Designing with Learners for Game-Based Collaborative Learning: An Account of T-Rex Group

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Abstract: This presentation discusses our design approach to incorporating learner voices in developing a game for learning Earth system science, Voyage to the Age of Dinosaurs (VAD). We will particularly focus on the account of a group (T-rex) of 4 participants as to what kind of meanings they are attributing to the artifacts they are creating during the workshops and how these meanings from learners' voices are contributing to our design.

Introduction

This presentation discusses our design approach to incorporating learner voices, in developing a game for learning Earth system science, *Voyage to the Age of Dinosaurs* (VAD). The goal of VAD is to provide an immersive experience by recreating and replaying the traces of Earth's history using intelligent agent technology and 3D multi-user game environment. Much literature has documented the difficulties learners have in understanding the Earth as a complex system with naïve conceptions often developing early in childhood (e.g., Barnett et al., 2004; Gobert, 2000; Lee, 1999; Sneider & Ohadi, 1998; Tsai, 2001). At the same time, the learning technologies that support the understanding of Earth's structure and dynamics may still lack the basis of research-based design principles and research into how people learn using such technologies.

We have been working with two Singapore secondary schools in the three-year collaboration in order to develop a culturally appropriate learning design that reflects diverse voices of stakeholders using an informant design process (e.g., Druin, 2002; Scaife et al., 1997). Our design approach addresses important issues in the Earth Science education in various ways. The initial stage of the design explored learners' Earth science conceptions and how technology could support alternative ways of perceiving and understanding Earth's processes. We are using dinosaurs and their fossils as conceptual and motivational anchors for the learning of Earth system science, which will be further discussed in presentation. Through the design approach of engaging learners in various activities, we are investigating how learners immerse themselves into Earth system concepts and how associated emotions affect their conversations and artifacts about Earth's processes. This presentation will discuss our design approach and look at the account of a group (T-rex) of 4 participants as to what kind of meanings they are attributing to the artifacts they are creating during the workshops and how their meanings are contributing to our design.

Informant Design and Earth Science Conceptions

This project has the opportunity to engage schoolteachers and students from two secondary schools (U.S. grade 7-10) as active design partners throughout the iterative design process. The first phase of this project is focused on working with the Singapore teachers and students in order to understand their needs and conceptual challenges and to tease out their ideas about meaningful learning environment. Our design approach starts with the understanding of learners' conceptions of the Earth processes as people of all ages have alternative conceptions about the causes for earthquakes (e.g.,Tsai, 2001), interactions among natural phenomena such as volcanoes and earthquakes (e.g., Barrow & Haskins, 1993), and lack a deeper understanding of the Earth's process, such as plate tectonics (e.g., Gobert, 2000).

Gobert (2000) studied students' (fifth grade) models of the Earth's interior and its causal and dynamic processes for plate tectonics, which requires understanding of the various Earth's mechanisms. The students' diagrams were used to understand their conceptions such as a simple causal mechanism of volcanic eruption (i.e., only heat or only movement as cause) and revealed how students hold onto such conceptions over the series of interviews and adversely affect understanding. For our workshop, we developed a set of open-ended questions for dinosaurs, fossils, and important concepts from their geography textbook, and ask them to write, draw diagrams if appropriate, and explain in a focus group setting. This was conducted with 10 students in each school on separate days. We collected all the artifacts created by the participants and recorded (video and audio) how they describe their understanding during the discussions and build onto each other's ideas.

The second workshop was focused on exposing students' hands and minds to contexts and real-world applications and giving them a chance to develop a script to make their own movies. This workshop was held over two days during school holidays in order to give students an opportunity to work together in groups of four (a total of 16 students from two schools), outside of school in a different environment, to brainstorm and develop ideas about dinosaurs, fossils, and the prehistoric environment by drafting stories about dinosaurs based

on their interests and ideas. Each group made a short movie using the props (both provided and improvised by students) at the end of the workshop. We also collected the created artifacts and video-recorded their processes of working together as a group for the two days.

Becoming the T-rex

The design and research of this project adopt the notion of distributed cognition and emotions, which views cognition and emotions beyond a person's properties as shared and spread among people, artifacts and symbols (Salomon, 1993; Stets & Turner, 2008). Computer technology provides means to experience and understand in relation to the represented situation, otherwise impossible. The design of learning activities using such technology should embody the processes and situations of the particular events or the knowledge creation (e.g., volcanic eruption or inquiry process). Novel opportunities through technology, such as traveling to microscopic worlds or to outer space, can initially provide some excitement. At the same time, technological capabilities of interacting with other learners within virtual space provide another dimension of distributed thinking and sharing feeling. Emotion arise not just from the interesting content, but more often in response to relational meanings around the content (Planalp, 1999).

In an attempt to design and research a program that takes advantage of the affordances of technology and provides meaningful experience to learners, we examined how learners were working with each other and with symbols and artifacts in order to develop and express their ideas and emotions. In the below, we summarize the T-Rex group's account. We will first provide a brief understanding about the four members of the T-rex group, who were all in different groups during the first workshop. We will then briefly introduce how they came together and contributed to the group production of the short movie clip.

Four T-Rex Members with Different Characteristics

In terms of the first workshop on the earth science conceptions, regardless of their exposure to formal lesson on these topics, students' depth of understanding and explanations were mostly shallow, but the level of vocabulary and scientific terms used varied quite a bit. Many students tried to remember some facts or images and fit their explanations to what they remembered (from lessons, textbooks, television programs, popular books, magazines, etc.). Irene, Tony, Victor, and Weilong were not exceptions. They pulled their ideas from different resources, and their characteristics played a big part on how they approached the questions. Irene and two of her girl friends were in the focus group together. It seemed that she was perceived as a "smart" one among them. She had watched many documentaries before and tried to remember what she had seen before. She was also concerned about spellings of different terms and her "bad" drawings when we asked them to draw. Irene started talking about volcano when discussing earthquake and plate tectonics as she thought volcano causes earthquake and lava also has something to do with making the plates move or break apart.

Tony is very expressive and even exaggerative in describing Earth's events verbally as well as visually through drawings. He uses various analogical expressions, which often included human figures or emotions and dramatic descriptions of catastrophe and urgency of situations. He was especially excited when talking about volcanoes and his initial drawing highlighted volcanic eruption as the main disaster that the dinosaur could have encountered. During this workshop, Tony was good at posing "why" questions to the members, which sparked further conversations and constructing ideas together. Victor was partnered with a friend from a primary school. He was very open to talking about what he imagined based on what he heard and saw before. His mother seems to influence his science knowledge as he referred to what he heard from his mother during the conversations. However, he imagined plates as "blades" inside of the Earth that shakes the ground to cause earthquake, and also inside of the Earth as full of lava. Weilong, unlike others, went through the topic in his recent geography class. His responses were more dry and proper with terms. He talked about the events very objectively and did not draw the Earth's processes until the facilitator requested again, which showed minimal illustration of the events. In the presentation, we will include actual drawings and conversations that characterize four members.

T-rex's Ideas about Dinosaurs

The common characteristic of the movies across different groups was "role-playing" in the second workshop. They liked to play the role of paleontologists who find fossils of dinosaurs. The climax of their stories tended to include dinosaurs fighting before their death and burial. Dinosaurs' actions in these scenes usually reflect how they were depicted as fossils in previous scenes about fossil findings. These common themes reflect aspects of what students were interested in knowing about dinosaurs, but at the same time seem to be influenced by the IMAX movie they watched earlier in the workshop in which paleontologists excavate dinosaur fossils and scenes recreate what might have happened to the dinosaurs. One of the distinctive aspects of the T-rex group's movie making was their creation of and excitement over the volcanic eruption scene, which we will be able to demonstrate their movie and the process during the presentation.

Their movie takes places in two main settings: present time fossil finding site and the same location 100 million years ago. The main characters include two paleontologists and two dinosaurs (Confuciusornis and

Dilong). When they started filming their movie, they naturally positioned in certain roles. Irene became the narrator of the movie, which interestingly resonates with how she was being concerned about "getting things correct." Throughout the preparation, practice, and filming, we heard her practicing the pronunciations and confirming with other members repeatedly. Tony, on the other hand, took on many roles on and off the stage: playing one of the paleontologists, maneuvering dinosaur props, providing ideas for sound and other effects and finding ways to make them. Tony's expressive character, especially how he includes emotional aspects for the concepts, made a significant contribution to the T-rex group's work. Victor also played one of the paleontologists and helped with effects. However, he mostly followed what Tony suggested him to do instead of him finding his position in the group and he seemed to be content with his roles. Weilong took the camera for filming and also took on the role of the movie director, which also interestingly connects with his dry and 3rd person viewpoints of events. When Tony and Victor were busy with preparing effects, Irene and Weilong spent most of their time with planning the scenes and fine-tuning their scripts for narration.

Design Elements and More

T-rex group used various design elements to express their ideas and related emotions, such as paleontologists having mustache, driving jeep, crying when could find any fossil, and dancing when found one, and volcanic eruptions as sudden event with lava (using a red disposable poncho) covering a large area. Tony, for a quite long time during the planning and filming session, insisted and searched for something to represent lava. In the presentation, we will demonstrate the artifacts, filming sessions, and conversations that show how they weaved their ideas into the design, and discuss and demonstrate how our further workshops and VAD prototype are unfolding for the project by incorporating learner voices.

References

Barnett, M. K., A.; Bellegarde, H.; Pfitzner, A. . (2004). *Impact of Inquiry-Based Science Instruction on Middle School Student Understanding of Seismological Concepts.* Paper presented at the American Geophysical Union, San Francisco, CA.

Barrow, L., & Haskins, S. (1993). *Earthquakes haven't shaken college students' cognitive structure.* Paper presented at the Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics, Ithaca, NY.

Druin, A. (2002). The role of children in the design of new technology. *Behaviour and Information Technology 21* (1), 1-25.

Gobert, J. D. (2000). A typology of causal models for plate tectonics: Inferential power and barriers to understanding. *International Journal of Science Education, 22*, 937-977.

Lee, O. (1999). Science knowledge, world views, and information sources in social and cultural contexts: Making sense after a natural disaster. *American Educational Research Journal, 36*(2), 187-219.

Planalp, S. (1999). *Communicating emotion*. New York: Cambridge University Press.

Salomon, G. (1993). No distribution without individuals' cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 111-138). New York: Cambridge University Press.

Scaife, M., Rogers, Y., Aldrich, F., & Davies, M. (1997). Designing for or designing with? Informant design for interactive learning environments. In S. Pemberton (Ed.), *Proceedings of CHI 97 Conference on Human Factors in Computing Systems: Looking to the Future* (pp. 343-350). New York, NY: ACM Press.

Sneider, C. I., & Ohadi, M. M. (1998). Unraveling students' misconceptions about the earth's shape and gravity. *Science Education, 82*(2), 265-284.

Stets, J. E., & Turner, J. H. (2008). Sociology of emotions. In M. Lewis, J. M. Haviland-Jones & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 32-67). New York: Guilford Press.

Tsai, C. C. (2001). Ideas about earthquakes after experiencing a natural disaster in Taiwan: An analysis of students' worldviews. *International Journal of Science Education, 23*, 1007-1016.

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