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## **Hypertext-Based Argumentation: Role of Tools, Motivation, And Cognition**

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### **Abstract**

In this 2x2x2-design study the effects of visualization tools, Need for Cognition and role of expected audience on hypertext-based argumentation were examined. 40 subjects were given an argumentation task on environmental issues. A hypertext-database containing necessary resources for task completion provided learners with background information for argumentation. The influence of the independent variables on motivational outcomes, knowledge acquisition and quality of argumentation were measured. Results suggest that a graphical argumentation tool can enhance learners' motivation, but has no influence on knowledge acquisition or quality of arguments. The "Need for Cognition"-score as valid predictor in argument reception failed as predictor in argument production. The role of an expected audience had a negative influence on intrinsic motivation due to its extrinsic motivational function. Above all the combination of an argumentation task with hypertext-based knowledge acquisition provided an efficient way of learning with non-linear media.

**Keywords:** Hypertext - Argumentation - External Representation - Aptitude Treatment  
Interaction - Knowledge Acquisition

## **1. Introduction: Hypertext, Argumentation and Social Context**

Since the beginning of educational research on hypertext it has always been a crucial issue to investigate and optimize learning with non-linear media. As of its non-linearity hypertext seems to be a preferred way of teaching any content that is ill-structured and/or contains wicked problems (Spiro & Jehng, 1990; Stepien & Ryke, 1997). Another possible approach to enhance knowledge acquisition within ill-structured domains is to enhance students' argumentation or Critical Thinking skills. In this paper we would like to present an approach combining hypertext and argumentation and investigate how to foster hypertext-based argumentation skills. According to Spiro and Jehng's (1990) Cognitive Flexibility theory learning with hypertext seems to be very advantageous, although some limitations have to be made. First, "experts" seem to profit more from a quick access to information while "novices" seem to profit more from a "guided tour" (Jacobson, Maouri, Mishra & Kolar, 1996). Furthermore, learners sometimes do not have a clear idea what to do with the overwhelming amount of information available in a hypertext system (Schnotz & Zink, 1997). This may result in the "lost in hyperspace" phenomenon or an aimless navigation (Gerdes, 1997; Kuhlen, 1991). In order to enhance hypertext-supported knowledge acquisition and overcome these disadvantages tools for external representations can be used (e.g. Jonassen, 1996; Jonassen, Beissner & Yacci, 1993). Possible functions of these tools may be to create overviews, to restructure content or to reorganize, deepen or elaborate a subject's knowledge. Especially in the field of computer supported argumentation graphical tools for visualization are often used in order to enhance structuring and to simplify an overview (Bosnjak, Reimann & Wichmann, 1997). Using argumentative tasks in education has a long tradition dating back to Greek philosophy. By using the combination of knowledge acquisition and meta-cognitive reflection processes it can be regarded as a subset of what is summarized under the term "Critical Thinking" (Ennis, 1987; Voss & Means, 1991). In order to visualize arguments graphic tools or concept mapping methods are often used. A major advantage of these tools might be explained with Paivio's dual coding theory (1978). However, it is questionable whether real dual coding or just another form of arranging textual information is employed. Social context is an additional source of information in argument encoding and evaluation of persuasiveness. It is important to distinguish the target group or the aim an argumentation is made for, e.g. in order to support an individual's learning or to convince others. Petty and Cacioppo's (1986) Elaboration-Likelihood-Model (ELM) offers an empirically well investigated framework. The influence of external monitoring should motivate an individual

to choose a central way of information processing (Cacioppo, Petty, Feinstein & Jarvis, 1996). According to the ELM the central route includes careful elaboration, structuring and evaluation of foreign statements and a high validity of self-produced arguments. Closely related to the ELM is the concept of “Need-for-Cognition” (NFC) from Cacioppo and Petty (1982). This trait includes among other characteristics the general tendency towards central information processing (Bless, Wänke, Bohner, Fellhauer & Schwarz, 1994). Yet it is not clear whether NFC or social context has the same impact on argument production and knowledge acquisition that it has been found to have on argument reception. We conducted the following experiment in order to examine the influence of external representation tools, context and NFC on argument production and knowledge acquisition.

## **2. Experiment**

### **2.1 Goal and hypotheses**

This experiment was designed in order to detect influences of contextual parameters on hypertext-based knowledge acquisition and argumentation skills. The first experimental factor was the tool for external argument representation. On the one hand a graphical concept-mapping tool, on the other hand a two-columned text-based argumentation tool has been provided. The second factor was induced by telling half of the subjects to defend their argumentation in front of a pretended target group ("public") whereas the other group was told their argumentation served for individual learning purposes only ("private"). A quasi-third factor was established by using a median-divider in each cell related to subjects' NFC-values measured with the German version of the NFC-Short Scale (Bless et al., 1994). The following hypotheses were tested:

We expected the way of visualization to influence the motivational attitude of learners and the quality of subjects' argumentation. No difference in knowledge acquisition in both groups was expected.

The factor "private" vs. "public" was assumed to have an influence on motivation and the content quality of argumentation. The "Public" condition was assumed to lead to increased extrinsic motivated work as a consequence of having to defend one's opinion in front of an audience. Furthermore this was thought to decrease intrinsic motivation. We expected subjects in the "public" condition to prefer a central route of information processing and therefore argumentation quality was expected to be enhanced.

Subjects with a high value in NFC were expected to display an increased level in intrinsic motivation. We expected high NFC to lead to more central and elaborated information processing and to a better quality of argumentation.

## **2.2 Experimental design**

In order to test the hypothesis we used a 2x2x2 design. Factor 1 was the experimental manipulation of the pretended target group (“private” vs. “public”). The second factor was the tool for external visualization (“text based tool” vs. “graphic based tool”). For the third factor those four groups were divided in half by median division regarding their value for NFC. Forty subjects between the ages of nineteen and forty years took part in the experiment. Most subjects were students with different majors. Nine were male and 31 were female. For taking part reward was given.

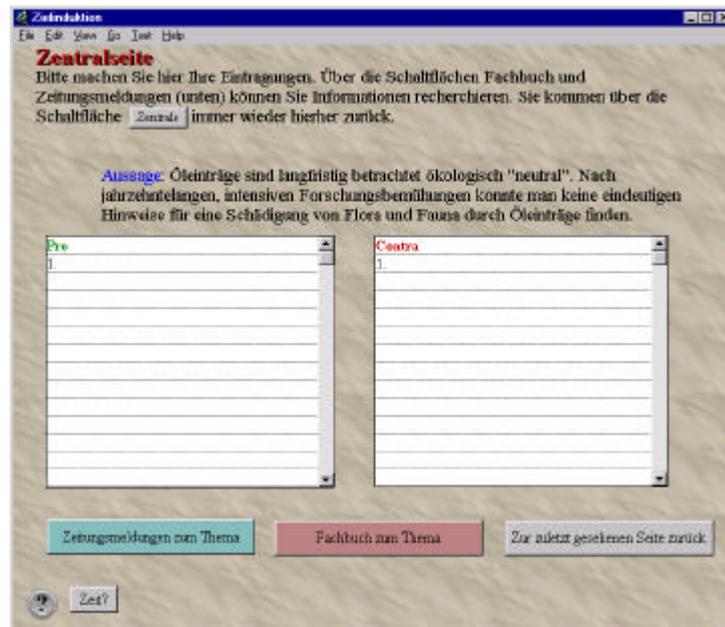
## **2.3 Material and course**

Four computer programs were designed for this experiment. All programs contained the hypertext “Sea pollution caused by oil”. At the beginning of each experiment subjects were introduced to the program, personal data was collected and learners were given the German version of the Scale “Need for cognition”, a motivational questionnaire and a concept-mapping knowledge pre-test.

The actual experimental task was the argumentative analysis of the following statement: “Oil pollution is no danger to marine ecosystems in the long run. After decades of intensive research there were no obvious cues for a long term damage to flora and fauna caused by oil pollution.”

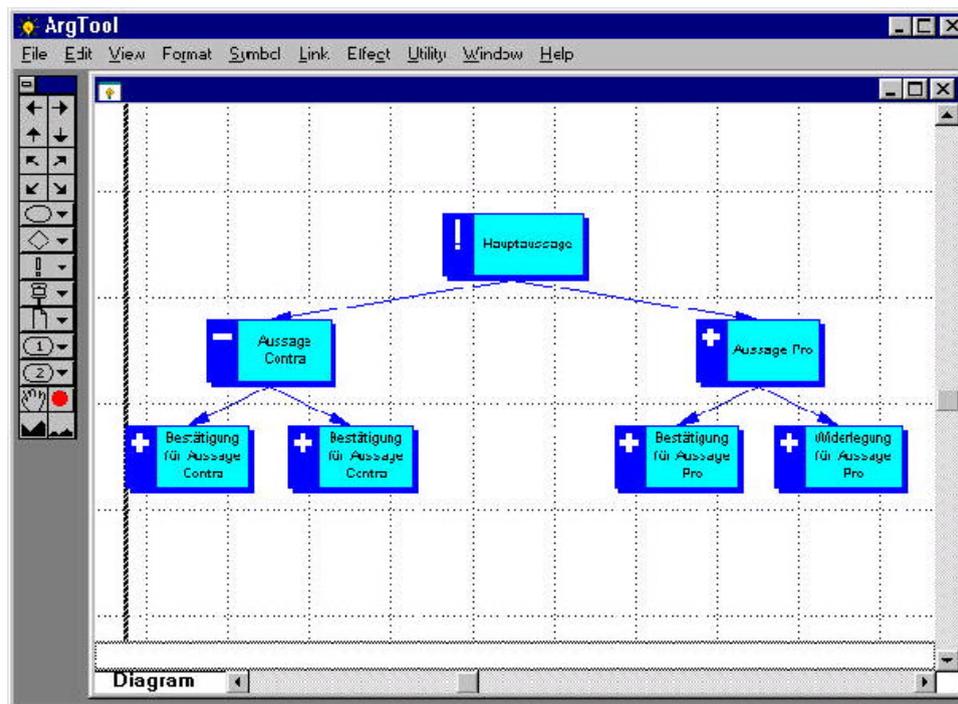
Subjects were asked to look for relevant information in the underlying hypertext system and to use the given argumentation editors. In one experimental condition a text based tool using an input formula with two columns, one for pro and one for contra arguments (see figure 1) was given to the learners.

*Figure 1: Text based argumentation editor.*



The complementary graphic based tool “ArgTool” allowed subjects to draw notes and to connect them with arrows. They had the opportunity to add a “+” or a “-” in order to mark a pro or a contra statement (see figure 2).

Figure 2: Argument visualization with 'ArgTool'.

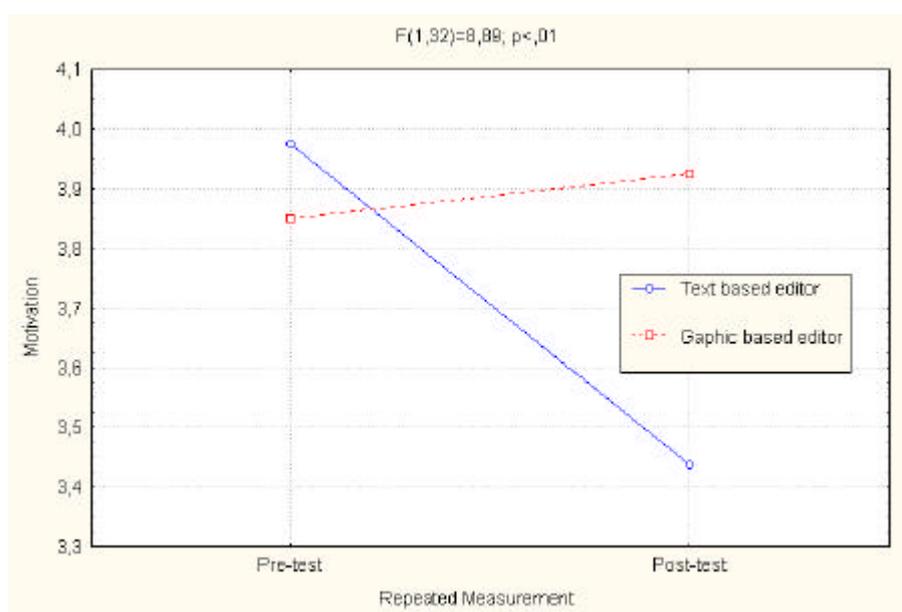


The private condition was induced by a few text based alerts in course of the program. The whole experiment took one hour and thirty-five minutes closing with motivational and knowledge posttests.

## 2.4 Results

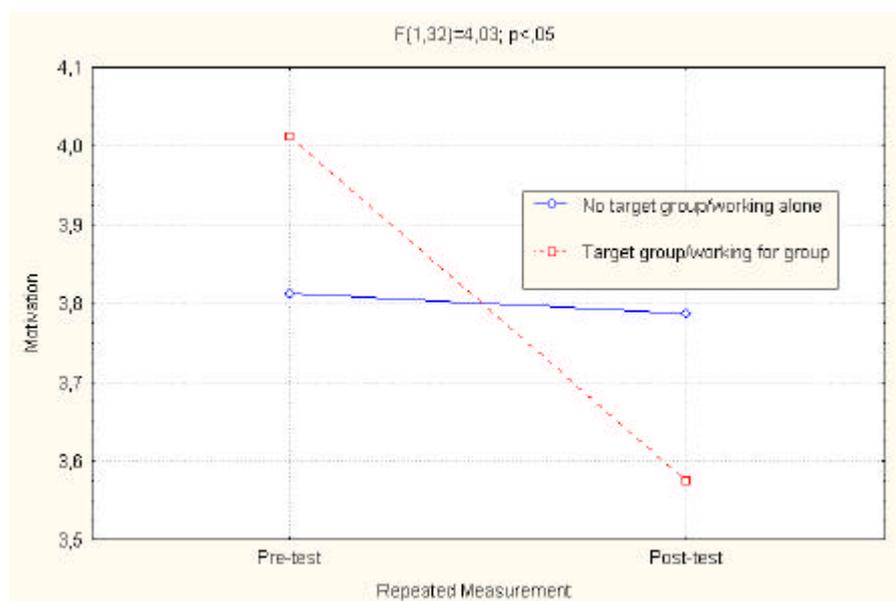
An analysis of variance suggested no group differences regarding motivational parameters before the treatment. In the posttest there were no significant differences for the "public/private" condition (ANOVA:  $F(1,32)=0,82, p=.37$ ) and NFC-score (ANOVA:  $F(1,32)=3,1, p=.09$ ); the external representation had a significant influence on subjects' motivation with a more motivating graphical argumentation editor (ANOVA:  $F(1,32)=5,07, p<.05$ ). Furthermore a significant interaction between the time of measurement and the visualization tool was detected (ANOVA:  $F(1,32)=8,89, p<.01$ ). While the condition "graphic based tool" seemed to maintain motivation there was an obvious decrease in the "text based" condition (see figure 3).

Figure 3: Influence of tool on motivational parameters.



Another significant interaction was found between the time of measurement and the "public/private" factor (ANOVA:  $F(1,32)=4,03, p<.05$ ). Motivation decreases in the "public" condition while it increases in the "private" condition (see figure 4).

Figure 4: Motivational parameters and pretended target group.



There was no influence of the NFC-score (ANOVA:  $F(1,32)=1,96, p=.17$ ). We found no effect regarding “interest in content”, even though there was an increase (ANOVA:  $F(1,32)=4.08, p=.05$ ).

There were no differences within the knowledge pretest and posttest. However, there was a general increase between the pre- and posttest (ANOVA:  $F(1,32)=74,62, p<.001$ ).

Subjects' arguments were judged on the criteria of “relevance”, “specificity”, “emotionality” and “distinctiveness”. A factor analysis showed a two-factor solution with “emotionality” building one and the other three variables building the second factor (compare table 1). An additional variable “balance of arguments” as part of argumentations' “soundness” was not verified as a valid measurement in the analysis.

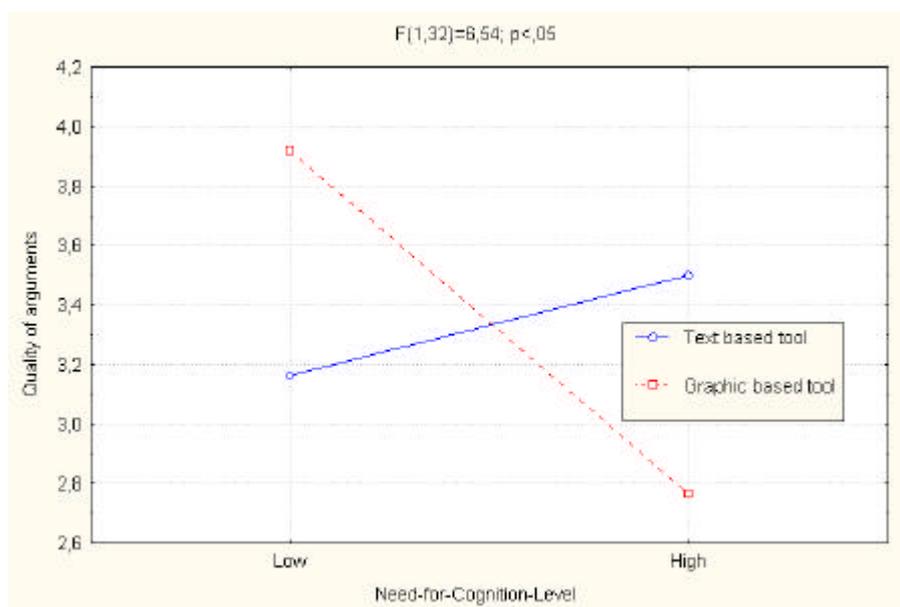
*Table 1: Factor analysis on qualitative measurements in argumentation assessment.*

Principal Components Method (with Varimax Rotation)	Loadings Factor 1	Loadings Factor 2
Acceptability	0,95	0,07
Relevance	0,94	0,01
Emotionality	0,00	0,98
Specificity	0,91	-0,08
Balance	-0,74	-0,42
<b>Explanation of Variance</b>	<b>3,18</b>	<b>1,14</b>
<b>Prp.Totl</b>	<b>0,64</b>	<b>0,23</b>

Thus a scale “content quality of an argument” with the items “distinctiveness”, “relevance” and “specificity” was computed and analyzed separately from both other factors. There were no significant differences between “visualization tool” (ANOVA:  $F(1,32) = 0,00, p=.17$ ). An

unexpected and difficult to explain negative interaction between the level of NFC and the “visualization tool” occurred (ANOVA:  $F(1,32) = 6,54$ ,  $p < .05$ ; see figure 5).

Figure 5: Interaction of NFC-Level and tool for argument visualization.



The level of NFC had no significant influence on quality of arguments (ANOVA:  $F(1,32) = 0,54$ ,  $p = .47$ ) neither had the "public/private" condition (ANOVA:  $F(1,32) = 2,71$ ,  $p = .11$ ). The “visualization tool” had an influence on the balance of argumentation. The text based version lead to a more balanced pro and contra structuring in argumentation (ANOVA:  $F(1,32) = 7,78$ ,  $p < .01$ ). Quality of arguments and balance correlated to  $r = -.67$  ( $p < .05$ ).

### 3. Discussion and summary

We examined the influence of external visualization tools for argumentation, induction of pretended audience for subjects' argumentation and subjects' "Need-for-Cognition"-level on hypertext-based argumentation and knowledge acquisition. Results suggest that graphic argument visualization maintained subjects intrinsic motivation although there was a general decrease in motivation regarding the treatment task. This indicates on the one hand, that the given argumentation task was not very challenging or somehow boring and needs to be modified for further uses. On the other hand, the use of the graphic based tool seems to provide a challenging component that probably compensates the motivational decrease with an increased playfulness. Still we need to mention that this effect could possibly be caused by curiosity as well. The missing or completely unexpected effects of the NFC-score can be regarded as a first hint that the NFC-scale might be suited for assessing argument reception but not for argument production.

Overall there was no effects of the independent variables on knowledge acquisition, although a significant increase in knowledge between the pre- and posttest was found. There was no difference in results between visualization tools. These results provide potential evidence against dual coding according to Paivio (1978) if mainly plain text information (as usual in argumentation) will be processed. There was no effect of pretended audience. A possible explanation could result from the request to “argue in an objective way”. There was no significant main effect for arguments' content quality on the NFC-score; the unexpected interaction of visualization tool with the NFC-score is yet another evidence that a transfer from argument reception to argument perception is not adequate. The evaluation of the balance of pro/contra-arguments suggests a clear preference for the text based tool. However, this might be a potential bias caused by its design. Still the factor analysis suggests that it is doubtful whether the balance of pro and contra arguments can be used as a content quality criteria. All in all the study suggests that the combination of argumentation tasks and learning with hypertext is an effective approach for knowledge acquisition. The use of graphic based tools for external visualization purposes might help to maintain learners' intrinsic motivation in a challenging and playful way, despite the fact that we could not find a surplus value in cognitive support. Furthermore the use of tasks combined with tools for external visualization purposes is strengthening the objectivity of argumentation and information processing. The applicability of the NFC-scale in educational fields is still questionable. Our research suggests that for further analysis in aptitude treatment interaction other scales should be used or adapted.

### **Acknowledgements**

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