Geovisual Analytics and Children's Learning

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Abstract In this paper an ongoing research is presented. The study is focused on understanding of young students' learning with representations by information visualization technology and its associated sciences of perception, interaction and comprehension. The paper introduces this ongoing research project. It gives a short presentation of the research area, the used application of multi external representations, its intended methodological approaches as well as a minor report from a Pilot Study.
Keywords: information visualization; geovisualization; geovisual analytics; multiple representations; visual perception; learning and comprehension

The research area

Geovisual Analytics is a technique that in a powerful way can help illustrating spatiotemporal statistical data. Research and usability testing of geovisualization tools do exist, but there is a lack of studies of what impact these tools have on processes of learning. The geovisualization research community has, so far, failed to bridge the gap between their research and research of possible users and their process of understanding and learning (Haklay, & Tobon, 2003). Research has, up to now, focused on tools that explore statistical data while methods that communicate and publish gained knowledge with clarity, precision, and efficiency has not achieved the same attention (Jern, Rogstadius, Åström, & Ynnerman, 2008) nor has research in any greater extension yet, tried to uncover and specify factors that encourage or discourage deeper understanding or learning (Ainsworth, 2006). Research on learning with representations has shown that when learners can interact with an appropriate representation their performance is enhanced. The issue is not anymore if multiple external representations (MERs) are effective or not, but concerns the circumstances that influence the effectiveness of MERs (Goldman, 2006). Ainsworth (2006) means that there are a number of design factors that should be considered when addressing aspects of learning with MERs. She addresses that multiple representations can best be understood by considering three aspects of learning; the design parameters, the functions and the cognitive tasks (DeFT). This study is aiming at investigate elementary students' use of novel geovisual analytic storytelling methods, to examine:

- the students perception, interpretation and comprehension of representations,
- how the interaction possibilities, that the geovisual analytics offer, interact with the learning processes
- what thinking strategies young students use when working with geovisual analytics.

The eXplorer Platform

The geovisual analytics used in this study has a conceptual approach. It is an authoring and publishing concept based around three complementary characteristics: eXplorer, storytelling and Vislets. Statistical data are possible to analyze through the use of multiple-linked views. Complex patterns can be detected through a number of different visual representations simultaneously that can help stimulate the analytical visual thinking process (Jern, Thygesen, Brezzi, 2009). The eXplorer server maintains eXplorer and Vislet flash (swf) files together with a story repository, statistical data and regional shape maps. The eXplorer runs locally in Flash Player on the client machine and gives possibilities to storytelling. It also generates HTML code representing the story. This "story" is the Vislet, possible to open in the reader's Web browser and requested data, GIS, visualization widgets, eXplorer code (metadata with snapshots) are accessed from the eXplorer server The Vislet is possible to manually (copy/paste) embed into a Web page (Stenliden, Jern, 2010).

The Main Study; Research Approaches and Methods

With a major interest in studying human understanding and learning within complex technology mediated learning environments this research builds on a number of analytical concerns and assumptions. The study has a socio-cultural perspective on learning (Vygotsky, 1986) together with perspectives on the significance of visual aspects on learning (Gibson, 1969). The methodological position is connected to the growing body of video based studies of social interaction and the use of different technologies (Heath, & Luff, 2000). To address the issues outlined above, an empirical study is carried out in three Swedish elementary schools, in grade four up to grade six. Altogether 75 students, in the age of ten to twelve year, will be involved in the study. In phase one the teachers of the participating students' are introduced to the tool; they produce an educational plan according to the curricula, organizing the content and the task by involving use of "the eXplorer platform". In phase two the students work will be followed by 1) Questionnaires to measure the student's performance 2) Video observations to follow the students, focusing on the communication between the children and the ways they interact with the tool 3) Speak aloud interviews to investigate the student's understanding and learning process. Interaction analysis (Jordan, & Henderson, 1995) and the DeFT framework (Ainsworth, 2006) will be used for the analytical concerns. So far a pilot study is accomplished. The main study is in phase one (see above).

The Pilot Study

The pilot study was delimited to focus on the usability of the chosen geovisual analytics within in the age group, not to cover the overall aim in the main study.

Design. An evaluation was made of a Vislet, in terms of usability and examined by effectiveness, efficiency and user satisfaction. This case-study was carried thorough in the school setting and the participants were 12 years old. The class had 28 students. Three methods for evaluation were used; 1) Questionnaires to measure the student's performance 2) Observations to follow the student's efficiency when working with the Vislet focusing on the communication between the children and the ways the children interacted with the tool 3) Interviews to investigate the student's satisfaction of using the Vislet.

Educational Setting. To produce the Vislet, discussions with experts in social science and teachers, took place. The content for the educational sequence was decided to relate to statistics where, among others, GPD per capita and CO^2 effluent were the indicators in focus. In cooperation, Vislets according to the educational setting and the educational content were produced. The targets for the students were to gain knowledge about the following educational objects.

1. To understand the connections of the Vislet's interactive tools.
2. To understand the connections between the dynamic linked views offered by the Vislet.
3. To be able to treat statistical information by using the Vislet.
4. To understand the concepts; living conditions, GPD per capita and CO2 effluent.
5. To be able, by the Vislet, to compare their own and other's living conditions in other environments
6. By using the Vislet experience comfort in using and satisfaction of the learning process

Procedure. A lecture was given to brief the students of the topic geovisual analytics and how to use the Vislet. Observations were made of the students' behavior and work during three consecutive lessons. This step was performed in a half-class situation. The interviews were made after these three sessions were finished. Altogether, 26 students completed the questionnaire, 12 observations were made as well as 12 interviews.

Usability Criteria. The usability criteria were about: effectiveness - the accuracy was measured in what way the participants in the school setting were successful to achieve object nr 1 – 2, efficiency - the accuracy and completeness was measured in what way the participants were successful to achieve

object nr 3 – 5, user satisfaction - the comfort and acceptability of the system were measures by the participants attitudes towards the tool and their experience of learning, object nr 6.
Summary of Results. Effectiveness; the students have good ability to comprehend and control the interactive function as well as the indicators. They had few problems to understand the dynamic linked views. Efficiency; the students ability to treat information is satisfactory. Few had problems in understanding the concepts or through the Vislet compare different kinds of living conditions. User Satisfaction*;* the students see the tool as resourceful, apparent and immediate. They express a conviction of a learning process that differs from the ordinary. The satisfaction is extensive at least used as brand new tool - the long lasting effects are however unknown.

Conclusion and Further Developments

It is possible to assert that the usability of the geovisual analytics is sufficient. It is, however vital to consider that usability studies do not give concrete answers when it comes to implications for learning (Andrienko, Voss, Bernardo, Hipolito, & Kretchmer, 2002). The next step is therefore to carry on this research to focus the students learning processes and strategies when using visual analytics.

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