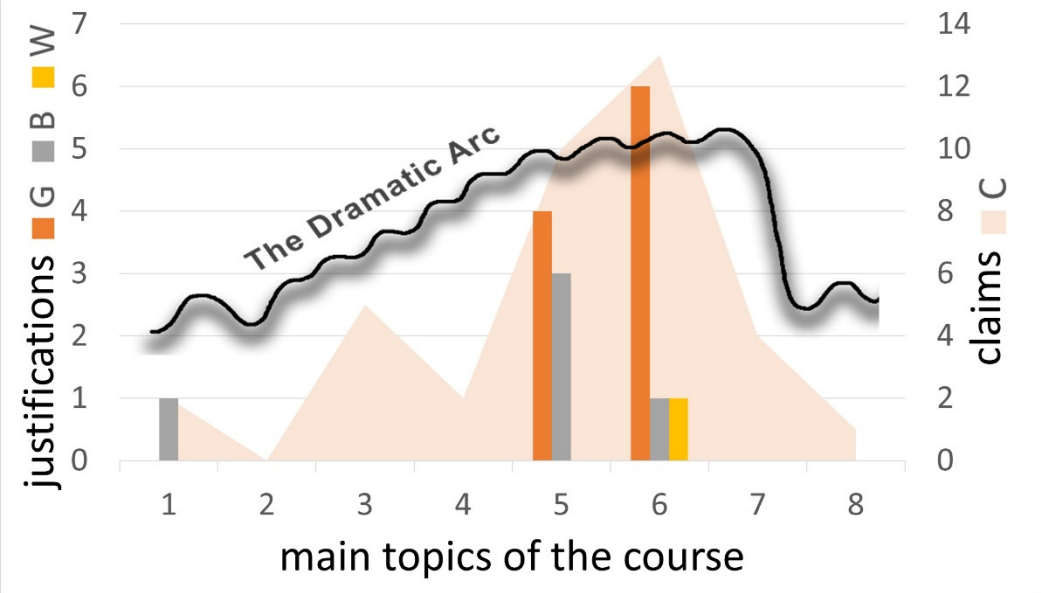


Figure 8. Argumentation categories of student (S10) from group 1. The right vertical axis shows the number of claims and the left axis shows the number of ARRA-analysis justification categories ground (G), backing (B) and warrant (W). The horizontal axis shows the chronological progress and the main topics of the course: 1 "What is culture and what is my cultural identity", 2 "Development cooperation and meters of the development", 3 "Population growth", 4 "Migration", 5 "Urbanization and regional planning", 6 "Livelihood and natural resources", 7 "Globalization and world economy" and 8 "Development cooperation and sustainable development". The line describes the form of a theoretical Dramatic Arc.

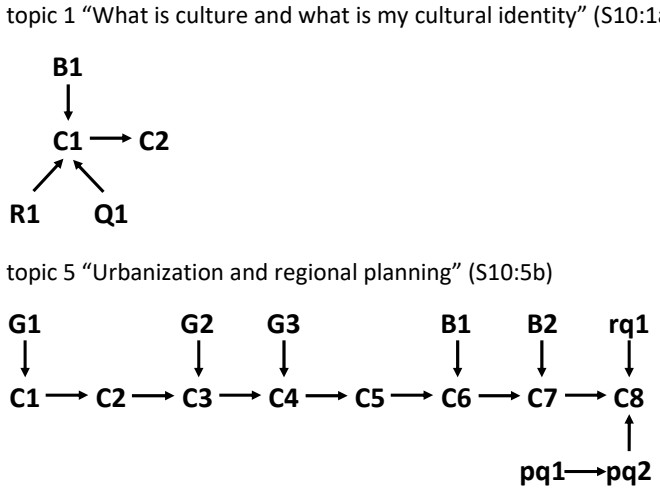


Figure 9. Argumentation chains of student S10 who had a weak start and clearly developed during the course.

Although the claims are justified, they are more similar to independent opinions than critical thinking with different points of view or new created knowledge. On topic 5 the student also presents opinions, although the thinking is comprehensive, and he/she clearly creates new knowledge. In the following excerpt, three claims are presented: "Participatory design is, in my view, a sensible activity in the design of new construction projects (C5). Who else knows best what the target group of the construction project wants from the end result (C6)? Children are a good example of this (B1). A playground can be boring for a child if it is completely the handwriting of an outside engineer (C7, B2)."

In addition, this is only part of longer thinking about the issue and there is also a connection to previous and following parts of the text.

Figure 10 describes a student (S2) who was good in the beginning but did not clearly improve his/her argumentation. The student had most claims on topic 6, and the number of argumentation categories (claims (n = 72) and justification categories G (n = 19), B (n = 29) and W (n = 6)) in the learning diary was much higher than in group 1. The difference between argumentation categories in different topics was not clear and did not follow the dramatic arc. Topic 1 already contained all justification categories (G, B and W) and the number of claims was high. Thereafter, excluding topic 6, the development of argumentation was falling towards the end of the course.

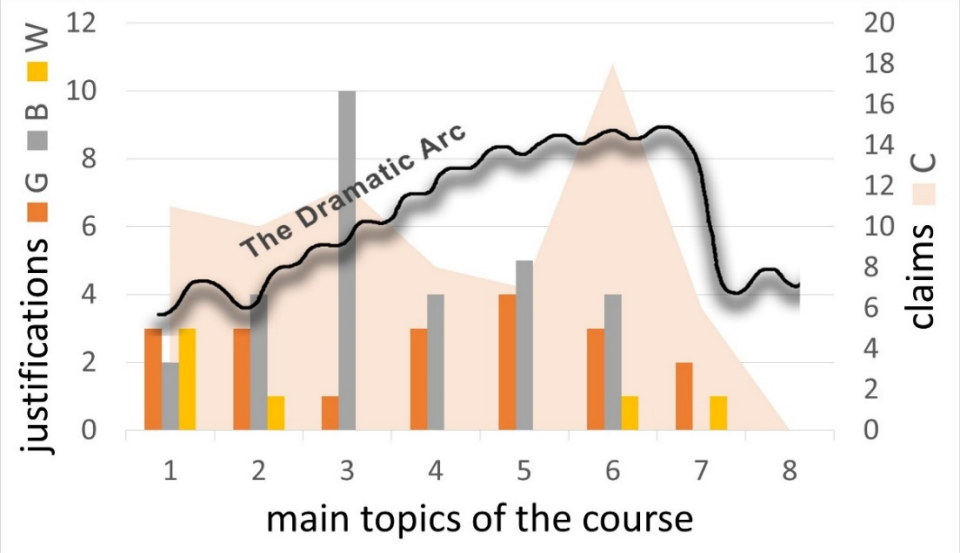


Figure 10. Argumentation categories of a student (S2) who was good in the beginning but did not clearly improve in argumentation. The right vertical axis shows the number of claims and the left axis shows the number of ARRA-analysis justification categories ground (G), backing (B) and warrant (W). The horizontal axis shows the chronological progress and the main topics of the course, which were: 1 "What is culture and what is my cultural identity", 2 "Development cooperation and meters of the development", 3 "Population growth", 4 "Migration", 5 "Urbanization and regional planning", 6 "Livelihood and natural resources", 7 "Globalization and world economy" and 8 "Development cooperation and sustainable development". The line describes the form of a theoretical Dramatic Arc.

The argumentation chains in Figure 11 show that the argumentation skills of student (S2) were better on topic 1 than on topic 6, although the difference was only small. There were six claims (C1-C6), six justifications (G1, G2, B1, W1, W2 and W3) and two rhetorical modes (rq1 and rq2) in the first learning diary text of the course on topic 1 "What is culture and what is my cultural identity" (S2:1a). The most claims are presented in the text of topic 6 "Livelihood and natural resources" (S2:6c) and there are three more (C1–C9) than in the text of topic 1. The number of justifications drops by three (G1, B1 and B2) and the number of rhetorical modes increases by two (Q1, Q2, rq1 and rq2). When comparing the texts on topic 1 and on topic 6, the thinking was critical and the argumentation good in both texts. The texts were understandable and contained independent claims, good justification and rhetorical modes such as rhetorical questions which carried the texts.

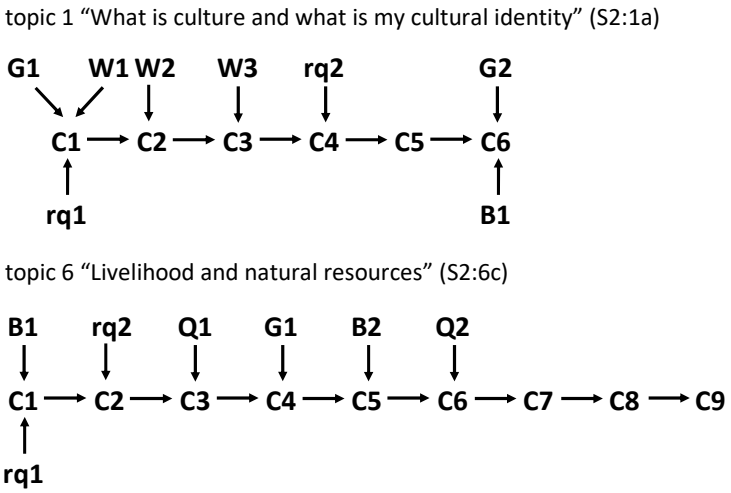


Figure 11. Argumentation chains of a student (S2) who was good in the beginning but did not clearly improve.

Text sample on topic 1:

One of my friends in London is a Muslim, and says (W2) there is a really large and close-knit Muslim community in London (C2). However, another thinks (W3) that there are very few Muslims in London (C3). If it is difficult to distinguish such different groups of people, is it right to talk about different cultural groups (rq2, C4)? I don't think so (C5).

Text sample on topic 6:

Could a person live only on local food (rq1)? No (C1). Each of us uses products imported from afar (B1). Even if someone would claim to live in a self-sufficient economy so as not to buy anything (C2), where would the seeds of the plants come from (rq2)? Probably (Q1) from the other side of the world (C3).

Only one student (S9) was clearly well above the others. This student was good already at the beginning and developed to an excellent level during the course. The total number of argumentation categories in the learning diary was high (claims (n = 101)), as were the numbers of the justification categories G (n = 24), B (n = 37) and W (n = 5)). Figure 12 shows that this student did not write the learning diary on topic 1 at the beginning of the course at all, but then the development increased considerably towards topic 5. Thereafter, the argumentation decreased towards topic 8. This development was similar to that in the whole group and also to the shape of the dramatic arc.

The student (S9) developed excellently in the argumentation, as shown in the argumentation chains (Figure 13). The student wrote in the first diary text from topic 2 "Development cooperation and meters of the development" (S9:2a). The argumentation of the first text was better and more comprehensive than the other students' argumentation. At the beginning there were six claims (C1–C6), five justifications (B1–B5) and five rhetorical modes (rq1, rq2, Q1, R1 and R2). In the text of topic 5 "Urbanization and regional planning" (S9:5c), the number of claims increased to 14 (C1–C14). The number of justifications was only four (B1-B4), but rhetorical modes increased to 16 (Q1, Q2, Q3, R1, R2, rq1–rq10 and e1). All in all, the total number of all categories in this argumentation chain increased to 34, which is the maximum amount per text of all the data in this study. Although the example text on topic 2 was shorter and the number of argumentation categories was lower than that in the text on topic 6, both of these examples form a coherent whole and indicate a deeper understanding and learning. The following excerpt from topic 6 text represents a very high level of critical thinking and also indicates how the student used rhetorical questions as a basis for the claims.

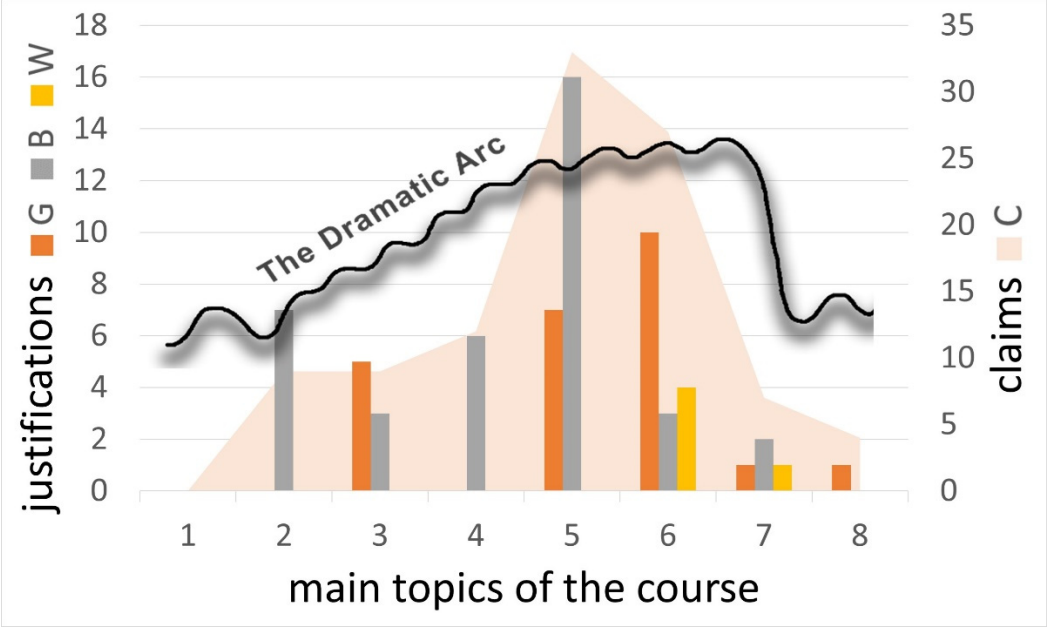


Figure 12. Argumentation categories of a student (S9) who was good at the beginning and developed to an excellent level during the course. The right vertical axis shows the number of claims and the left axis the number of justification categories ground (G), backing (B) and warrant (W). The horizontal axis shows the chronological progress and the main topics of the course: 1 "What is culture and what is my cultural identity", 2 "Development cooperation and meters of the development", 3 "Population growth", 4 "Migration", 5 "Urbanization and regional planning", 6 "Livelihood and natural resources", 7 "Globalization and world economy" and 8 "Development cooperation and sustainable development". The line describes the form of a theoretical Dramatic Arc.

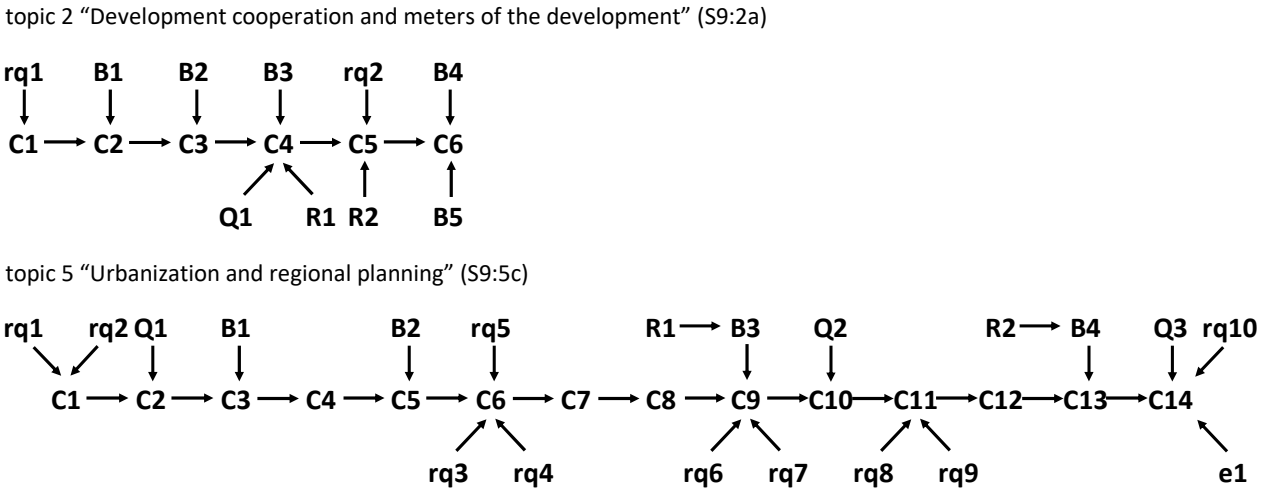


Figure 13. Argumentation chains of the student (S9) who was good at the beginning and developed to an excellent level during the course.

"But why not follow our [Finnish society] example (rq3)? Why is such radical social segregation allowed in São Paolo, for example (rq4)? Why, in general, do so many people have to live in slums and always worry about the next meal when, in another district, the chefs are splashing in the pools and eating caviar (rq5)? I think that the reasons for this are the lack of democracy and indifference (C6). When a small number of people have a lot of power (and money), they are not interested in the opinion of the people (C7)."

The students (S10) and (S9) both had a clear rising action, climax and falling action in their argumentation development. This conforms to the shape of the dramatic arc. The

student (S9) had considerably better argumentation skills than (S10). Argumentation development of the student (S2) was not clear, although he/she presented good argumentation during the course. There was no clear similarity to the dramatic arc or to the results of the whole group's argumentation development.

5. Discussion

The present study contributes to the current argumentation education literature both conceptually and methodologically [1,11,12]. The aim of the study was to analyze the quality of upper secondary school students' argumentation skills in geography education. We used the ARRA coding system [63,64], which is modified from Toulmin's [7] ideas. The benefit of ARRA analysis is that it includes a clear coding scheme [55,64,66]. The coding scheme used in this study contained the same essential aspects of the justified components as in general: claim, ground, backing, warrant, qualification, rebuttal, emotional expressions, proper questions and rhetorical questions [7,9,10]. The benefit of ARRA analysis was that it is a useful tool for assessing the quality of student's arguments as well as for visualization of arguments [52,66].

The teaching was implemented in the context of environmental issues and geography education [19,43] in a course in which upper secondary school students had to develop critical thinking [3,70,71] and argumentative skills [44]. Their argumentative skills developed well during the course, both in reflexive skills and critical reasoning [45–48].

The upper secondary school students were able to construct written texts, in contrast to the results of Valentine [35] and Kaposi and Dell [36]. However, they had problems in formulating justification for all claims [2,18,19,38]. Almost half of the claims presented by them had no justification at all [3,29]. In our study, the ability to cite properly was not examined [39]. However, we found that to some extent, upper secondary school students repeated the things presented in the sources as such without presenting their own thoughts. This result supports the research results of Abasi and Graves [41]. This was seen especially in the text without claims.

The results showed that argumentation followed the Dramatic Arc phases [60]. This was a new and surprising finding. The upper secondary school students' argumentation skills improved, becoming better during the course and especially in the climax phase. This finding is in line with the study of Telenius et al. [72], who found that the oral argumentation skills of Finnish upper secondary school students improved during the inquiry. The longer the course continued, the more upper secondary school students generated valid claims based on grounds and backings showing deeper understanding and learning [3,48,70,71]. The role of the teacher is important in supporting and promoting students' argumentation skills [42].

Differences in the development of argumentation chains between upper secondary school students were observed. In this study we grouped the students into three different argumentation levels. All the students developed their argumentation skills during the course, but especially one high-performing student had a longer chain with claims and justifications than the average- and low-performing students. The low-performing students' argumentation skills also developed, especially in the climax phase. The upper secondary students used computers to write their learning diaries, and it is possible that the use of information and communication technology supported the development of written argumentation skills [49–51].

The upper secondary school students wrote arguments that required environmental reasoning. They presented arguments about social welfare, environmental protection, growing populations in poverty, increasing competition for limited natural resources and degradation of the environment [53]. It is essential that upper secondary school students be prepared to develop arguments, and geography education helps prepare students for these tasks. Previous studies [1,28,73] have shown that the use of arguments plays a critical role in the development of critical thinking and deep understanding of complex environmental

and social issues. In this study, the students wrote diaries individually, and thus the role of interaction and collaboration was not important [13].

In Finland, the school geography curriculum/education [15,74] has undergone many changes during the past years but it still highlights critical and geographical thinking skills as well as an interdisciplinary view. Morgan [13] as well as Van der Sheen and Lidstone [53] also argued that students' argumentation skills are crucial for understanding spatial conflicts and complex social and environmental issues. Geographical knowledge and argumentation skills enable students to follow and participate in debates on significant local, national and global issues [55,56].

During the process of learning carried out in this study, it was found that the writing task was not easy for every student. In this study, argumentation is understood as a capacity to use only written arguments. In further research, it will be very important to highlight oral argumentation and students' capacity to use arguments for communicative purposes [2]. Both written and oral arguments are important in the context of SSI-education. Socioscientific issues involve open-ended problems with multiple solutions. Collaborative oral arguments develop through discussion and debate [75].

The instruction for learning diaries was quite open. The advantage of open instruction is that it allows students to use "natural" arguments. Learning diaries were useful because argumentation in geography is commonly open-ended, enabling different argumentation solutions [13]. According to Van der Schee and Lidstone [53], argumentation competence in geography is important and thus this study can be considered as a successful exploration into understanding the teaching and learning processes in the upper secondary school. Previous studies have shown that argumentation has been used primarily in science education [2,42,76] or environmental topics [19,43]. For example, the use of ICT and scaffolding are important tools that develop students' argumentation skills [49,50]. In addition to these, they can also be developed using drama education including the dramatic arc, as our study shows.

According to the results of this study, the ARRA argumentation tool seems to be useful when identifying the components of argumentation in upper secondary school, as Åhlberg [63–66] has previously shown. The main parts of argumentation chains [7,11,63,64] were presented in upper secondary school students' argumentation. These expressions glue the components of the argumentation chain together and make the argumentation process more reliable and understandable. Rhetorical mode categories are expressions of confidence, probability and likelihood (qualification [Q]), rebuttal expressions, which introduce reservations and the limits of the argumentation (rebuttal [R]), emotional expressions (e), proper questions (pq) and rhetorical questions (rq). Good and high-quality argumentation includes several justifications and rhetorical modes (Figure 2). The whole argumentation process may also contain many shorter argumentation chains with multiple claims [7,11,63,64].

In this study, it was possible to use researcher triangulation to increase the credibility and validity of research. This was important because it was difficult to apply Ramage's et al. [11] and Toulmin's [7] framework, to distinguish claims, data, warrants, and backings. The written comments made by students could sometimes be classified into multiple categories. In this study data was collected with the aid of learning diaries. The learning diary is not only thought to stimulate cognitive learning strategies, but also to encourage the application of metacognitive strategies [57]. The diaries also offered the teacher valuable insights into the student's learning processes [77]. The learners were encouraged to reflect on their learning activities and to take responsibility for their own learning process [78].

Assessments of upper secondary school students' argumentation skills confirm the failure of the Finnish educational system to provide students with an adequate understanding of social and environmental issues [79]. Thus, the significance of this study is also connected to changes in our national curriculum, in line with ongoing municipal reforms in the curriculum and the discussion on geography education. In our rapidly changing, interdependent and complex world, the importance of argumentation is obviously high.

This is in line with the results of Juntunen and Aksela [79] in the context of chemistry education in Finland.

Although the number of participants in this study is quite small, the case study allows for a profound examination of lesser researched issues [62,70]. These results cannot be generalized but they can be utilized in planning geography education for upper secondary school students. Newton, Driver and Osborne [2] highlighted that argumentation is not only context-specific, but it was also found to be teaching strategy-specific.

In this study, to increase the internal validity and therefore authenticity of the results, the context has been emphasized by describing it thoroughly and the study design has been set in terms of the context in which the study was carried out [80]. The plausibility and integrity of the research has been made explicit by presenting authentic data and interpreting this data in a transparent manner.

The validity of the research results is based principally on the process of data analysis. ARRA-analysis as well as SOLO-taxonomy are suitable tools for assessing the quality of arguments. This study was conducted in one school and one class, which limits the generalizability of the results. However, the challenges of argumentation are in line with university students' as well as upper secondary school students' argumentation skills in Finland [27,52,72] and thus, the results may well be transferable to other school environments in Finland. The results indicate that the experiences expressed by these upper secondary school students are general in nature. A limitation of the study is that although the results illustrate a pedagogically well-organized intervention, the data were based only on learning diaries [81,82]. The disadvantage of learning diaries is that they are quite time-consuming [77,78]. For ethical reasons all participants were well informed before the study and it was emphasized that participation was voluntary, and that the students could withdraw their data from the study at any time.

Participation in society requires increasing awareness of environmental action. Geography education bridges the natural and social sciences, and thus deals with spatial variability within and between places as well as human activities and their interrelationships and interactions with environments on local to global scales. In the future, environmental problems will become more extensive and more significant because of changes in the environment, and thus the role of argumentation in geography and environmental education is important and topical [72,83].

6. Conclusions

The dramatic arc in the development of skills of Finnish upper secondary school students was evaluated. Assessments of individual argumentation skills on environmental and social issues showed that the students improved in their argumentative skills. The role of argumentation in geography education is important because participation in society requires increasing awareness of environmental action and participation. It is obvious that the upper secondary school students have too few opportunities for the practice of argumentation. Thus, it is important to develop geography education for upper secondary school students in order to help improve their argumentation skills. With the aid of the ARRA-argumentation tool, the teacher can analyze students' writings. In future research it will be important to study how to scaffold students' argumentation skills through the integration of multiple science and environmental texts. Argumentation research should also be extended to include different schools and educational institutions. Upper secondary school students make decisions that have far-reaching consequences with cultural, economic and environmental repercussions for other people and places.

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Institutional Review Board Statement: The study was conducted in accordance with the ethical standards of the University of Eastern Finland and Finnish National Board on Research Integrity TENK. In addition, all participants were volunteers, they had the right to cancel their participation at any time, and the research material was completely anonymized and did not contain any sensitive information.

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

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

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References

1. Capkinoglu, E.; Yilmaz, S.; Leblebicioglu, G. Quality of argumentation by seventh-graders in local socioscientific issues. *J. Res. Sci. Teach.* **2020**, *57*, 827–855. [CrossRef]
2. Driver, R.; Newton, P.; Osborne, J. Establishing the norms of scientific argumentation in classrooms. *Sci. Educ.* **2000**, *84*, 287–312. [CrossRef]
3. Erduran, S.; Simon, S.; Osborne, J. Tapping into Argumentation: Developments in the Application of Toulmin's Argument Pattern for Studying Science Discourse. *Wiley Intersci.* **2004**. [CrossRef]
4. Kaya, E.; Erduran, S.; Cetin, P.S. Discourse, argumentation, and science lessons: Match or mismatch in high school students' perceptions and understanding? *Mevlana Int. J. Educ.* **2012**, *2*, 1–32.
5. Venville, G.J.; Dawson, V. The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning, and conceptual understanding of science. *J. Res. Sci. Teach.* **2010**, *47*, 952–977. [CrossRef]
6. Zohar, A.; Nemet, F. Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *J. Res. Sci. Teach.* **2002**, *39*, 35–62. [CrossRef]
7. Toulmin, S. *Uses of Argument*; Cambridge University Press: Cambridge, UK, 1958.
8. Van Eemeren, F.; Grootendorst, R. *A Systematic Theory of Argumentation: The Pragma-dialectical Approach*; Cambridge University Press: Cambridge, UK, 2004.
9. Kneupper, C.W. Teaching argument: An introduction to the Toulmin model. *Coll. Compos. Commun.* **1978**, *29*, 237–241. [CrossRef]
10. Abi-El-Mona, I.; Abd-El-Khalick, F. Perceptions of the Nature and "Goodness" of Argument among College Students, Science Teachers, and Scientists. *Int. J. Sci. Educ.* **2011**, *33*, 573–605. [CrossRef]
11. Ramage, J.; Callaway, M.; Clary-Lemon, J.; Waggoner, Z. *Argument in Composition*; Parlor Press LLC: West Lafayette, IN, USA, 2010.
12. Kakkuri-Knuuttila, M. *Argumentti Ja Kritiikki: Lukemisen, Keskustelun Ja Vakuuttamisen Taidot*; Gaudeamus: Helsinki, Finland, 2015.
13. Morgan, A. Argumentation, Geography Education and ICT. *Geography* **2006**, *91*, 126–140. [CrossRef]
14. Taylor, C. Towards a geography of education. In *Disciplines of Education, Their Role in the Future of Education Research*; Furlong, J., Lawn, M., Eds.; Routledge: London, UK, 2010; pp. 132–152.
15. Finnish National Agency for Education. *National Core Curriculum for General Upper Secondary Schools*; Finnish National Agency for Education: Helsinki, Finland, 2019; Available online: https://www.oph.fi/en/statistics-and-publications/publications/core-curriculum-general-upper-secondary-schools-nutshell (accessed on 13 April 2021).
16. Jasanoff, S. Science and citizenship: A new synergy. *Sci. Public Policy* **2004**, *31*, 90–94. [CrossRef]
17. UNESCO (United Nations Educational, Scientific and Cultural Organization). Leading SDG 4—Education 2030. Available online: https://en.unesco.org/themes/education2030-sdg4 (accessed on 13 April 2021).
18. Balgopal, M.; Wallace, A.; Dahlberg, S. Writing from different cultural contexts: How college students frame an environmental SSI through written arguments: Framing SSI Arguments. *J. Res. Sci. Teach.* **2017**, *54*, 195–218. [CrossRef]
19. Karpudewan, M. The role of green chemistry activities in fostering secondary school students' understanding of acidbase concepts and argumentation skills. *Chem. Educ. Res. Pract.* **2016**, *17*, 893–901. [CrossRef]
20. Alanko-Kahiluoto, O.; Käkelä-Puumala, T. *Kirjallisuudentutkimuksen Peruskäsitteitä*; Suomalaisen Kirjallisuuden Seura: Helsinki, Finland, 2008.
21. ElShafie, S.J. Making science meaningful for broad audiences through stories. *Integr. Comp. Biol.* **2018**, *58*, 1213–1223. [CrossRef] [PubMed]
22. Korhonen, P.; Ostern, A. (Eds.) *Katarsis: Draama, Teatteri Ja Kasvatus*; Atena Kustannus: Jyväskylä, Finland, 2001.
23. Andriessen, J.E.; Schwarz, B.B. Argumentative Design. In *Argumentation and Education*; Muller, M.N., Perret-Clermont, A.N., Eds.; Springer: Boston, MA, USA, 2009; pp. 45–174.
24. Weinberger, A.; Stegmann, K.; Fischer, F.; Mandl, H. Scripting Argumentative Knowledge Construction in Computer-Supported Learning Environments. In *Scripting Computer-Supported Collaborative Learning*; Fischer, F., Kollar, I., Mandl, H., Haake, J.M., Eds.; Springer: Boston, MA, USA, 2007; Volume 6, pp. 191–211.

25. Schwarz, C.V.; Reiser, B.J.; Davis, E.A.; Kenyon, L.; Acher, A.; Fortus, D.; Schwartz, Y.; Hug, B.; Krajcik, J. Developing a Learning Progression for Scientific Modeling: Making Scientific Modeling Accessible and Meaningful for Learners. J. *Res. Sci. Teach.* **2009**, *46*, 632–654. [CrossRef]
26. Chinn, C.A. Learning to Argue. In *The Rutgers Invitation Symposium on Education Series: Collaborative Learning, Reasoning, and Technology*; O'Donnell, A.M., Hmelo-Silver, C.E., Erkens, G., Eds.; Lawrence Erlbaum: Mahwah, NJ, USA, 2006; pp. 355–383.
27. Salminen, T.; Marttunen, M.; Laurinen, L. Argumentation in secondary school students' structured and unstructured chat discussions. *J. Educ. Comput. Res.* **2012**, *47*, 175–208. [CrossRef]
28. Fang, S.-C.; Hsu, Y.-S.; Lin, S.-S. Conceptualizing Socioscientific Decision Making from a Review of Research in Science Education. *Int. J. Sci. Math. Educ.* **2019**, *17*, 427–448. [CrossRef]
29. Hahn, U.; Oaksford, M. Rational argument. In *The Oxford Handbook of Thinking and Reasoning*; Holyoak, K.J., Morrison, R.G., Eds.; Oxford University Press: Oxford, UK, 2012. [CrossRef]
30. Kuhn, D.; Hemberger, L.; Khait, V. *Argue with Me: Argument as a Path to Developing Students' Thinking and Writing*; Wessex Inc.: New York, NY, USA, 2013. [CrossRef]
31. Barzilai, S.; Zohar, A. Epistemic Thinking in Action: Evaluating and Integrating Online Sources. *Cogn. Instr.* **2012**, *30*, 39–85. [CrossRef]
32. Bråten, I.; Strømsø, H.; Britt, M.A. Trust Matters: Examining the Role of Source Evaluation in Students' Construction of Meaning within and across Multiple Texts. *Read. Res. Q.* **2009**, *44*, 6–28. [CrossRef]
33. McGrew, S.; Ortega, T.; Breakstone, J.; Wineburg, S. The Challenge That's Bigger Than Fake News: Civic Reasoning in a Social Media Environment. *Am. Educ.* **2009**, *41*, 4–39.
34. Walraven, A.; Brand-Gruwel, S.; Boshuizen, H.P. How students evaluate information and sources when searching the World Wide Web for information. *Comput. Educ.* **2009**, *52*, 234–246. [CrossRef]
35. Valentine, K. Plagiarism as literacy practice: Recognizing and rethinking ethical binaries. *Coll. Compos. Commun.* **2006**, *58*, 89–109.
36. Kaposi, D.; Dell, P. Discourses of plagiarism: Moralist, proceduralist, developmental and inter-textual approaches. *Br. J. Sociol. Educ.* **2012**, *33*, 813–830. [CrossRef]
37. Grooms, J.; Sampson, V.; Golden, B. Comparing the effectiveness of verification and inquiry laboratories in supporting undergraduate science students in constructing arguments around socioscientific issues. *Int. J. Sci. Educ.* **2014**, *36*, 1412–1433. [CrossRef]
38. Zeidler, D.L. The central role of fallacious thinking in science education. *Sci. Educ.* **1997**, *81*, 483–496. [CrossRef]
39. Breen, L.; Maassen, M. Reducing the incidence of plagiarism in an undergraduate course: The role of education. *Issues Educ. Res.* **2005**, *15*, 1–16.
40. Gilmore, J.; Strickland, D.; Timmerman, B.; Maher, M.; Feldon, D. Weeds in the flower garden: An exploration of plagiarism in graduate students' research proposals and its connection to enculturation, ESL and contextual factors. *Int. J. Educ. Integr.* **2010**, *6*, 13–28. [CrossRef]
41. Abasi, A.R.; Graves, B. Academic literacy and plagiarism: Conversations with international graduate students and disciplinary professors. *J. Engl. Acad. Purp.* **2008**, *7*, 221–233. [CrossRef]
42. Duschl, R.A.; Osborne, J. Supporting and promoting argumentation discourse in science education. *Stud. Sci. Educ.* **2002**, *38*, 39–72. [CrossRef]
43. Sadler, T. Socio-scientific issues-based education: What we know about science education in the context of SSI. In *Socio-Scientific Issues in Classroom: Teaching, Learning and Research*; Sadsler, T., Ed.; Springer: New York, NY, USA, 2011; pp. 355–369.
44. Jin, Q.; Kim, M. Emergence of Argumentation in Elementary Students' Science Learning. *Can. J. New Sch. Educ.* **2020**, *11*, 9–17.
45. Abrami, P.; Bernard, R.M.; Borokhovski, E.; Wade, A.; Surkes, M.A.; Tamim, R.; Zhang, D. Instructional interventions affecting critical thinking skills and dispositions. *Rev. Educ. Res.* **2008**, *78*, 1102–1134. [CrossRef]
46. Bangert-Drowns, R.; Hurley, M.M.; Wilkinson, B. The effects of school-based writing to learn interventions on academic achievement. *Rev. Educ. Res.* **2004**, *61*, 213–238. [CrossRef]
47. Mitchell, S.; Prior, P.; Bilbro, R.; Peake, K.; See, B.H.; Andrews, R. A reflexive approach to interview data in an investigation of argument. *Int. J. Res. Method Educ.* **2008**, *31*, 229–241. [CrossRef]
48. Wells, G.; Mejia Arauz, R. Dialogue in the classroom. *J. Learn. Sci.* **2006**, *15*, 379–428. [CrossRef]
49. Coffin, C.; O'Halloran, K. Researching argumentation in educational contexts. *Int. J. Res. Method Educ.* **2008**, *31*, 219–227. [CrossRef]
50. Ravenscroft, A.; McAlister, S. Investigating and promoting educational argumentation. *Int. J. Res. Method Educ.* **2008**, *31*, 317–335. [CrossRef]
51. Eggert, S.; Nitsch, A.; Boone, W.J.; Nückles, M.; Bögeholz, S. Supporting Students' Learning and Socioscientific Reasoning about Climate Change—The Effect of Computer-Based Concept Mapping Scaffolds. *Res. Sci. Educ.* **2017**, *47*, 137–159. [CrossRef]
52. Keinonen, T.; Kärkkainen, S. University students' argumentation in science and environmental education. *Probl. Educ. 21st Century* **2010**, *22*, 54–63.
53. Van der Schee, J.; Lidstone, J. 2016 International Charter on Geographical Education. IGU Commision on Geographical Education. 2019. Available online: https://www.igu-cge.org/wp-content/uploads/2019/03/IGU_2016_eng_ver25Feb2019.pdf (accessed on 16 April 2021).

54. Roberts, M. *Geography through Enquiry: Approaches to Teaching and Learning in the Secondary School*; Geographical Association: Sheffield, UK, 2013.
55. Murphy, A.B. *Geography: Why It Matters*; Polity Press: Cambridge, UK, 2018.
56. Leicht, A.; Heiss, J.; Byun, W.J. (Eds.) *Issues and Trends in Education for Sustainable Development: Education on the Move*; United Nations Educational, Scientific and Cultural Organization: Paris, France, 2018; Available online: https://unesdoc.unesco.org/ark:/48223/pf0000261954?posInSet=1&queryId=c2a619f8-d20a-4b88-8ac4-1d52388e7e12 (accessed on 16 April 2021).
57. Ewijk, C.; Fabriz, S.; Büttner, G. Fostering Self-Regulated Learning Among Students by Means of an Electronic Learning Diary: A Training Experiment. *J. Cogn. Educ. Psychol.* **2015**, *14*, 77–97. [CrossRef]
58. Murtonen, M. Ohjattu oppimispäiväkirja reflektion välineenä yliopistopedagogiikan opinnoissa. *Yliopistopedagogiikka* **2013**, *20*, 19–23.
59. Tarán, L.; Gutas, D. *Aristotle Poetics: Editio Maior of the Greek Text with Historical Introductions and Philological Commentaries*; BRILL: Laiden, The Netherlands, 2012.
60. Moore, R.W. The Technique of the Drama: Gustav Freytag, E.J. MacEwan. *Sch. Rev.* **1895**, *3*, 238–239. [CrossRef]
61. Flick, U. *Managing Quality in Qualitative Research*, 2nd ed.; SAGE Publications Ltd.: Los Angeles, CA, USA, 2018.
62. Onwuegbuzie, A.; Leech, N. Generalization practices in qualitative research: A mixed methods case study. *Qual. Quant.* **2010**, *44*, 881–892. [CrossRef]
63. Åhlberg, M. HConcept maps, Vee diagrams and rhetorical argumentation (RAA) analysis: Three educational theory-based tools to facilitate meaningful learning. In Proceedings of the Third International Seminar on Misconceptions in Science and Mathematics, Ithaca, NY, USA, 1–3 August 1993; Cornell University: Ithaca, NY, USA, 1993; pp. 1–5.
64. Åhlberg, M.; Kaivola, T. Käsitekartat, Vee-heuristiikka ja argumentaatioanalyysi kestävää kehitystä edistävän tutkivan opiskeluprosessin apuvälineinä. In *Korkeakouluopetus Kestäväksi: Opas Yk:N Kestävää Kehitystä Edistävän Koulutuksen Vuosikymmentä Varten*; Kaivola, T., Rohweder, L., Eds.; Opetusministeriö, koulutus- ja tiedepolitiikan osasto: Helsinki, Finland, 2006; pp. 74–83. ISBN 952-485-091-5.
65. Salmio, K. *Esimerkkejä Peruskoulun Valtakunnallisista Arviointihankkeista Kestävän Kehityksen Didaktiikan Näkökulmasta: Vuosien 1993–1995 Valtakunnalliset Kokeet Ja Vuoden 1998 Luonnontieteiden Oppimistulosten Arviointi*; Joensuun yliopisto: Joensuu, Finland, 2004.
66. Åhlberg, M.; Chapman, J.; Reiss, M. How can we teach about global warming in an intellectually honest way as part of education for sustainable development? In Proceedings of the Third World Environmental Education Congress (3WEEC), Torino, Italy, 2–6 October 2005.
67. Biggs, J.; Collis, K. Towards a model of school-based curriculum development and assessment using the SOLO taxonomy. *Aust. J. Educ.* **1989**, *33*, 151–163. [CrossRef]
68. Chan, C.C.; Tsui, M.; Chan, M.Y.; Hong, J.H. Applying the structure of the observed learning outcomes (SOLO) taxonomy on student's learning outcomes: An empirical study. *Assess. Eval. High. Educ.* **2002**, *27*, 511–527. [CrossRef]
69. Karaksha, A.; Grant, G.; Nirthanan, S.N.; Davey, A.K.; Anoopkumar-Dukie, S.A. Comparative Study to Evaluate the Educational Impact of E-Learning Tools on Griffith University Pharmacy Students' Level of Understanding Using Bloom's and SOLO Taxonomies. *Educ. Res. Int.* **2014**, *2014*, 934854. [CrossRef]
70. Kim, M.; Roth, W.-M. Argumentation as/in/for dialogical relation: A case study from elementary school science. *Pedagog. Int. J.* **2014**, *9*, 300–321. [CrossRef]
71. Sampson, V.; Clark, D.B. Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Sci. Educ.* **2008**, *92*, 447–472. [CrossRef]
72. Telenius, M.; Yli-Panula, E.; Vesterinen, V.-M.; Vauras, M. Argumentation within Upper Secondary School Student Groups during Virtual Science Learning: Quality and Quantity of Spoken Argumentation. *Educ. Sci.* **2020**, *10*, 393. [CrossRef]
73. Rapanta, C. Argumentation as Critically Oriented Pedagogical Dialogue. *Informal Log.* **2019**, *39*, 1–31. [CrossRef]
74. Finnish National Agency for Education. *National Core Curriculum for General Upper Secondary Schools*; Finnish National Agency for Education: Helsinki, Finland, 2015.
75. Knight, A.M.; McNeill, K.L. Comparing Students' Individual Written and Collaborative Oral Socioscientific Arguments. *Int. J. Environ. Sci. Educ.* **2015**, *10*, 623–647.
76. Duschl, R.A. Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Rev. Res. Educ.* **2008**, *32*, 268–291. [CrossRef]
77. MacQuarrie, S. Everyday teaching and outdoor learning: Developing an integrated approach to support school-based provision. *Education* **2018**, *46*, 345–361. [CrossRef]
78. Park, C. Engaging Students in the Learning Process:the learning journal. *J. Geogr. High. Educ.* **2003**, *27*, 183–199. [CrossRef]
79. Juntunen, M.; Aksela, M. Improving students' argumentation skills through a product life-cycle analysis project in chemistry education. *Chem. Educ. Res. Pr.* **2014**, *15*, 639–649. [CrossRef]
80. Elo, S.; Kääriäinen, M.; Kanste, O.; Pölkki, T.; Utriainen, K.; Kyngäs, H. Qualitative Content Analysis: A Focus on Trustworthiness. *SAGE Open* **2014**, *4*, 1–10. [CrossRef]
81. Krippendorff, K. *Content Analysis: An Introduction to Its Methodology*, 2nd ed.; Sage: Thousand Oaks, CA, USA, 2004.

82. Vaismoradi, M.; Jones, J.; Turunen, H.; Snelgrove, S. Theme development in qualitative content analysis and thematic analysis. *J. Nurs. Educ. Pract.* **2016**, *6*, 100. [CrossRef]
83. Yli-Panula, E.; Jeronen, E.; Telenius, M. Argumentaatiotaitojen harjoittaminen ekosysteemiopetuksessa: Aiheena yhteiskunnallis-luonnontieteelliset ilmiöt (Phenomena-based socio-scientifc issues in practicing argumentation skills in teaching ecosystems). In *Opetuksen Ja Oppimisen Ytimessä. Suomen Ainedidaktisen Tutkimusseuran Julkaisuja*; Luukka, E., Palomäki, A., Pihkala-Posti, L., Hanska, J., Eds.; Tampereen Yliopisto: Tampere, Finland, 2021; Volume 19, pp. 222–247.