Knowledge Acquisition and Opinion Formation at Science Museums: The Potential of a Discussion Terminal for Collaborative Elaboration on Controversial Issues

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Abstract: This PhD project examines the potential of a discussion terminal to support deep elaboration of controversial information and formation of well-founded opinions at science museums. It is assumed that the salience of controversial information, the opportunity to express one's own opinion, and availability of social comparison information are crucial factors for both learning and opinion formation. A first data collection concerned the impact of active opinion expression and salience of arguments on elaboration processes and knowledge acquisition in a 2x2-design. Results are still outstanding. The second data collection phase will also consider the influence of social comparison information and asynchronous discussion at the discussion terminal.

Science Museums and Public Understanding of Science

Oppenheimer has already stated 1968 (p. 206) that there is an "increasing need to develop public understanding of science and technology" and today, due to rapid growth of new technologies, this need is even bigger than ever before. Informal learning in science museums can be a major contributor in promoting public understanding of science as museums are one central medium in communicating central scientific ideas and presenting relevant objects (Durant, 1992). To promote public understanding of science, multiple viewpoints from different perspectives are needed to be presented (Bayrhuber, 2001): Boyd (1998, p. 214) considers the modern science museum as a "marketplace of multiple points of view, a forum where controversy can be aired". In addressing current socio-scientific issues today, science museums are challenged to present the ambiguity and controversy of these topics and to support visitors in developing reflective and critical thinking (Halpern, 1989). Thus, new installations are needed which emphasize involvement and activity of the museum visitor and put the exhibition content in socially and personally relevant context (McLean, 2006).

Pedretti (2006, p. 30) states that "spaces for dialogue […] enhance the spirit of inquiry, allow for a free exchange of ideas, and encourage the formulation and articulation of carefully thought out, defensible opinions." To create this space, in this project, a computer-mediated discussion terminal was designed to mediate and encourage elaboration on and opinion exchange about the topic nanotechnology as one the most explosive science topics nowadays. Discussion involves the museum visitor in the public debate about science, turns public debate into a personal, "private" one, and should therefore foster reconsideration and reflection of information (Schellens, & Valcke, 2004).

A Discussion Terminal as Scaffold for Critical Thinking and Opinion Formation about Nanotechnology

Critical thinking at science museums refers to visitors' ability to evaluate the evidence for and against New Technologies like nanotechnology, for example. In examining the potentials and risks of new technologies the museum visitor must have "the ability to judge the plausibility of specific assertions, to weigh evidence, to assess the logical soundness of inferences, to construct counterarguments and alternative hypotheses" (Nickerson, Perkins, & Smith, 1985, pp. 4–5). However, as museum visits are leisure activities in most cases and people do not come with a clear learning intention in mind (Falk, & Dierking, 1992), one must assume that visitors do usually not show deep elaboration of exhibit information. But at the same time, this would be an important "learning" goal of exhibit designers and museum curators as our understanding of a good museum has shifted from 'collecting and presenting loose objects' to 'promoting public understanding of science and opinion formation' (Durant, 1992).

The idea of scaffolding systematic and deep processing of relevant information about risks and potentials of nanotechnology to enhance critical thinking and opinion formation of the museum visitors is central to our research: A media terminal has been developed which considers relevant pre-requisites that information processing theories (e.g., ELM, Petty, & Cacioppo, 1986; HSM, Eagly, & Chaiken, 1993) have identified, namely, involvement, and availability of relevant information. Specific cognitive processes are fostered which should lead to deep elaboration on information and belief-based opinion formation. After individual activities, Ss visiting the exhibition 'nanodialogue' have the opportunity to engage in an asynchronous 'debate' about nanotechnology (NT).

Different types of cognitive mechanisms are assumed to lead to deeper elaboration of content when visitors interact with the discussion terminal: 1) *Active participation, involvement and personal relevance*. The discussion terminal increases visitors' involvement by asking for their personal opinion and by challenging this personal opinion by social comparison with others' opinions. Writing down one's personal opinion should result in higher motivation and involvement and also support reflection and abstraction (e.g., Petty, & Cacioppo, 1986).
2) Salience of multiple perspectives. A main objective of the discussion terminal is to support bottom-up processes of opinion formation by increased salience of available and relevant arguments from various perspectives. Expert statements are presented as these are regarded as necessary information about NT which is required for critical evaluation of this new technology. To support critical thinking, these expert statements will be rated by visitors with regard to agreement and relevance. This should help to identify relevant attributes of NT and should therefore scaffold belief-based, thoughtful opinion formation.
3) Social comparison information and opinion exchange. Social influences on individual opinion formation and information processing will be regarded in our research as according to social comparison theory people tend to evaluate their own opinions by using similar others as models (Suls, Martin, & Wheeler, 2004). The discussion terminal raises new possibilities to support communication and debate between visitors - independent from their time of visit. Therefore, this research project will consider the impact of reported opinions of other visitors on individual cognition.

Research Method
A study was designed to investigate whether a discussion terminal supports deep elaboration of controversial information and formation of well-founded opinions. It is assumed that salience of information, opportunity to express one's own opinion, and availability of social comparison information are crucial factors for learning and opinion formation. The impact of these three independent variables on elaboration processes and knowledge acquisition will be tested in a 2x2x2-design.

A "virtual museum" about NT is used which is based on a real exhibition about NT which informs citizens about both facts about nanotechnology and its potentials and risks. It contains quite a number of relevant expert statements which comprise different arguments both in favour of and against NT.

160 participants are randomly assigned to eight conditions (cp. table 1). They explore the exhibition without constraints and time pressure. Afterwards, they interact with the discussion terminal: In the condition of salience of arguments but without active expression of their opinion, participants assign eight statements to corresponding experts (cond. 1). A second group rates NT in general as either "I am in favour NT" or "I am against NT" and types an own statement into the discussion forum (cond. 2). The third group additionally evaluate eight expert statements by 'persuasive power' and 'relevance' before rating NT in general (cond. 3). The control group works on a NT-quiz. On condition of active expression of opinion, feedback about others' opinions is available after individual rating activity. This feedback is experimentally faked and systematically varied as consistent (cond. 4/5) or conflicting with Ss' own opinion (cond. 6/7).

During exploration of the exhibit website, all activities of the participants are retained as log file-data. As exploration of the exhibition takes place without any instructions or constraints, this data are relevant to assess which information was gathered during the 'museum visit'. Knowledge acquisition is assessed by means of a short knowledge test, containing nine questions on nanotechnology, ranging from simple factual knowledge to more transfer knowledge which requires drawing of

inferences. Additionally and even more interesting is acquisition of *attitude relevant knowledge*, that is relevant arguments in favor or against nanotechnology from a variety of application areas and perspectives (medicine, military, society, economics). This knowledge is assessed by means of instruction to list all arguments the participants can remember from the exhibition and to write down a short summary. This summary of participants' personal impressions about NT will be analyzed with regard to indicators of critical thinking and awareness of controversy. Participants' attitudes towards nanotechnology and new technologies in general are assessed by attitude profiles.

Table 1: Research design.

		Active expression of opinion			
		no	yes		
			Social comparison information		
			neither	consistent	conflict
Salience of arguments	no	control group	condition 2	condition 4	condition 6
	yes	condition 1	condition 3	condition 5	condition 7

Expected Impact on Knowledge Acquisition and Opinion Formation

It is assumed that salience of controversial information, possibility to express one's own opinion, and social comparison information are all crucial factors for both learning and opinion formation. Based on theoretical considerations, it can be assumed that salience of arguments and opinion expression are crucial factors for learning and opinion formation. Elaboration of information should be deeper when both factors are implemented. Participants of condition 3 should therefore gain most knowledge, remember more relevant arguments and have more sophisticated opinions about nanotechnology. Salience of arguments should have an effect on attitude relevant knowledge remembered and also on perceived ambivalence and difficulty to evaluate nanotechnology. This should results in less extreme but more stable attitudes. An indicator of information integration would be response time at the overall rating, too. Participants of the control condition (who solve a quiz about nanotechnology) should recall more factual knowledge about the exhibition as they have the opportunity to deal with items from the knowledge test already at the opinion terminal, and they also get feedback about right answers to these questions. Social comparison information and opinion exchange should further stimulate elaboration of arguments and evaluation of visitor's own opinion, especially if a cognitive conflict between one's own opinion and others' opinions is elicited. This conflict should elicit further activities at the discussion terminal and within the exhibition. Visitors might, for example, read through others' statements to learn about their arguments ("*Why* do they think that?").

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