Paper ID #16772

Curriculum for an eMentorship Program

Dr. Cameron Denson, North Carolina State University

Cameron Denson is an assistant professor of Technology and Engineering Design Education (TDE) in the Dept. of Science, Technology, Engineering and Mathematics (STEM) Education at N.C. State University.

Dr. Matthew D. Lammi, North Carolina State University

Assistant Professor of STEM Education

Curriculum for an *eMentorship* Program (Evaluation)

Abstract

The *eMentoship* program was an eight-week program that provided a virtual mentoring experience for underrepresented students living in rural North Carolina. The *eMentorship* program utilized an innovative approach to teaching and mentoring by employing a “flipped” model of instruction. Graduate students served as *eMentors* for 18 underrepresented youth living in rural areas of North Carolina. Students engaged and interacted with their *eMentors* weekly using a variety of communication technology including Google chat, text message, phone conversations and email. The *eMentors* committed to provide their protégés at least one hour of synchronous advising per week.

In addition to providing a mentorship experience, the *eMentorship* program offered an innovative curriculum for the teaching of three-dimensional (3-D) modeling skills. Participating schools were provided with laptops that contained the latest 3-D modeling software. The *eMentors* provided instructional material in the form of video-recorded tutorials of instruction that the students would view and follow along. To provide necessary scaffolding for such an experience, student participants met bi-weekly with the project’s principal investigator to reinforce concepts learned throughout the week. Students were presented with the challenge of designing an original phone case using the modeling software. Student groups who were able to complete the challenge were able to have their original phone case printed out using rapid prototyping machines. Results from exit interviews conducted with the student participants indicate that the mentoring experience was of value to the student participants and was able to enhance their learning experience. Further development will include extending the mentoring experience and building upon the existing curriculum in an effort to effect change in student behavior.

Introduction

In the 21st Century, formal learning environments continue to struggle to introduce underrepresented students to STEM content and career choices (Denson, Austin, Hailey, 2012). This issue is exacerbated when considering the combination of underrepresented student groups who live in rural parts of the country where access to institutions of higher learning and other resources is limited. Turning to informal learning environments as a means of introducing students to STEM content may help provide some answers for educators. As an informal learning environment, mentoring has shown promise as a strategy for the recruitment of underserved students to STEM fields (Denson & Hill, 2010) and there is even evidence of mentorships’ impact on learning (Maughan, 2006). When considering underrepresented students living in rural areas, a distance-learning approach to learning may help facilitate these mentoring experiences.

Federal legislation distinctly mentions that one purpose for mentoring is (to) “encourage students from underrepresented groups to pursue scientific and technical careers” (U.S. energy Policy Act, Sec. 1102, p. 10, line 16, 2006). As a tool of recruitment, mentorship programs have shown the ability to recruit and retain minorities in the workplace (Allen & O'Brien, 2006). Research has also indicated that mentorship programs have a positive effect on students' academic success, especially for at risk students (Hall, 2006). The framework guiding this innovation is based on Kram's (1983) theory of mentoring. Kram (1983) proffers that mentoring is a relationship between an experienced member of an organization and an understudy whereby the experienced role model provides support and direction. To build upon this theory the social learning theory was employed to help explain the mentoring experience (Merriam & Carafarella, 1999). According to Merriam and Carafarella (1999) "social learning theories contribute to adult learning by highlighting the importance of social context and explicating the process of modeling and mentoring" (p. 139). This theory states that people learn from one another and it includes the concepts of observational learning, imitation, and modeling.

Purpose

This project piloted an innovative mentoring approach by creating a virtual flipped classroom experience where students received instruction via prerecorded tutorials describing tasks for the week in addition to their mentoring experience. Over an eight week-period, graduate students from a research one university in Southeast U.S. mentored underrepresented student groups from rural counties in the participants' respective state. In addition to the mentoring experience, students were introduced to the engineering design process and three dimensional (3-D) modeling software and techniques.

Participants

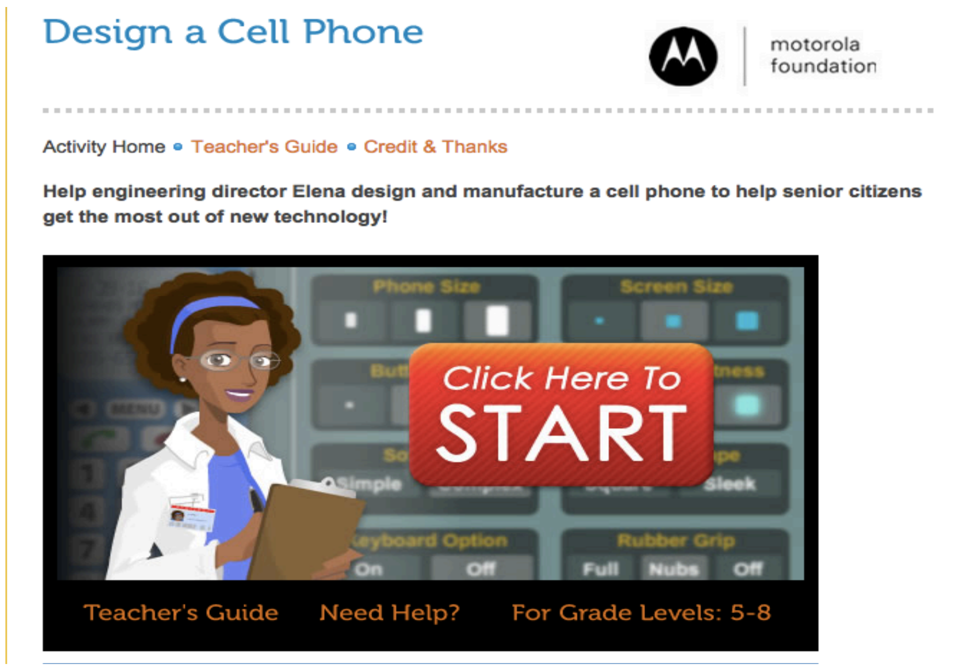
The participants for this study were African-American high school students who resided in the northeast region of North Carolina. Students were from two different rural districts in North Carolina and featured 5 different high schools. Student team designations were based upon their enrollment at a particular high school. This provision ensured that students were able to meet with their team members throughout the week to work on the design challenge. The students were pseudo-randomly selected from a population of underrepresented students who were participants in the Math, Science and Engineering Network (MSEN), an outreach program that introduces students to STEM-based content and careers. The research team worked under the auspices of the aforementioned outreach program, which allowed them the capacity to conduct research under IRB permissions granted through the program. Student enrollment for the *eMentorship* program was limited to 18 students. Student teams were assigned to 5 different *eMentors* randomly. The design team breakdown is as follows; *design team* 1 consisted of 4 participants, *design team* 2 consisted of 5 participants, *design team* 3 consisted of 3 participants, design team 4 consisted of 4 participants and design team 5 consisted of 2 participants. The groups consisted of 14 boys and 4 girls who all identified as African-American or Black.

The eMentors were all recruited from the Department of STEM Education at a Southeast university. They were all graduate students and each possessed a working knowledge of three-dimensional modeling. Two of the five mentors represented minorities for STEM fields. During the training sessions the PIs for this study discussed in detail the 4-point protocol that *eMentors* were responsible for implementing. The *eMentors* also collaborated with the PIs to help develop the curriculum framing the program. *eMentors* were subsequently assigned two weeks within the program that they were responsible for developing and/or locating content for the respective week. The *eMentors* followed a four-point protocol developed by the PI, based on formal mentorship "best practices". This four-point protocol included (a) video representation that is representative of a career in STEM, (b) field experience that offers the student exposure to a STEM profession, (c) a design challenge to be solved using graphics software, and (d) advising sessions where students are advised on college preparatory and other related topics (Denson & Hill, 2010).

Telecommunication in the 21st Century

To help provide structure and a framework for the *eMentorship* program a website was developed for student participants. The site was hosted on the university's server and temporary IDs were developed for student participants, which provided them with access to the site for the duration of the program. The theme of the *eMentorship* program was *Telecommunications in the 21st Century,* which was indicative of the media used to facilitate the program and content that was covered in the program. As an introduction to the engineering design process student participants were prompted to participate in the *Build a Cell phone* activity developed by The Ohio State University engineering program http://www.edheads.org/activities/eng_cell/swf/index.htm. The animated web source walks students through the designing of a cellphone for an elderly person. The design teams work with a client in order to determine the desired goals of the project. Students have to make decisions on button size, screen brightness, features, shape, etc., while working under a budgetary constraint of $200. Once the students' submit their design they are notified if they have achieved the sales goals of the client. Successful groups printed out their results and submitted them to the PI during their field experience.

Figure 1. Edheads



Students built upon this experience by learning and developing 3-D modeling skills using a popular solid modeling software. As an introduction to solid modeling, the design team's first challenge is to model an Apple iPhone™. This phone was chosen due to students' familiarity with the model and the relative unsophistication of the phones outward features. The design features a basic sketch (rectangle), and extrusion (to provide depth), one feature (fillets to round the corners) and the addition of slots to represent the buttons of the iPhone ™.

The engineering graphics design challenge faced by the student design teams was that of designing a cell phone case. Students groups were allowed to design a cellphone case of their choice as long as they were able to locate specifications for the design. Students also had the choice of using calipers to identify the dimensions of the phone case. However, this was not a requirement of the *eMentorship* program. Once a design was agreed upon student groups worked with their *eMentors* to model their cases. Student groups who successfully modeled their phone cases had their designs fabricated using rapid prototyping machines. In addition, all students who completed the program received a $50 gift card.

Three-Dimension Modeling

The *eMentorship* program launched on March 15, 2015 only after ensuring that all student groups had access to the popular solid modeling software. This was made possible by collaborating with the Southeast Regional Director of the software provider who agreed to grant temporary licenses for the student participants. Most of the content populated within the site was purposed for college freshmen with an interest in engineering or technology, however, mentors provided tutorials, videos and diluted the content in such a way that could be comprehended by the participants. Participants worked within the graphic design software to produce shapes, extrusions, and cuts in coherence with basic engineering principles such as linear and circular relationships. The end goal was presented that students were to design a cell phone case, which would then be printed using a rapid prototyping machine with successful designs being distributed to student participants. Each week, assignments would build upon previous weeks' lessons to prepare students to construct their personal cases for their group. *eMentors* were responsible for keeping a weekly log that was submitted each week in order to receive compensation. The following table below provides the weekly structure of the program.

eMentor Weekly Structure

Table 1. ***eMentor Curriculum***

Week	Activities	Outcomes
1. Getting to Know One Another	**Assignment 1** : eMentees fill out demographic survey. **Assignment 2**: eMentees take the Purdue Spatial Visualization Test **Assignment 3**: Learn about your eMentor **Activity 1**: Build a Cell Phone	**a. Demographic form** **b. PSVT pre-tests** **c. Build a Cellphone printout**
2. Intro to Solidworks™	1. What is a sketch? 2. What is a feature? **Assignment 1**: Fully define a rectangle in a sketch. Optional: Extrude sketch	**a. Fully defined rectangle**
3. More Solidworks™	Modifying Sketches **Assignment 1**: Sketch our basic phone! Edit original sketch to include rounded corners. Sketch fully defined at the end. Wrinkle: Updating features (editing sketches) if optional was completed prior week	**a. Fully defined sketch**
4. Extruding a Sketch	Extrusions **Assignment 1**: Extrude our phone! Extrude last week's sketch.	**a. Extruded sketch**

	Afterwards, go in and change the extrusion distance. Then try and edit the sketch. No changes need to be made, make sure you can get into the sketch.	
5. Additional Features/ ***Introduce final project, begin working***	**Assignment 1**: Add the buttons to last week's phone. Make sure they are on the correct side. Wrinkle: Some of these dimensions are awkward. Knowing how to change end conditions makes life easier. Teaching this is straight forward, but beyond what they need. **Assignment 2**: Decide on which phone (or phones?). Decide on case design. Figure out 'modeling procedures.'	**a. 3-D modeled phone**
6. Work on final project	**Assignment 1**: Start creating the case. Focus on getting all the material present. Cut out buttons/etc later.	**a. N/A**
7. Work on final project	**Assignment 1**: Get the basic case finished up. You should be able to focus on cutting out a space for buttons, cords, etc. Should the cutouts be the size of the buttons or bigger? How much bigger? Mentors should check clearances of cases to make sure everything fits.	**a. N/A**
8. Final Product Delivered	**Assignment 1**: Refine the case so it is ready for your mentor.	**a. Final Product**

All student groups met with the PIs for this study every other Saturday. This was part of the field experience that was facilitated by the MSEN program. The bi-weekly sessions allowed students to visit labs at the cooperating university, meet faculty and provided reinforcement for the lessons learned throughout the week. Data collected during the *eMentorship* program indicated levels of success for engaging student participants, assisting them in building knowledge structure, as well as introducing them to concepts they would have otherwise not have experienced in their current setting. The success of this preliminary study gives credence for the need to further develop the program and accompanying curriculum.

Value of the *eMentorship* program

Of the five design teams that participated in the program two groups and a total of 10 students were able to successfully complete the program, which included designing their own phone case using the 3-D modeling software. Groups who were able to submit a completed design had their designs printed out using a rapid prototyping machine. To better understand why certain groups were not able to complete the final design exit interviews were conducted with each design team.

Focus group interview protocols were used to guide the semi-structure interviews. Focus groups are used to gather opinions. They consist of a series of interviews, conducted with five to ten participants, wherein the researcher attempts to gain a certain perspective from a particular group (Krueger & Casey, 2009). In an effort to ascertain the value students had for the *eMentorship* program two questions were asked (1) What do you feel that you are gaining by participating in the *eMentorship* program? (2) What aspect of the program were you particularly excited about? Researchers asked additional probing questions based on participants responses.

Career, College and Modeling

Student responses below illustrate what they felt they were gaining by participating in the program. This included gaining knowledge specifically in the area of careers, college, and 3-D modeling. The following quotes illustrate students' thoughts.

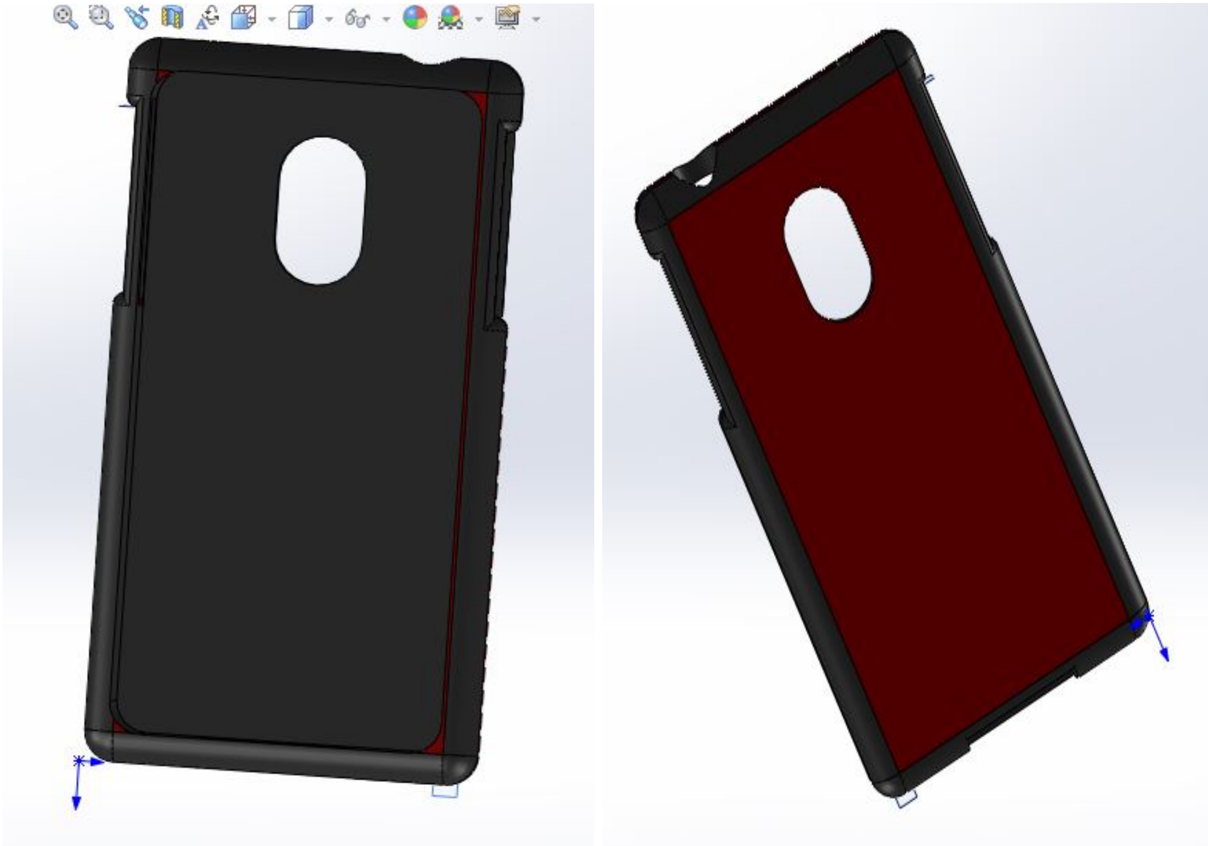
"I feel like I'm gaining uh knowledge, against, towards a profession I want to go towards." (Design team 1)

"Getting to learn more about 3-D modeling and getting designing on computers and stuff" (Design team 5)

"…like an elder like to help you out during your high school years. To be prepared for when you go to college."(Design team 2)

Figure 2. Front and Back views of a student-designed phone case

(Front View) **(Rear View)**



Phone cases, phone cases and the program

When asked about an aspect of the *eMentorship* program that students were particularly excited about participants overwhelming expressed their excitement about creating their own phone case although one group was excited about the program itself. The following quotes offer insight into students' thoughts.

"Really the program itself...The fact that I get to do it (3-D modeling) and learn how to use it, that means a lot." (Design team 1)

"Building a phone case" (Design team 2)

"I was excited about making the phone case. Yeah" (Design team 3)

"It's just the idea of like being able to create your own case and to, um, print it out and have that" (Design team 4)

Communication is Key

When asked what they would like to see done differently the design teams all expressed a want for more time in the program and better communication between faculty and staff and their respective schools. Many student participants complained of their teachers not allowing them to participate in the program during school hours.

"I would want like my school to be more aware of like what is going on because, like. The way it is set up, I only have like three, three periods a week and like I try to do some of the stuff then, but it like never works out with the software." (Design team 2)

"Like if we had like more time up here to work on it rather than at school. Cus it's kinda hard to do that." (Design team 4)

"Yeah, they didn't know. Miss, Ms. H### was like, only person that really knew and I don't think she working over there no more. " (Design team 3)

Conclusion

Students from underserved populations often lack the common resources, opportunities and exposure needed to build self-efficacy and knowledge structure for STEM content. Due to a decline in underserved populations in the economic pipeline and an increase in STEM related careers, faculty members and graduate students developed the *eMentorship* program. The focus of the program was to engage students, build knowledge structure, and introduce new concepts through utilization of the flipped classroom method. The program concluded after eight weeks however, students provided evidence that this was a sufficient amount of time to complete assigned projects and gain a new perspective on 3-D modeling. Qualitative research provided evidence that student participants obtained positive experiences and valuable knowledge acquisition that will assist them as they persist in their educational and professional pursuit. Further development of the *eMentorship* program will provide a platform to help develop 21st Century skills for underserved students and provide them with opportunities that will enable them to compete in a global society.

Results from this study include a model for virtual mentoring and an eight-week curriculum for teaching 3-D modeling in a flipped classroom setting. It is the researchers' intention to scale up the program to feature more student participants and increase the number of *eMentors*. The scale-up would include extending the mentoring program to last for 4 months in lieu of the eight-weeks that framed this program. It is important to remember that this is in fact a mentoring experience and research points to the fact that mentorship programs must sustain over time in order to affect change (Denson & Hill, 2010). In closing, the researchers would like to secure more resources in an effort to build the infrastructure for the program, recruit more schools and *eMentors,* and improve the technology supporting the project.

References

Act, U.S. Energy Policy. (2006). edited by 1st Session 109th Congress. Retrieved from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?_bills&docid=f:h6pcs.txt.pdf.

Allen, T.D., & O'Brien, K.E. (2006). Forml mentoring programs and organizational attraction. *Human Resource Development Quarterly, 17*(1), 43-58.

Denson, C., Austin, C., & Hailey, C. (2012). *Investigating unique aspects of the MESA program for underrepresented students.* Paper presented at the American Society for Engineering Education, San Antonio, TX.

Denson, C.D., & Hill, R.B. (2010). Impact of an engineering mentorship program on Africa-American male high school students' perceptions and self-efficacy. *Journal of Industrial Teacher Education, 47*(1), 99-127.

Denson, C.D., Lammi, M.D., White, T.F., & Bottomley, L. (2015). Value of informal learning environments for students engaged in engineering. *Journal of Technological Studies, 51*(1), 40-47.

Kram, K.E. (1983). Phases of the mentor relationship. *Academy of Management Journal, 26*(4), 608-625.

R. A. Krueger, & Casey, M.A., *Focus Groups: A Practical Guide for Applied Research*, 4th ed. London: Sage, 2009.

Maughan, B.D. (2006). *Mentoring among scientists: Building an enduring research and development community. Unpublished raw data.*