

Critical Thinking with Alice: A Curriculum Design Model for Middle School Teachers

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ABSTRACT

This paper describes a curriculum design model for the use of the 3D animation program, Alice, with middle school students. Based on the learning theory of SCCS (social and cognitive-connectedness schemata), the model's design interweaves the construct of TPACK (technology, pedagogy, and content knowledge) within the 21st century skills framework developed by The Partnership for 21st Century Skills (P21) in order to develop engaging lessons that will engender critical thinking, while promoting proficiency in core subject areas.

Categories and Subject Descriptors

K.3.2 [Computing Milieu]: Computers and Education – *computer uses in education*

General Terms

Theory

Keywords

Learning theory, pedagogy, content knowledge, 21st century skills, core subjects, Alice, virtual worlds, middle school, TPACK, SCCS, critical thinking

1. INTRODUCTION

The title of a recent *USA Today* article asked, What to learn: 'core knowledge' or '21st century skills'?[15] The article highlighted an ongoing debate among education scholars. Some educational leaders, such as E.D. Hirsch, founder of the Core Knowledge Foundation, weigh in on the side of core knowledge. Others, such as Ken Kay, co-founder of Partnership for 21st Century Skills, argue that today's students need world-class skills and world-class content. The article's question, however, belies the true query: In today's economy, is it possible for students to achieve a level of proficiency in the core subjects, while developing 21st century skills? An ever-growing cadre of teachers, such as educators who have integrated the free 3D Alice [1] program into their curriculum, would answer this question with a resounding yes - especially when these lessons correspond

to content standards and utilize research-based pedagogy. This article presents an instructional model called Critical Thinking with Alice that can help teachers implement Alice in a way that weds the construct of TPACK (technology, pedagogy and content knowledge)[16], within a 21st century skills framework – a nuptial that can enable students to develop proficiencies in core subjects while also developing 21st century skills.

1.1 TPACK

The model presented here, Critical Thinking with Alice, advocates the intentional integration of the TPACK construct into every aspect of its curriculum design. The construct of TPACK, formulated at the 9th Annual National Technology Leadership Summit (2007), captures two key aspects of technology integration[14]. First, TPACK emphasizes, through its letters, the three kinds of knowledge that are essential building blocks for intelligent technology integration: technology, pedagogy and content knowledge. Second, and as important, TPACK captures the fact that these three knowledge domains should not be taken in isolation, but rather as an integrated whole, to help teachers take advantage of technology to improve student learning. The Critical Thinking with Alice model interweaves these three areas by providing Alice-related lesson plans that investigate at least one controversial issue, tied to a content standard, in the core subject areas for grades 5-8. Through the use of primary source documents, students create an Alice world that illustrates the subject's controversy.

1.2 P21 SKILLS FRAMEWORK

In addition to weaving TPACK into its format, Critical Thinking with Alice also interlaces 21st century skills into its design. The Partnership for 21st Century Skills (P21) outlines nine core subjects, and four interdisciplinary themes that it believes are essential for the development of 21st century skills. These subject areas include English, reading or language arts; world languages; arts; mathematics; economics; science; geography; history; government and civics [9]. The Critical Thinking with Alice model seeks to gather lessons for grades 5-8, tied to curriculum standards, in each of these core areas. Each lesson will also touch on at least one of the four interdisciplinary themes outlined by P21: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; and health literacy. In addition, the P21 framework also emphasizes the need for educators to help students develop creativity and innovation, critical thinking and problem solving, and communication and collaboration, as well as increased competencies in information literacy, media literacy, and communications/technology literacy. By design, the Critical Thinking with Alice model incorporates all of these areas.

2. ALICE, TPACK, AND 21ST CENTURY SKILLS

Alice is a 3D graphics programming environment that, utilizing a drag and drop interface, allows those without any 3D graphics or programming experience to create interactive 3D virtual worlds. Through the generosity of Carnegie Mellon University, this free software is available from <http://www.alice.org>.

Each Critical Thinking with Alice lesson presents primary source information for at least two sides of a controversial issue, and a tutorial for first-time Alice users that demonstrates how the first-hand information can be presented in an Alice world. Both the teacher and the students learn how to use Alice as they walk through the tutorial. Each lesson also provides background information relating to the controversial issue that will be addressed in the Alice world. Students then create their own Alice world to illustrate at least one side of the controversy by integrating the primary source information into their world. For example, the 6th Grade California Social Studies Content Standard 6.6 requires students to analyze the geographic, political, economic, religious, and social structures of the early civilizations of China. The Critical Thinking with Alice lesson for 6th grade social studies presents quotes from the Chinese philosophers of Confucius, Laozi, and Hanfeizi. The tutorial shows students how they can insert graphic objects representing these philosophers into a scene where the philosophers discuss their views with each other. The students must also insert a modern character into the scene, representing themselves, and add a quote of their own that either agrees or disagrees with the points of views presented by the philosophers. The lesson also provides background information teachers can use to help students make connections with P21's interdisciplinary theme of global awareness [11]. The lesson includes a download of gallery objects and sounds related to the Chinese philosophers' world that can then be added to the students' Alice galleries.

Another Critical Thinking Alice lesson presents primary source information surrounding land disputes between the Native Americans and the settlers near Yosemite in the 1850's. Based on content standards for 5/8th grade social studies, the primary sources included in this lesson provide quotes from Totuya, the last living survivor of the Yosemite Indians to be interviewed before her death in 1931, and Dr. Lafayette Bunnell, a member of the Mariposa Battalion that became the first white discoverers of the Yosemite Valley in 1851 [12]. Other critical thinking lessons could include an 8th grade science Alice world that examines Newton's theory of gravity, as opposed to Einstein's theory of relativity, or a math lesson that grapples with the implications of Einstein's theory of curved space on our understanding of Euclidean geometry (can parallel lines actually meet?). These kinds of lessons place students in the center of the learning environment as they make meaningful connections between core subjects and real-world problems, using 21st century skills.

3. SCCS LEARNING THEORY

In addition to interlacing 21st century skills into the Critical Thinking with Alice lessons and basing its format on the construct of TPACK, this design model also takes its pedagogy cues from the learning theory of SCCS (social and cognitive-connectedness schemata). SCCS learning theory focuses on the formation of schemata in the process of learning, particularly social-connectedness and cognitive-connectedness schemata [13].

The affordances of today's technologies have resulted in massive changes in the ways students connect to each other and information. Studies have found that the environment and culture in which people grow up affect their thought processes, and that cognitive processes are far more malleable than previously assumed [6]. Evidence provided by magnetoencephalographic (MEG) imaging suggests that structural rewiring of the brain "can and does occur via experience" [8]. Interactive and interpersonal applications of digital technology shape the social and cognitive development of those who use them [10]. SCCS takes these important developmental changes into account in order to structure more engaging and effective instructional environments.

3.1 SOCIAL-CONNECTEDNESS SCHEMA

Students' social-connectedness schema governs and is structured by their ability and desire to connect socially with others; the affordances of today's technologies have resulted in massive changes in this schema as students have more opportunities to connect in a wider variety of contexts. Students engage their social-connectedness schema in a set of behaviors that SCCS describes as "link, lurk, and lunge". Students link up with others who have the knowledge they need; they lurk, watching others who know how to do what they want to do; and they lunge, jumping in to try new things often without seeking guidance beforehand [3]. Students' social-connectedness schema underlies their ability to create and sustain physical, virtual, and hybrid social networks [7].

3.2 COGNITIVE-CONNECTEDNESS SCHEMA

Students' cognitive-connectedness schema structures their ability and desire to know how what they are learning connects to a larger picture. Changes in their cognitive-connectedness schema have enabled today's students to see knowledge not as separate bits of information but as something that has "constituent parts [that] index the world and so are inextricably a product of the activity and situations in which they are produced" [4]. These changes are reflected in a cognitive-connectedness schema that includes constructs for digital navigation literacy; a preference for interactive, discovery-based learning; and the desire to make reasoned judgments based on independent exploration of digital resources [2]. All of these attributes are sharpened by the availability of digital tools that make information instantly available and the connections between different pieces of information clearly visible. Students' use of these tools has become part of their lifeworld, shaping the development of their cognitive-connectedness schema. A graphic model of SCCS can be viewed at <http://tinyurl.com/3hh58u>.

4. SUMMARY AND FURTHER STEPS

The 3D programming environment of Alice was designed to provide students with their first exposure to object-oriented programming. As proposed here, the curriculum model of Critical Thinking with Alice barely scratches the surface of Alice's capabilities. It does, however, provide middle school teachers and students with an introduction to this powerful and engaging program as it immerses students in core subject areas, activates their social and cognitive-connectedness schemata, and provides opportunities for the development of 21st century skills.

To further this project, subject matter experts with middle school experience, familiar with the Alice environment, need to

collaboratively develop Critical Thinking with Alice lessons for grades 5-8 in each of the core subject areas outlined in the P21 framework. Grants should be sought out to fund such workshops, and leaders identified to coordinate the project. More 3D object galleries must be developed that relate to these subject areas. For example, partnerships could be developed with Alice developers and graphic arts schools, challenging 3D art students to develop Alice models as part of their coursework, or as internships. Partnerships should also be developed with universities and colleges that train our future teachers, introducing them to the Critical Thinking with Alice curriculum model as a viable way to help today's students learn core subject matter while also developing 21st century skills.

At the end of the dot.com boom and bust, Carly Fiorina, then CEO of Hewlett-Packard, stated, "The last twenty-five years in technology have been just the warm-up act. Now we are going into the main event...in which technology will literally transform every aspect of business, every aspect of life and every aspect of society" [5]. The question for educators is, when will we allow technology to really transform education?

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