EXPERIENCES OF THE USE OF ARGUMENTATION VISUALISATION IN SECONDARY SCHOOLS

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ABSTRACT

Argument visualisation refers to graphical or other non-verbal means of making reasoning chains and conclusions explicit. Constructing argument diagrams is one way to visualise argumentation. The solving of ill-structured problems, commonly related to societal and educational questions, can be facilitated by a visual depiction of the variety of viewpoints relevant to the problem in hand, and the arguments used to support different solutions.

In this study 7 male and 10 female Finnish secondary school students were set the task of constructing and elaborating an argument diagram on the issue of genetically modified organisms (GMO). The task proceeded in three successive phases using a network-based tool. The students constructed their first diagram on the basis of their previous knowledge on GMO, modified it after having read three articles on the theme, and finalised the diagram after they had engaged in a dyadic chat debate on the same theme. The diagrams were analysed for shape and content.

The results showed that the students’ final diagrams included the greatest amount of argument boxes, the broadest and longest chains of argument, and the greatest number of topics relevant to the theme. The most evident change was observed after the students had read three articles on the topic. The results suggest that the students deepened and broadened their knowledge on the theme during the course. It was concluded that by means of alternate phases of reading, discussion and reflection secondary school students’ knowledge and thinking can be elaborated, thereby fostering their learning.

KEYWORDS

Argumentation, Visualisation of argumentation, Collaborative learning, Secondary schools

1. INTRODUCTION

Argumentation means the putting forward of relevant and sufficient arguments in favour of one’s positions and opinions. Argumentation is sufficient when claims have been supported from various viewpoints essential in terms of those claims. Argumentation is relevant when the arguments presented are related to a claim in a meaningful way. Thus, relevance refers to the relation of a claim and an argument, not to their quality (Hitchcock, 1992).

A person skilled in argumentation is able to put forward relevant and sufficient arguments in support of his/her claims. Furthermore, s/he is able to warrant arguments and to refute counterarguments presented by other people. An argument is warranted when one has explained why the argument in question should be regarded as appropriate and as a good support for the claim (Toulmin, 1984). Counterarguments and refutations of counterarguments are of particular importance in argumentative discussions (van Eemeren, 1991). Counterarguments are used in order to oppose arguments presented by other people. When a person defends his/her arguments against others’ counterarguments his/her aim is to show they are invalid and inappropriate.

Argumentation skills play an important role in getting one’s voice heard in society. People today are increasingly expected to be able to participate actively in public discussions and to have an influence on political decisions on many, often global, societal issues, such as pollution and the distribution of welfare. Due to the rapid development of information and communication technology there are many information

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sources available for every citizen to model one’s opinion. Experiences of argumentative discussion facilitate critical evaluation of information sources in general and the strengths and weaknesses of different items of information in particular.

Argumentation is also an essential means for learning collaboratively with other people. When different viewpoints, arguments and counterarguments are put forward in the course of discussions, people may be able to learn and understand certain issues more thoroughly. The aim of collaborative argumentation is not to try to prove that our own thoughts and arguments are the only right ones and other’s arguments false, but, jointly, to deepen and expand knowledge by critically examining issues from various perspectives.

2. VISUALISATION OF ARGUMENTATION

Visualisation of argumentation refers to making chains of reasoning and arguments relating to claims and conclusions explicit using graphical or other non-verbal techniques (van Gelder, 2003). Visualising arguments can be regarded as an optional way along with argumentative writing and argumentative discussions to present opinions and arguments in support of them.

One way to visualise argumentation is to construct argument diagrams. By the aid of diagrams a person can effectively illustrate his/her viewpoint on some particular issue, and the arguments s/he wants to use in support of it. Diagrams are also helpful in showing how supporting arguments can be questioned and criticized, and in making the interrelationships between claims, arguments and counterarguments visible to a reader. A major benefit of argument diagrams compared to argumentative texts is that diagrams make it easier for the reader to form a general view on the opinions and arguments of the writer (van Gelder, 2003). Common problems in reading argumentative texts are, first, that the reader has to identify the writer’s claims and arguments in the text and second, that s/he has to interpret the ultimate meaning of those arguments and their interconnections. When reading an argumentative text the reader may, for example, find it difficult to understand unambiguously whether some specific argument is meant to support the main claim of the text or is merely an argument in support of some other argument of the main claim. van Gelder emphasises that difficulty in interpreting the argumentative structure of a text often results in misunderstanding the writer. When claims, arguments, and their interrelationships are depicted by help of a diagram, the reader may find it easier to direct his/her cognitive resources in a more appropriate way. This means that the reader no longer has to struggle to search for relevant information in the text and organise it into a more understandable form, but can concentrate directly on its argumentative content (c.f. van Bruggen & Kirschner, 2003).

Forming a general view of argumentation is also helpful in solving ill-structured problems (van Bruggen et al., 2003). It is characteristic of ill-structured problems that they are often ambiguous and loosely defined, solving the problem necessitates the use of several potential sources of information, and that there is no single path to the valid solution. Argumentation is essential in solving ill-structured problems: the relevance of the problem as well as the criteria for different optional solutions need to be justified carefully. As van Bruggen and Kirschner (2003) put it, there are no true or false solutions to ill-structured problems, only good or bad ones. How good a solution is depends eventually on how well it has been justified. Examples of ill-structured educational problems are: How does one write a good argumentative text?, and How does one broaden and deepen one’s knowledge by means of argumentative debate with someone else? There are several ways of solving both of these problems. The different solutions depend on the argumentative skills of persons, their manner and way of putting forward arguments, as well as their knowledge of the issues in question. However, a valid solution to both problems will include similar argumentative elements: both a good argumentative text and an educational debate will include relevant arguments in support of opinions and claims, counterarguments, and refutations of counterarguments in order to show that one’s opponents critique is weak and irrelevant.

This study focuses on constructing argument diagrams in a virtual environment in secondary schools. The task of the students was a) to design an argument diagram on the basis of their previous knowledge on a particular topic, b) to elaborate the diagram after having read topic-related texts, and c) to finalise the diagram after having discussed the topic together. The development of the students’ diagrams was investigated with the help of the following research questions: (1) How many arguments did the diagrams include? (2) How deep and how broad were the students’ diagrams? (3) How many viewpoints on the topic
3. METHOD

3.1 Subjects

The subjects were 7 male and 10 female Finnish secondary school students aged from 16 to 17 years. During the fall term 2003, the students engaged in a six-week course, *The power of language*, which is included in the national curriculum on the mother tongue in Finland. This obligatory 30-hour course also includes argumentation studies. Argumentation-related course content covered such themes as rhetorical means in speech and writing, writing of argumentative texts on the basis of given source material, and pictorial and textual means to affect people. Furthermore, during the course the students practised argumentation with the CABLE (Collaborative Argumentation-Based Learning) Internet tools. These tools form a network learning environment in which students can construct argument diagrams individually or collaboratively, engage in chat with each other, and write texts together (more information on the tools can be found at: http://www.euroscale.net/). For eight class hours (four double lessons) the students practised argument visualisation by constructing argumentation diagrams with the CABLE tools. These lessons are described in more detail in the following.

3.2 Teaching arrangements

Teaching argumentation with the CABLE tools comprised the following three phases: (1) Learning the basic concepts of argumentation, and training to use the tools; (2) Constructing and modifying argument diagrams; and (3) Debate and consolidation of learning.

3.2.1 Learning the basic concepts of argumentation, and training with the tools

The first double lesson (90 minutes) was spent on the theory of argumentation in order to prepare the students for subsequent exercises with the CABLE tools. The students and the teacher discussed together the essence and characteristics of argumentation, the purposes and aims of argumentation, and the difference between argumentation and presenting opinions. In addition, the following concepts were defined: a thesis, a secondary thesis, an argument, a counterargument, a chain of arguments, and the elaboration of arguments. The students were also taught the basic rules for constructing argument diagrams. At the end of the session the students analysed the argumentative structure of a short argumentative dialogue and constructed a diagram on the basis of their analysis.

During the second double lesson the students learned how to use the CABLE tools. They were given a self-study material pack which advised them how to use the chat area, how to make argument boxes (claims, arguments and counterarguments) and fill in them with meaningful content, and how to add comments and elaborations to arguments by means of commentary boxes. The students also practised how argumentative links between the boxes could be created and labelled with either a + (argument in favour) or - (counterargument) sign.

3.2.2 Constructing and modifying argument diagrams

In the beginning of the third double lesson the students constructed an individual argument diagram on the given topic *Genetically Modified Organisms* (henceforth GMO). They were given 25 minutes to do the diagram on the basis of the following task assignment:

Think about your own opinion on GMO. Think about the advantages and disadvantages of GMO, and the arguments for and counterarguments against it. Then construct an argument diagram in order to respond to the following question: Should the production of GMO be allowed?

After the students had completed the diagram they were given three articles on GMO. One of the articles was anti GMO (a text relating to the work of Greenpeace), another represented a permissive approach to GMO (a
text concerning a food biotechnology company, Monsanto), and the approach to the topic in the third text (a text about French ministry of research) was neutral. The students were asked to read the texts cursorily, and to make notes and underline the texts if they so wished. The task was as follows:

The following articles deal with GMO from three viewpoints: against, for, and neutral. Through the articles you can obtain a comprehensive understanding of the arguments and counterarguments commonly used to support or oppose the production of GMO. Familiarize yourselves with the texts for 20 minutes. The idea is not to read the texts in close detail but cursorily in a selective way. You will certainly find much in the texts which will help you improve your diagram. While reading the material you may make notes or mark the texts where issues are touched on that you find important.

After the students had read the texts they were given 35 minutes to further elaborate their individual diagrams. They were allowed to read and screen the texts while modifying their diagrams. The task was the following:

After you have familiarized yourselves with the texts, improve your diagram on the basis of the information in the texts and in your notes. You can scan the articles and make use of them when improving your diagram. When modifying your diagram remember to connect the different boxes with argumentative links. Remember also to develop and supplement your arguments and counterarguments with help of the commentary boxes. The purpose of your diagram is to give your answer to the following question: Should the production of GMO be allowed?

3.2.3 Debate and consolidation of learning

In the fourth double lesson the students were given paper copies of the diagrams they had prepared in the previous lesson. With reference to their diagrams they were asked to recall their thoughts on GMO before engaging in chat debates. After 10 minutes the diagrams were collected in.

Next, the students engaged in dyadic debates on GMO for 30 minutes. The teacher formed seven dyads and one trio from the students. The teacher tried to form as many mixed gender pairs as possible. She also tried to form pairs with students she knew could work collaboratively. During the session the students discussed freely whether the production of GMO should be allowed or not.

After the debate the students were given 10 minutes to construct an argument diagram in collaboration with their partner. In their diagram the students depicted the most essential claims, arguments, and counterarguments their dyadic debate contained. They were also allowed to add new arguments and counterarguments to their diagram if they wished. After finishing the diagram the students recapitulated their discussion for five minutes. The students talked about what they had learned from the debate and from the co-construction of the diagram, and assessed how well their diagram presented the pros and cons of GMO.

During the last 25 minutes of the lesson the students completed their individual diagrams on GMO. The task was given as follows:

“Your task is to modify and complete your argument diagram presenting your answer to the question: Should the production of GMO be allowed? In completing your diagram you may utilise the viewpoints and arguments you discussed with your interlocutor. In improving your diagram you may make use of the following suggestions: (1) Improve your diagram with new arguments which either support or criticise the ones that already exist in your diagram; (2) Read through each of your arguments once more and improve and specify their content if needed; (3) Check the argumentative links between different arguments. Check also those points at which you have elaborated your arguments (commentary boxes).

3.3 Data and analyses

The data in this study consist of 16 diagrams the students constructed individually before reading the texts on GMO, 15 diagrams they elaborated after having read the texts, and 16 diagrams that the students finished after their dyadic debate. Not all the 17 students were present in all lessons.

The diagrams were analysed for shape and content (see Séjourné et al., 2004). The analyses of shape focussed on the size, breadth, and depth of the diagram, as well as how branched out the argumentation was.

The size of the diagram was assessed by counting the number of argument boxes and commentary boxes, and the breadth was assessed by counting the arguments and counterarguments directly linked to the main thesis (e.g. the breadth of the diagram in Figure 1 was scored 3). The depth of the diagram was assessed by counting the number of arguments and counterarguments successively linked to each other. Successive arguments and counterarguments form chains of arguments. For example, the diagram in Figure 2 shows
three argument chains. The depth of the two shorter chains was scored 2, and the longest chain was scored 4. The branches of the diagram were assessed by counting the number of secondary theses linked to more than one argument or counterargument. A secondary thesis refers to all the arguments and counterarguments that are either supported by one or more new arguments or opposed by one or more new counterarguments. Figure 2, for example, shows two such secondary theses (Through genetic modification…; According to studies…). Thus, the diagram scored 2 for this variable.

Figures 1, 2 and 3 do not show any commentary boxes as these became visible only when the cursor was moved onto the argument box. The student was thus able to see only one commentary box at any one time. The content of the commentary boxes of Diagrams 2 and 3 are presented in Table 2 in the results section (the diagram in Figure 1 did not contain any commentary boxes).

The content of the diagrams was analysed, first, by focussing on the topics of the arguments and counterarguments for and against GMO. Figure 1, for example, shows two topics: protection of plants, and biological warfare. In Figure 2 the number of topics has increased up to five: protection of plants, environmental protection, economic profit, the world’s food problem, and health. One topic, biological
warfare, has been removed. Second, the content of the diagram was analysed by checking whether the students had consistently linked their supporting arguments to other arguments with + signs, and counterarguments with - signs. The third content criterion of the diagrams was the clarity of the main thesis.

4. RESULTS

The students’ argumentation diagrams were deepened and broadened during the three successive times they were elaborated. This was an expected result since the students were asked to improve their diagrams. The interesting questions, however, are how and to what extent the diagrams improved. Table 1 shows that the size of the diagrams enlarged a lot: the students’ first diagrams contained 5.8 argument boxes on average, while the mean number of the boxes in the last diagram was 14.1. Correspondingly, the mean number of commentary boxes increased from 0.3 in the first diagram to 5.3 in the third diagram. The students’ diagrams also became broader and chains of argument longer: the mean number of arguments and counterarguments directly linked to the main thesis (breadth) increased from 2.6 to 5.9, and the chains of argument lengthened from 2.3 to 3.8. The increase in length was greatest after the texts had been read: from 2.3 to 3.7. The secondary theses did not branch out very often, but nevertheless the mean number of branches increased from 0.2 to 0.7.

Table 1. Shape and content of the students’ argument diagrams

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before the texts</th>
<th>After the texts</th>
<th>After the debate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shape of the diagrams</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of argument boxes (M)</td>
<td>5.8</td>
<td>12.1</td>
<td>14.1</td>
</tr>
<tr>
<td>Number of commentary boxes (M)</td>
<td>0.3</td>
<td>2.9</td>
<td>5.3</td>
</tr>
<tr>
<td>Breadth of argumentation (M)</td>
<td>2.6</td>
<td>4.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Depth of argumentation (M)</td>
<td>2.3</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Branches of arguments (M)</td>
<td>0.2</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Content of the diagrams</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topics (M)</td>
<td>3.1</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Correctly marked argument links (%)</td>
<td>66</td>
<td>75</td>
<td>74</td>
</tr>
<tr>
<td>Not clear main thesis (%)</td>
<td>69</td>
<td>47</td>
<td>25</td>
</tr>
</tbody>
</table>

The diagrams developed also in terms of content (Table 1). In the first diagram only a few topics occurred (3.1 topics on average), but along with the successive modifications the number of topics increased up to 4.5. Reading the texts on GMO, in particular, increased the number of topics: from 3.1 to 4.3 on average. The organization of argumentation in the diagrams also become better: although the number of argument boxes increased considerably, the proportion of correctly marked argument links increased from 66 % to 74 %. The development of the content of the diagrams is also demonstrated by the improved clarity of the students’ main theses. At first 69 % of the diagrams contained a thesis that did not clearly indicate the writer’s stand on the topic. Finally, only 25 % of completed diagrams contained such vague theses. The development of the students’ main theses is clearly illustrated in Matti’s (a pseudonym) three successive diagrams. In his first diagram (Figure 1) he presents his main thesis with only one word (Genetic modification), in the second diagram (Figure 2) his thesis has taken the form of a question (Should the production of genetically modified organisms be allowed?), and the thesis in his final diagram (Figure 3) is clear and unambiguous (The production of genetically modified organisms should be allowed).
Table 2. Comments on arguments in the diagrams shown in Figures 2 and 3

<table>
<thead>
<tr>
<th>Argument in the box</th>
<th>Comment in the commentary box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gene companies exploit customers</td>
<td>A company produces a genetically modified product which is resistant only to poisons produced by the same company (included in the 2\textsuperscript{nd} and 3\textsuperscript{rd} diagrams).</td>
</tr>
<tr>
<td>Some authorities may manipulate research</td>
<td>For example, according to some studies, smoking does not increase lung cancer risk (included in the 2\textsuperscript{nd} and 3\textsuperscript{rd} diagrams).</td>
</tr>
<tr>
<td>Research can be wrong as well</td>
<td>For example, in laboratory research genetically manipulated soy was not found to contain any properties causing allergies. When the research was repeated, substances causing allergies were found (included in the 2\textsuperscript{nd} and 3\textsuperscript{rd} diagrams).</td>
</tr>
<tr>
<td>Mistakes can always happen</td>
<td>Or over-enthusiasm when modifications have not been studied enough (included in the 2\textsuperscript{nd} and 3\textsuperscript{rd} diagrams).</td>
</tr>
<tr>
<td>Diseases will get stronger</td>
<td>Original plants are not resistant to diseases (included only in the 3\textsuperscript{rd} diagram).</td>
</tr>
</tbody>
</table>

5. CONCLUSIONS

The results indicated that the students’ diagrams improved when they were able to elaborate them on the basis of successive periods of reflection and thinking, reading and discussion. The students’ last diagrams, compared to their first ones, included more arguments, longer and deeper chains of argument and more topics relating to the theme. This result suggests that the students deepened and broadened their knowledge of the topic during the intervention.

When analysing the results we did not assign different weights for the size, depth and breadth of argumentation diagrams because the goal of the course was both learning to argue and arguing to learn. If learning new knowledge about GMO had been the main emphasis of the course, the depth of argumentation would not have necessarily been an advantage. Namely, long chains of arguments lead the discussion easily too far from the main claim. In this study, however, the argument chains were not very long and the students kept well to the issue in hand. In future studies the possibility to weight certain properties of argument...
diagrams could be a useful way to direct students’ attention towards the learning goals. Also the content of single arguments and counterarguments could be analysed more deeply.

The results also indicated that clearest improvement in the quality of the diagrams occurred after the students had read the texts on the topic. Quite often, while still at the secondary level of education, students are not well-motivated to read texts and find reading texts to be hard work. One explanation for the low motivation to read may be that it is not clear to students how they can utilise their knowledge after reading. In this study, it is possible that, as the students knew that they were expected to make immediate use of the reading material in modifying their own diagrams, their reading motivation also improved.

Practising the elaboration of one’s thinking about issues on the basis of different sources of information, and discussing ideas with other people is an important skill in today’s working life where continuous education is of increasing importance. In the contemporary workplace the need to constantly update one’s knowledge and skills is important in being able to cope with the demands of the job. Successive periods of theoretical and practical work, during which theoretically acquired knowledge and skills are reflected on in concrete work assignments, will be increasingly common in the future. For this reason, it is important that students, already during their secondary school years, practise their knowledge-building skills on the basis of alternate periods of reading, discussion and reflection.

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REFERENCES


