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FUTURE WORLDS: Development of Assessment Methods for an Interactive Cyberlearning Platform for Informal Explorations in Sustainability for Students Ages 9 – 12 (Research to Practice)

Ms. Rebecca Arielle Citrin, Lafayette College

Rebecca Citrin is a junior Civil and Environmental Engineering student at Lafayette College with a strong interest in K-12 Engineering Education. She is currently working with Lafayette College and North Carolina State University faculty members on an NSF-funded education project. Citrin has conducted research on various informal K-12 engineering education projects and has worked on developing assessment methods for these projects. Citrin has organized various student events such as the Lafayette College Engineering Brain Bowl and the Lafayette College STEM Camp, to both promote engineering and science education for K-12 students, as well as assess the learning outcomes of these programs.

Dr. Arthur D. Kney, Lafayette College

Dr. Arthur D. Kney received his Ph.D. in Environmental Engineering from Lehigh University in 1999 and his professional engineering license in 2007. He is currently serving as an associate professor and department head in the Department of Civil and Environmental Engineering at Lafayette College. He currently serves on several national, state and local committees. Dr. Kney's areas of interests involve water and waste water treatment (including industrial waste water treatment) and urban sprawl and its environmental effects on watersheds. He is also interested in combining undergraduate and K-12 academics in innovative ways. He has been awarded a number of NSF grants for both research and teaching. With the help of EXCEL scholars and other faculty members, he has written several peer reviewed journal articles and many conference papers. Dr. Kney has also co-authored a book chapter and a technical guidance manual.

FUTURE WORLDS: Development of Assessment Methods for an Interactive Cyberlearning Platform for Informal Explorations in Sustainability for Students Ages 9 – 12

Abstract

FUTURE WORLDS is an interactive, museum based cyberlearning system which aims to expose students from grades K – 12, specifically targeting students ages 9 – 12, to the concept of sustainability in an informal setting. Through the FUTURE WORLDS interface, which is currently under development, students will have the opportunity to explore various sustainability concepts and environmental engineering practices, which can both help improve present day society as well as provide practical solutions for our future. Students will investigate concepts related to energy, food and water, and will examine how these ideas can be engineered to help improve the health of our planet. Using an interactive tabletop, students will work collaboratively in a museum based setting to solve sustainability puzzles of varying difficulty with the goal of generating a cleaner, greener planet.

In order to develop the most effective and efficient game, several assessment methods are being employed to ensure students attain optimal learning outcomes from FUTURE WORLDS. Various focus groups have been conducted, where students' knowledge was assessed both before and after interactions with a paper prototype model. The data collected from these interactions is undergoing analysis to examine student learning and engagement with the FUTURE WORLDS framework. Video and audio recordings were collected at the focus groups as well to evaluate the effectiveness of collaborative learning among the student participants. Ongoing investigations will take place throughout the development of the FUTURE WORLDS cyberlearning system to iteratively assess its effectiveness in translating sustainability and environmental engineering concepts to K – 12 students in a museum setting. Assessment methods developed to evaluate the effectiveness of FUTURE WORLDS will be broadened in order to establish a standard for assessing informal engineering education practices for K – 12 students. The results are expected to motivate a rise in informal engineering education practices for K – 12 students by demonstrating the importance of early exposure to these disciplines.

Introduction

FUTURE WORLDS is an interactive, cyberlearning platform that will be implemented in a museum based setting, where students ranging from ages 9 – 12, will be targeted to explore various sustainability and environmental engineering concepts through a watershed framework. Through the use of an interactive tabletop surface, participants will complete various puzzles increasing in complexity, as the educational content builds through each level of the game. Students will explore how our food, water and energy supplies affect the watersheds we live in, and how these areas of land can be improved through the implementation of sustainable solutions and engineered concepts. In order to ensure that the informal science curriculum the FUTURE WORLDS interface is based upon is effectively engaging students and is a positive supplement to the knowledge students have gained in the classroom, various assessment methods have been explored. Through focus groups, which will continue to be conducted throughout the development of FUTURE WORLDS, data will be collected and analyzed in order to improve upon the scientific content in which this interactive system is founded upon.

Data Collection and Analysis

In order to effectively assess the FUTURE WORLDS framework, data will continue to be collected through various mediums during the focus group sessions, which will both quantitatively and qualitatively evaluate this system. The focus groups, which target the same age range that the game is intended to be utilized by, will continue to take place at various increments throughout the design and development of FUTURE WORLDS. The focus groups will take place in a similar setting to the actual installation of the game itself, utilizing graphics and puzzles that are envisioned to be implemented in FUTURE WORLDS. By assessing the curriculum of the FUTURE WORLDS interface throughout its development, any necessary changes that need to be made can be identified at an early stage. The collection of data sources that can be both quantitatively and qualitatively analyzed will be conducted through various techniques, such as through two-tiered before and after questionnaires and Personal Meaning Maps, or PMM, as well as through video footage.

Two-tiered before and after questionnaires will be distributed to the students of the focus groups to assess the participants' knowledge of various topics related to sustainability and the three main sub-topics of the game including food, energy and water. By assessing the students' knowledge prior to any interactions with the FUTURE WORLDS interface, a base level of knowledge can be established. When comparing the post test results to a student's corresponding initial assessment, a comparison can be made to see if students are grasping the concepts conveyed through interactions with the game. In addition to comparing the initial questionnaire to the post testing to assess what knowledge is gained, the initial testing also ensures that the curriculum represented in FUTURE WORLDS goes beyond what the students have learned in school. The purpose of student interactions with the FUTURE WORLDS framework is to supplement knowledge gained in a classroom setting and enhance this knowledge through practical applications. For example, students may learn what pollution is in science class and why it is harmful to the environment, and through the FUTURE WORLDS interface students will have the opportunity to make changes to a community to reduce or eliminate hazardous materials that are polluting a particular watershed.

The questionnaires will be developed to demonstrate two-tiered assessment, which aims to analyze the students' understanding of the concepts presented through FUTURE WORLDS, rather than purely being able to recall the facts and definitions illustrated during interaction. One goal for the game is for students to be able to apply prior scientific knowledge in order to develop solutions to real world situations, which requires the students to think critically about the various puzzles in the game. The before and after questionnaires will utilize two-tiered assessment strategies, as the questions proposed will not only ask students to answer a specific question, but will all ask the students to explain why they chose that answer. By requiring the students to provide a written explanation as to why they chose an answer, the data can be analyzed more critically to ensure students are not only repeating material learned through the game, but can understand the importance and applications of this information presented.[1]

During the initial assessment, students will be asked to complete a Personal Meaning Map based on a certain word or phrase presented, such as the *Environment*, and will be asked to illustrate with words, phrases or images what they know about this topic. During the post assessment, students will be given their original PMM and will be asked to modify their drawing, using a different color, based on what they learned through interactions with FUTURE WORLDS. A comparison between the before and after drawings will illustrate the student's evolution of knowledge of a particular topic as a result of the FUTURE WORLDS framework. In addition to allowing the students' to freely express their knowledge of a particular subject, the PMM will also allow for subsequent interviews to be conducted where further questions can be asked as to what was drawn or written in a student's PMM. The Personal Meaning Maps allow for additional information to be gained by allowing the students' to represent what they know verbally when questions are posed regarding their illustrations.[2]

In addition to quantitatively analyzing the data collected through the two-tiered before and after questionnaires, which will include the PMM, video footage will also be taken during the duration of the focus group sessions in order to qualitatively analyze the effectiveness of FUTURE WORLDS. Interactions with FUTURE WORLDS will be analyzed to assess exchanges both between the participant and the game itself, as well as between the participant and others interacting with the tabletop surface simultaneously. Using the *Visitor Engagement Framework*[3], students' interactions with the game will be assessed on various levels, including initiation behaviors, transition behaviors and breakthrough behaviors. Initiation behaviors will reveal students' initial interactions with the game itself and how they cooperate with other participants, transition behaviors will identify continued and revisited interactions with the game, and breakthrough behaviors will reveal students' ability to utilize previously gained knowledge to enhance their interactions with FUTURE WORLDS.

Conclusions

By continuing to assess the FUTURE WORLDS framework through focus groups, which will take place at various stages throughout the development of this interactive, cyberlearning platform, the effectiveness and success of this game can be efficiently monitored. Assessment techniques such as two-tiered assessment, which will be conducted through before and after questionnaires, as well as the utilization of Personal Meaning Maps, will allow for quantitative results revealing the effectiveness of the FUTURE WORLDS curriculum. Additional strategies will be employed, including the analysis of video footage, which will allow for a qualitative assessment of this interactive, museum based cyberlearning system. In order for FUTURE WORLDS to reach its full potential, it is important to assess its curriculum to ensure it is being appropriately accepted by the target age range of students from ages 9 – 12 and that it effectively exposes them to the sustainability and environmental engineering concepts illustrated throughout the game.

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