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# Peer Review of Animations Developed by Students

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**Abstract**

This paper describes the project "Visual Knowledge Communication", a joint project that started recently. The partners are psychologists and computer scientists from four universities of the German state Rhineland-Palatinate. The starting point for the project was the fact that visualizations have attracted considerable interest in psychology as well as computer science within the last years. However, psychologists and computer scientists pursued their investigations independently from each other in the past. This project has as its main goal the support and fostering of cooperation between psychologists and computer scientists in several visualization research projects.
The paper sketches the overall project. It then discusses in more detail the authors' subproject which deals with a peer review process for animations developed by students. The basic ideas, the main goals, and the project plan are described.
This paper is a work-in-progress report. Therefore, it does not contain any results.

*Keywords:* "Visual Knowledge Communication", peer review process, animations, engagement taxonomy

## 1 Introduction

Visualizations are becoming increasingly important for different kinds of communication. Newspapers, flyers, TV programs, and web pages today contain several times more pictures, graphics, diagrams, graphs etc. than they did several decades or years ago.

Visualizations also have attracted considerable interest in different scientific disciplines within the last years. In psychology, the role of pictures and animations as a learning aid was investigated in an impressive number of research projects [4], [5], [6], [10]. An interesting research field in learning with the help of pictures focuses on the fundamental differences between verbal and visual communication. One of the most significant differences is the fact that visualizations are usually more concrete

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than verbal descriptions can be. That means, it is not possible to describe a certain fact in a general way; a picture always illustrates a fact by an example. E.g., a drawn triangle is always a specific one; it is not possible to draw a general triangle. So the question is whether and how pictures and animations help in learning, especially whether and how the learners are able to generalize the perceived learning material.

In computer science, there are several fields that deal with visualizations. The area of computer graphics has achieved major breakthroughs. With the help of an off-the-shelf PC (near) photorealistic views with different kinds of light sources can be computed and rendered in real-time. The most prominent applications for these techniques are all kinds of games. In the future, it is expected that the field of virtual, augmented and mixed realities will become increasingly important.

A second field is scientific visualization. The objective of this field is the finding of appropriate representations for a huge amount of data gathered from different kinds of measurements in physics, chemistry, geology etc.

Last but not least, the subject of this workshop, namely program and algorithm visualization, is a third field in computer science that deals with pictures and animations. The field covers, e.g., algorithm animation techniques for computer science education as well as appropriate visualization techniques of huge (legacy) programs in order to get an overview of the existing dependency and usage relations of the different parts (modules, classes, ..) of the source code.

In the past, psychologists and computer scientists pursued their investigations independently from each other. On the one hand, psychologists often are not aware of the current trends in computer science. Computer scientists, on the other hand, are focusing primarily on technology. The consideration of human perception, thinking, and learning is often neglected by computer scientists.

This situation was the starting point for a joint project called “Visual Knowledge Communication” that started recently. The partners are psychologists and computer scientists from four universities of the German state Rhineland-Palatinate: the University of Applied Sciences in Kaiserslautern-Zweibruecken, the University of Koblenz-Landau, the University of Trier, and the University of Applied Sciences in Trier.

In section 2 of this paper an overview of the overall project is given. The ideas of the authors’ subproject are then described in more detail in section 3. The paper ends with a brief summary in section 4.

## 2 Project “Visual Knowledge Communication”

The project ”Visual Knowledge Communication” is funded by the Research Ministry of the German state Rhineland-Palatinate in Mainz. It started in March 2006. As its goal the project is supposed to investigate different problems in the area of visual knowledge communication. The project consists of six subprojects. Each subproject is driven by a separate research group. The subprojects are independent of each other. However, each research group will cooperate with and get advice from one

or two of the other research groups. Detailed information about the cooperation relationships is listed in the project plan. We omit this aspect here.

In the following table the six subprojects and their goals are briefly described:

| Title | Leader | Goal |
|---|---|---|
| Interactive Mixed-Reality-Visualization in Learning Systems | S. Mueller, University of Koblenz-Landau, Department of Computer Science | Investigation of useful applications for mixed realities, especially for interactive learning systems. |
| Knowledge Acquisition with Interactive Animations | K. Wender, University of Trier, Department of Psychology | Investigation of fundamental learning mechanisms caused by interactive animations, especially study of the conditions for effective, abstract knowledge acquisition. |
| Forms of Visualization and Dynamic Adaptation for Information Retrieval Interfaces | J. Krause, University of Koblenz-Landau, Department of Computer Science | Study of the design of graphical user interfaces and the dynamic adaptation of user interfaces to specific users and specific situations, especially user interfaces for information retrieval systems. |
| Learning Systems with Personalized Graphical User Interfaces | B. Reuter, University of Applied Sciences in Kaiserslautern-Zweibruecken, Department of Economics | Investigation of possibilities for the personalization of graphical user interfaces for learning systems. |
| Emotional Effects of Static and Dynamic Pictures in Science Education of Secondary Schools | A. Mueller and W. Schnotz, University of Koblenz-Landau, Department of Psychology | Investigation of the conditions for positive effects of decorative pictures in science education of secondary schools. |
| Animations Developed by Students and Assessed by a Peer Review Process | R. Oechsle, University of Applied Sciences in Trier, Department of Computer Science | See following section. |

# 3 Subproject "Animations Developed by Students and Assessed by a Peer Review Process"

## *3.1 Basic Idea*

In [7] a taxonomy has been defined comprising six levels of engagement with respect to algorithm and program visualization (AV):

1. No use of AV technology.
2. Viewing: Controlling the direction and pace of the animation.
3. Responding: Answering questions about the AV content.
4. Changing: Modifying the AV content.
5. Constructing: Building a new visualization of a given algorithm or data structure.
6. Presenting: Presenting an AV content to an audience for feedback and discussion.

Our subproject has its focus on the highest levels of engagement. But instead of presenting an algorithm animation to an audience, we propose an alternative way to deepen the involvement of the students: we want the students to do a peer review in order to mutually assess their animations. Thus we replace level 6 of the engagement taxonomy by level 6':

**6'** Peer Reviewing: The developed animations are assessed by a peer review process.

The review process is supposed to follow well-known procedures [11]: development and submission of animations, review of animations by peer students (each animation is reviewed by $N$ other students, $N = 2, 3, 4$; each student thus has to review N animations), and finally, each student has to study not only the reviews of her own animation, but also the other reviews for these animations that she had reviewed. This process may be iterated thus forcing the students to take into account the reviews and improving their animations.

The basic question that this project is supposed to answer is: In which way does this approach really enhance the knowledge and understanding of computer science subjects compared to other approaches? Can it be carried out in an efficient way (i.e. is the effort justified with respect to the learning results)? Are there any other (positive or negative) effects which are not related to the pure knowledge transfer?

## *3.2 Project Plan*

Because the project started only several weeks ago, we do not have any results yet. Instead, we describe an outlook of our project for which we foresee three phases (phase 1 and 2 are independent of each other and can be done concurrently):

1. Assessment and selection or development of appropriate tools or systems that students shall use in order to develop their animations.

   We plan to use the animation peer review in the students' first year. There-

fore, it is required that the students who still struggle with their first programming language, do not have to learn a lot in order to construct their animations; the building of animations should be as effortless as possible. As a first step we tried to build a binary seach tree animation using several different animation tools. Besides general animation tools like PowerPoint and Flash, we used specialized algorithm animation tools like Animal [9], Jawaa [8], MatrixPro [3], and ALVIS [2]. The result of this trial was that one of the tools has very limited scope (MatrixPro), and all the others are not effortless enough for our purposes. Therefore, we derived a wish list for an animation tool in the form of several use cases. The building of new animations could be approximated by using a graphic editor in combination with a screen recording tool. However, later modifications of recorded animations would be very tedious. This is the reason why we decided to build a new animation tool according to our wish list.

2. Development or adaptation of a web-based peer review system.

   The web-based peer review system will not be developed from scratch. We rather plan to integrate the peer review of animations into our own web-based system that we are currently developing for peer reviews and a semi-automatic assessment of student programs (style checking, testing).

3. Realization of a peer review experiment for animations. This part of the project will be supported by Karl Wender's psychologist research group from the University of Trier.

   For the experiment, one of the most important question to answer is: Against which other learning methods do we compare the learning results (for example, constructing animations with / without peer reviews, constructing animations with / without presentations)? In the past several experiments have been executed for comparing different levels of the engagement taxonomy [1], e.g. viewing versus responding, viewing versus changing, and viewing versus constructing. Because of the limited amount of time and test persons, it is clear that our experiment can contrast the peer reviewing with only a single other method. We decided to compare the construction and peer reviewing of animations with the mere construction of animations without giving any feedback to the constructors. We plan to execute two experiments with two groups: in the first experiment one group will do animation construction and peer reviewing whereas the other group will do only animation construction. In the second experiment it will be the other way round.

   Another question that has to be answered is whether the animations should only be reviewed by those students who developed themselves animations for the given subject? Or would it be better to let the animations be reviewed by students who have not been studying the animation subject before? Also because of the limited resources we cannot do both. We decided that the constructors and the reviewes are the same persons, because this is the pure form of a peer review process.

   It is still open which subjects will be animated by the students in the two

experiments, and how we will measure the learning progress and possible other effects.

## 4 Summary

This paper described the project "Visual Knowledge Communication", a joint project with psychology and computer science partners from four universities of the German state Rhineland-Palatinate. The paper gave an overview of the overall project. It then discussed in more detail the authors' subproject which deals with a peer review process for animations developed by students. The basic ideas, the main goals, and the project plan have been described.

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