Semiotic Analysis of Students' Use of Multi-Agent Based Modeling Software (NetLogo) in Making Meaning of Complex Systems in Science

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This paper proposes the use of screen capture software and video performance tagging software, specifically Camtasia Studio© and Studiocode©, to capture, identify and code the data required for a semiotic analysis of student's use of a multi-agent based modeling software package, specifically NetLogo.

The Computational Semiotics of Students' Reasoning about Complex Systems in Science

The focus of the research addressed in this paper is on exploring the use of multi-agent based computational models by students to make meaning of, specifically reason about, complex systems in science. In particular, investigating the specific affordances of the technology, multi-agent based modeling software, for students' reasoning about complex systems in science. The concept of complex systems is one of the six overarching ideas of the science component of the still developing Australian Curriculum. Similarly, information and communication technology, which includes software, is one of the general capabilities that shapes the Australian Curriculum (ACARA, 2012, pp. 7-8, 12-14). The reasoning that is conducted by the students when using multi-agent based modeling software is analysed in this research by using Peirce's semiotic. Peirce (1998) developed a specific approach to semiotics, a triadic conceptualisation of the sign system, which along with De Saussure's (1983) dyadic conceptualisation of the sign system, forms the basis of all semiotic theories. The specifics of a semiotic analysis using Peirce are not addressed in this paper, rather the emphasis is on the way in which rich data can be collected and relevant data coded, principally students' interactions with particular sign systems, in order to allow for such a semiotic analysis.

Multi-Agent Based Modeling Software - NetLogo

NetLogo (Wilensky, 1999) is a multi-agent based modeling software package that is designed specifically to allow simulation of complex systems. Complex systems are systems in which individual components at the micro-level interact with each other in order to produce emergent properties at the macro-level (Jacobson & Wilensky, 2006, pp. 13-19). The fundamental nature of complex systems is captured by the familiar phrase, "the whole is more than the sum of its parts" (Lesh, 2006, p. 51). The software allows users to create and modify the variables that determine the behaviour of the individual components at the micro level as well as the variables that determine the role played by the environment. The results of

running the simulations are displayed in various forms (e.g. graphs, figures), which again can be modified, and which display the outcomes at the macro-level (Sklar, 2007, pp. 305-310).

The software is low-threshold, high-ceiling and so while the software is easy to learn to use in order to perform basic functions, it can also be used to conduct complex investigations of the same concept (Sengupta & Wilensky, 2011). It is possible to both modify existing models of complex systems and create entirely new models using the software (Blikstein & Wilensky, 2010). As such, NetLogo is ideally suited for use by students to reason about complex systems, in a variety of different areas of science (Blikstein & Wilensky, 2004; Levy & Wilensky, 2010; Wilensky & Reisman, 2006).

Screen Capture Software - Camtasia Studio©

How can students' use of NetLogo be recorded in such a way that the rich data needed for a semiotic analysis is acquired? In this case, the data of most interest is the activity that is taking place on the computer screen. This is where students interact with the sign systems of interest. The most effective means to record what is taking place on the computer screen is through the use of screen capture software, of which Camtasia Studio© (TechSmith, 2012) is the most effective (Blevins & Elton, 2009; Carlson, 2009; Charnigo, 2009; Schnall, Jankowski, & St. Anna, 2005). Camtasia Studio© enables the capturing, in real time, and in high quality video form, of what is taking place on the computer screen, including any audio (Imler & Eichelberger, 2011, pp. 446-451). The result of using Camtasia Studio© is a video of what took place on the computer screen, but only while the software was activated.

Camtasia Studio© has most often been used to create videos for the purposes of instructing computer users in the use of particular software and Internet sites (Blevins & Elton, 2009; Carlson, 2009; Charnigo, 2009). However, Camtasia Studio© has been recognised by some researchers as an effective means of collecting rich data about the human-computer interaction; in other words, what takes place on the computer screen (Goodwin, 2005; Hargittai, 2004; Hider, 2005; Imler & Eichelberger, 2011; Makkonen, Siakas, & Shakespeare, 2011; Schnall et al., 2005). This includes the use of Camtasia Studio© to record students' use of NetLogo (Blikstein & Wilensky, 2010). This paper suggests that Camtasia Studio© is the most effective means by which to collect rich data about students' use of NetLogo because it records all the action that takes place on the computer screen, including in great detail students' interactions with specific sign systems. It is this comprehensive collection of rich data that is required in order to conduct a semiotic analysis of students' reasoning about complex systems.

Video Performance Tagging Software - Studiocode©

Once an array of rich data has been captured using Camtasia Studio©, how can the data relevant for a semiotic analysis be identified and coded? Just as the most effective means to capture what is taking place on the computer screen is through the use of Camtasia Studio©, this paper suggests that the most effective way to identify and code this data is through the use of Studiocode© (Sportstec, 2012). Imler and Eichelberger (2011, pp. 448-449) make the same conclusion in their study of user research behaviour, in which they argue that Camtasia Studio© and Studiocode© make a good software match in terms of data collection and coding. Studiocode© enables the tagging of events that occur in videos (Imler & Eichelberger, 2011). The result of using Studiocode© is a timeline on which relevant events are tagged, which can then be further analysed.

Studiocode© was originally developed to code video of sporting events (Imler & Eichelberger, 2011, p. 49). However, it has since been used in many different research areas, including educational research, mainly to code events taking place in the classroom. This includes research conducted at the International Centre for Classroom Research at The University of Melbourne (Xu, Tytler, Clarke, & Rodriguez, 2012) and both the EqualPrime (Tytler, Hubber, & Chittleborough, 2010) and CRISP projects (Aranda et al., 2012), of which this research is a part, based at Deakin University. This paper suggests that Studiocode© can be used to identify and code the video of students' use of NetLogo that is captured by Camtasia Studio© (*Figure 1*.). In this way, the data required for a semiotic analysis of students' reasoning about complex systems is identified and coded, principally their interactions with particular sign systems.

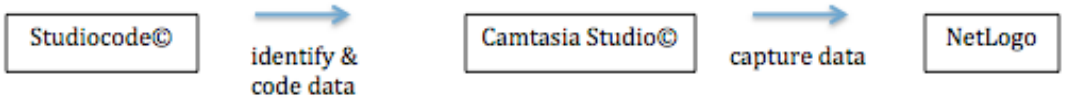

Figure 1: The use of Studiocode© to identify and code the video data of NetLogo captured through the use of Camtasia Studio©.

Combining NetLogo, Camtasia Studio© & Studiocode©

It is the combined use of screen capture software and video performance tagging software, specifically Camtasia Studio© and Studiocode©, which is proposed as an effective means of overcoming the methodological difficulties of conducting a semiotic analysis of NetLogo, in particular the difficult task of exploring students' reasoning about complex systems as they use multi-agent based computational models. Camtasia Studio© footage of NetLogo has not been identified and coded in this way using Studiocode©. In addition, semiotic analysis, whether using Peirce' semiotic or the work of other semioticians, has not been conducted using Studiocode© as the primary means of identifying and coding relevant data, primarily students' interactions with sign systems. This paper suggests that Camtasia Studio© and Studiocode© can be used together in order to conduct semiotic analyses of students' use of computer software, in particular multi-agent based computer software such as NetLogo.

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