AC 2012-3572: TINKERING TO INTRODUCE TECHNOLOGY, DEVELOPING AN INSTRUMENT TO MEASURE STUDENT'S PLAY PREFERENCES

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Tinkering to introduce technology, developing an instrument to measure student's play preferences

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Abstract

This purpose of the research described in this paper is to determine if a student could be identified to prefer hands-on activity and problem solving skills - "tinkering", to other forms of play. Adult engineers, scientists and technologists may take objects apart and put them back together to learn about the object. From there, they may try to invent a new object from something that they have experienced. The people that are doing such actions are called "tinkerers". [1] A vast amount of research has been done on the effects of play on learning. The goal of this project is to investigate the correlation of "tinkering" to interest in STEM areas of education. A pilot project developed and tested an assessment tool that could be used to determine a students' preference. The project used a visual tool developed by the researchers. The tool was utilized in an international preschool on the XXXX University campus. This preschool is used frequently to pilot research and their familiarity with research protocols allows ease of access and cooperation with teachers. Results of the study were compared to teacher knowledge of the students. The scientific design, methodology, and results are discussed in this paper.

Introduction

The numbers of women in Science, Technology, and Mathematics (STEM) have increased in the last two decades, but women are still not equally represented in these areas. [2] At XXXXX, the rate of women entering the College of XXXXXXX is only 12.5% while men had an entrance rate of 87.5%. [3] This illustrates the low rate of women who are pursuing STEM especially in technology. There are a number of reasons for the low rate of women in the STEM system. One of the reasons is that girls in high school find engineering boring or not attractive for a career. [4] High school students are not the only ones who not interested in a science, technology, or mathematics, but also children as young as the age of 8 to 10. These children are also "turned off" by science or mathematics.[5] Another reason that women are not pursuing STEM is that they cannot look up to anyone as a role model because there is not a specific person that the girls can relate to in engineering.[2] The purpose of this research is to promote hands-on activity, problem solving skills, and "tinkering" as well as investigating the effects of cartoon characters to children from pre-kindergarten to 3rd grade. The use of the movie, Tinker Bell & Tinker Bell the Lost Treasure and the children's book can help children at this age to "tinker". This research will be conducted with the use of classroom observations as well as an instrument to measure the result of the study.

Review of Literature

This project evolved from the used of an undergraduate research summer internship. Preliminary research was necessary to understand where future funding might be located. The first steps was to find out what projects have been funded by the National Science Foundation (NSF) in the pre-kindergarten level. The NSF has funded projects for such a grade level but not as much as it has funded the K-12 level. By organizing the funded projects into an Excel spreadsheet, it was easier to see what NSF has funded in the pre-kindergarten level. Most of the research that has been funded by the NSF relates to math. There was not any research that was focusing on the T (technology) in STEM.

As previously stated, studies have shown that girls between the age of 8 to 10 (3rd -5th grade) are “turned-off” by science or mathematics. [5] This can lead to the fact that there are less women in the STEM system. Moreover, women have stated that they choose engineering not because they have an interest in such area but that they were influence by their family members or teachers. [6,7,8] Women have also asserted that they have chosen majors in engineering, mathematics, or science based on the impact on the society. [6,7,9,10] This illustrates that some women are not interested in the STEM area and others are interested because the majors have a huge impact on the society. So do girls like to tinker or just play with dolls.

How do we interest children in STEM careers? To better develop answers to this question, this study sought to determine if a student could be identified to prefer hands-on activity and problem solving skills - “tinkering”, to other forms of play. Adult engineers, scientists and technologists may take objects apart and put them back together to learn about the object. From there, they may try to invent a new object from something that they have experienced. The people that are doing such actions are called “tinkerers”. [1] A vast amount of research has been done on the effects of play on learning. Some believe that play is just exerting energy; while others have shown that learning is occurring during play. Research has investigated the pros and cons of the time spent in play versus structured guided activities. The goal of this project is to investigate the correlation of “tinkering” to interest in STEM areas of education. A pilot project developed and tested an assessment tool that could be used to determine a students’ preference.

Design

The literature review and the experiences of the researchers led to the research question:

Can a tool be developed that would motive pre-school children to tinker?

The project used a visual tool developed by the researchers. The tool was utilized in an international preschool on the XXXX University campus. This preschool is used frequently to pilot research and their familiarity with research protocols allows ease of access and cooperation with teachers. Results of the study were compared to teacher knowledge of the students. The scientific design, methodology, and results are discussed in this paper.

The guided activity for the preschoolers was based on an event in a Tinker Bell book where Tink uses found objects to design and build a device to get her and her friends home. The researchers purchased blue cloth to represent water, used chairs to represent home and an island, then asked preschoolers to use objects in the bag provided or any object in the room to invent a way for them to get from the island to home…no pixie dust allowed.

Methodology

To test the hypothesis, two groups of preschoolers were used with permission from parents and approval of the Institutional Review Board at XXXX University. The first group was read the story about Tinker Bell and how she invents devices, builds them, and uses them to help her friends. The second group was not read the story. Each group of students come from different classes that do not meet at the same times. Each group was then exposed to the guided activity, and asked to help Tinker Bell. The children were given opportunities to opt out at intervals during the experiment.

Before the design challenge the students were "tested" to see if they would chose the tinkering items over other toys. This testing was done two weeks before the design challenge and was used to determine if there were natural tinkers in the group. Twenty pages, with three choices each, were made using pictures of the toys which were available at the school. Figure 1 shows what one set of choices would be. The pictures were each one 8 ½" X 11" papers which were bound into three books. The students were shown each set and asked to point to the one they like the best. Two researchers sat down with each child and recorded their preference from three items.

Figure 1: Sample instrument page for child play preference

The students were 3, 4 and 5 years old and have an international mix with Asian, Middle Eastern, Hispanic, and others due to the large international population of professors and students at this university. The results were used to classify if the students had strong preferences to tinkering. In Figure 1 the Legos would be the tinkering, tricycle would be active play and board game would be problem solving for example.

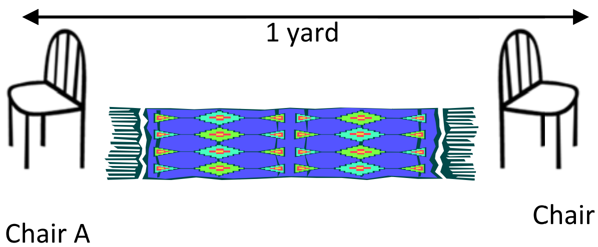
Design Challenge

The research team created a design challenge to emulate the type of challenge that Tinker Bell faced in the story and the video. The challenge required the participants to work in small groups of three students to design and build a solution to a simple problem by using a collection of everyday objects, see Figure 1. The design scenario was created using the Tinker Bell character as a role model for ‘tinkering’ activities and providing a collection of building materials similar to the ‘found’ objects Tinker Bell uses in the Tinker Bell media storylines.

Tinker Bell Challenge

Scenario – Imagine that Tinker Bell is on a journey to the main land but is stuck on an island. Tinker Bell has also run out of pixie dust so she must find a way to use her tinkering talents to design a way to get across the water (fabric) to the mainland (a chair). You and a few friends (a group of three) have been asked to help Tinker Bell by using some “found” objects to create a way to get Tinker Bell across the water. Two chairs have been setup for you, one is the island where Tinker Bell is stuck and the other is the mainland which is where Tinker Bell needs to go. The blue cloth in-between is water. You can use these (point to the objects) to get Tinker Bell (show the ping-pong ball) across the water without getting wet. Remember, don’t let her fall in!

Setup - The classroom will be set up with two classroom chairs; one chair representing the island and the second chair will represent the mainland. A ping pong ball with a Tinker Bell sticker represents Tinker Bell. See illustration below for dimensions.



“The Island” (“Water” represented by blue cloth) “The Main Land”

Collection of “Found” objects: The following materials are available for constructing a safe way for “Tinker Bell” (ping pong ball) to be transported from chair A to chair B. Students are allowed to use objects from the classroom but only if they ask. Do not tell them that they can use items other than what is on this list or what they ask for.

• ¼” cotton rope >1 yard in length	• Construct paper (various sizes)
• ½ PVC pipe (several at various lengths)	• Rubber Bands
• Paper towel tubes	• Oversized plastic paperclips
• Wood Spoon	• Tape (pre-cut tape dispenser)
• Rubber eraser	• Construct paper (various sizes)

Other Items needed:

- Ping-Pong ball (with Tinker Bell Sticker)
- Plastic tray or Tupperware container (landing pad for “Tinker Bell”)
- 1 yrd of blue cloth for the “water”

Figure 2. Tinker Bell Design Challenge

Results

The participants were using the collection of objects to create a solution to the design challenge. Each design team tried several different design ideas and watched to see what worked for their teammates. Many of the participants opted out to play in the others of the classroom by the end of the observation period.

The second group participants worked on the design challenge with different degrees of success on the design activity. Even before the challenge officially started, three female participants were talking about what they could do to try and complete the design task. One design team contained a member designing her own solution which was to construct a raft for Tinker Bell while her teammates worked on a type of bridge construction. Many design teams successfully completed the design challenge of getting 'Tinker Bell' (ping-pong ball) across the water, but then chose to keep working on more solutions to the given task. Both classes experienced a few students disengaging in the design task but the majority of the students were fully engaged in the design task with several seeking to continue the design task long after the allotted time.

The experimental group spent more than twice the time on the task compared to the control group (48.5 minutes compared to 21.4 minutes). Moreover, the experimental group spent more time on task for designing or developing multiple design ideas to solve the challenge (29 minutes vs. 6 minutes). The intervention of exposing to a cartoon character who is modeling tinkering behavior may have the potential to motivate children to also engaging in tinkering behaviors and might increase motivation to participate in design tasks. Further research is required to determine whether or not this increase is causal, and this pilot effort presents encouraging rationale for a larger study.

Future Instruments

With the excitement of getting 3, 4, and 5 year old children to tinker has lead these faculty members to the pursuit of future research in the area of developing a range of tools, models, and resources for use by K-12 STEM teachers that will increase student awareness and interest in technology as an academic pursuit and career opportunities, with a particular focus on girls. Utilizing real world applications and examples for the students to find relevance in the lessons will increase the self-efficacy of both the teachers and their students. The goal is to assist the teachers without adding additional work, but increasing student interest in STEM.

Research has shown that girls and women are particularly interested in technology as it applies to real-world scenarios, and in particular opportunities to assist others in a range of needs (health care, education, advancement, housing, business development, etc.). Examples of these connections to higher education might be:

Aviation technology and efficiency. What alternative fuels can be created and used to decrease the environmental impacts and other costs of aviation? What aviation management systems could be run more efficiently to decrease costs and allow more people to take advantage of airline transportation?

Building and Construction Management and Global Solutions. How can we build structures that are affordable, efficient, and provide clean water, heat, and air on a large scale for populations around the world that are living in poverty? What materials and methods can easily been found and used for efficient and attractive houses and buildings?

Energy and sustainability. What can be done to increase efficiency and decrease dependency on electrical plants, coal, oil, iron, or land resources? What products or byproducts can we reuse/repurpose, and how? What can be created that saves energy?

A future goal is to STEM, especially technology, to real-world problems. Some examples problems that can be integrated into science and math are:

Developing trusses for construction. Trusses in the shape of a triangle are stronger. The tools to be developed will cover calculating the length of the trusses as well as an understanding of forces and how they react to one another. This can align with geometry and physics.

Construction Estimating: A simple house plan can be used to show how to use geometry to calculate the amount of materials needed by calculating surface area and volume for different products. Materials can be developed that the teachers are given in which the students build what they calculate to visualize. This can aligns with many areas of math

Surveying: Measuring the height of a a tree using a tape measure and the sun with 90 degrees makes use the Pythagorean theorem and introduces students to civil engineering, city planning, and surveying. This is a very hands-on approach to geometry

Conclusion

The belief is the P-12 STEM teachers can be highly effective if connected with real world examples of tools that teach. The authors are in the midst of applying for a grant that would provide technology tools and models for teachers to easily integrate into classes. Very little research has been funded at the PreK level, but it has been discussed as a source for influencing students to have an interest in STEM. Children of the current generation have technical advantages far beyond the experiences of their parents or the leaders of today's industries and government. It is critical to our nation's competitiveness and security that P-12 teachers have the resources, tools, and models to prepare their students for a world filled with technological opportunities and advances in all fields of endeavor, from aeronautics to health care to engineering to construction and manufacturing, and to industries yet to be developed. Technological knowledge also provides a new way of thinking and about applying innovative approaches to solving problems. The research to develop the resources, tools, and models for P-12 instruction requires the involvement of diverse teams of P-12 teachers, academic leaders, technical innovators, and a strong community of communicators and technicians. This pilot study is now a basis for future development in this area, especially when looking at underrepresented populations in careers with opportunities.

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