Board 32: Preliminary Findings: RIEF – Understanding Pedagogically Motivating Factors for Under-represented and Non-traditional Students in Online Engineering Learning Modules

Prof. Kimberly Cook-Chennault, Rutgers, the State University of New Jersey

Kimberly Cook-Chennault is an Associate Professor in the Mechanical and Aerospace Engineering Department at Rutgers University. She holds BS and MS degrees in Mechanical Engineering from the University of Michigan and Stanford University respectively; and a PhD from the University of Michigan, Ann Arbor. Her research interests include design of integrated hybrid energy systems and investigation of the structure-property relationships in ferroelectric, dielectric and piezoelectric materials in the form of thin films and bulk composites for sensing/actuation and energy storage/harvesting applications. Dr. Cook-Chennault's research group, the Hybrid Energy Systems and Materials Laboratory, conducts work towards understanding the fundamental mechanisms and processing parameters that allow for the control of physical material characteristics. In addition to this work, Dr. Cook-Chennault is the director of the Green Energy Undergraduate Program (GET UP) program which is funded through the National Science Foundation and the Student Learn and Achievent in Aerospace and Mechanical (SLAAM) Engineering Program.

Idalis Villanueva, Utah State University

Dr. Villanueva is an Assistant Professor in the Engineering Education Department and an Adjunct Professor in the Bioengineering Department in Utah State University. Her multiple roles as an engineer, engineering educator, engineering educational researcher, and professional development mentor for underrepresented populations has aided her in the design and integration of educational and physiological technologies to research 'best practices' for student professional development and training. In addition, she is developing methodologies around hidden curriculum, academic emotions and physiology, and engineering makerspaces.

Preliminary Findings: RIEF - Understanding pedagogically motivating factors for under-represented and non-traditional students in online engineering learning modules

Abstract

The quest to incorporate digital games into US classrooms has been pervasive in educational communities over the last two decades. Educational video games have been studied as a mechanism for enhancing the engagement and performance of underrepresented groups (UGs) in spatial learning, physics, computer science, general engineering, software and electrical engineering, mechanical engineering (ME) computer aided design, and aerospace engineering. Less than a handful of these studies have explored games' appeal, efficacy or UG performance as a function of gender. Preliminary findings on a study that explores the appeal, efficacy, and performance of UGs in engineering-based educational video games as a function of gender and those of intersectional backgrounds is discussed. Emphasis is placed on elucidating these students' perceptions of serious game structure, design and content, and how these factors motivate their learning of engineering concepts and self-identification as engineers. This work builds upon the Technology Acceptance Model.

I.   Introduction

The quest to incorporate digital games into US classrooms has been pervasive in educational communities over the last two decades. Educational video games have been studied as a mechanism for enhancing the engagement and performance of underrepresented groups (UGs) in spatial learning [1], physics [2], computer science, general engineering [3], software and electrical engineering [4] – [17], mechanical engineering (ME) [18] – [25] computer aided design [26], and aerospace engineering [27]. Less than a handful of these studies have explored games' *appeal, efficacy* or UG performance as a **function of gender**. For example, Joiner et al., [19] who studied a population of 138 ME UGs (15/138 female) found that there was no difference in "motivation towards engineering" (4.2 ± 0.5, pre- **and** post-survey results) or in "perceived engineering competence" (3.4 ± 0.7, pre-survey to 3.3 ± 0.4, post-survey) after video game use for female students. Few engineering undergraduate studies examine games' impact as a function of other engineering subgroups, e.g. race/ethnicity, student age, sexuality, or the intersection of the subgroups. Race and gender are not mutually exclusively, but rather can intersect in various ways, affecting the experiences of women in multiple settings according the Crenshaw [28] - [29]. Crenshaw began to use the term *intersectionality* to describe the social injustice that African-American women were experiencing because of their dual racial and gender identities. In engineering, intersectionality has been used to explore how diverse students navigate the culture of engineering [30]. This works exposes a diverse population of engineering undergraduate students an online engineering educational game that focuses on trusses that are part of a traditional statics class. The perceptions of these students are described as a function of their gender and racial/ethnicity.

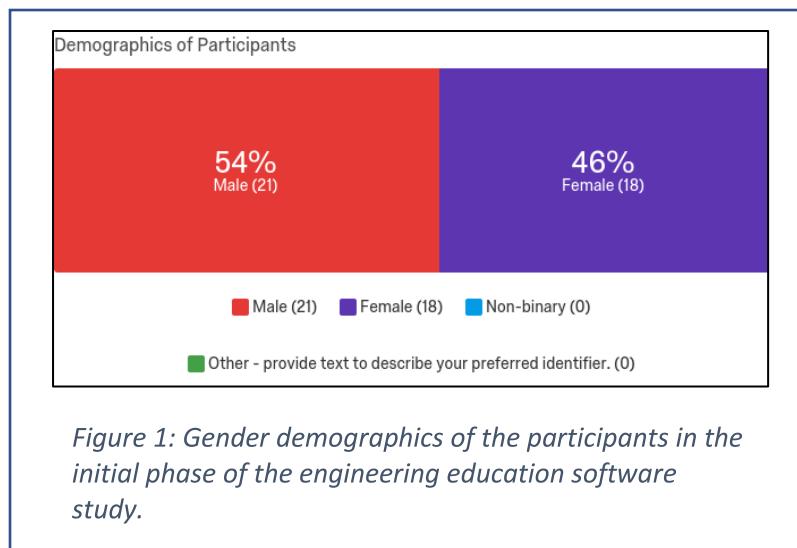The research questions addressed in this work are the following:
1. What aspects of the engineering educational game motivate/demotivate students?
2. Does playing the game influence students' confidence in their engineering abilities?
3. Are engineering topics introduced in the game understood by and transparent to the student?

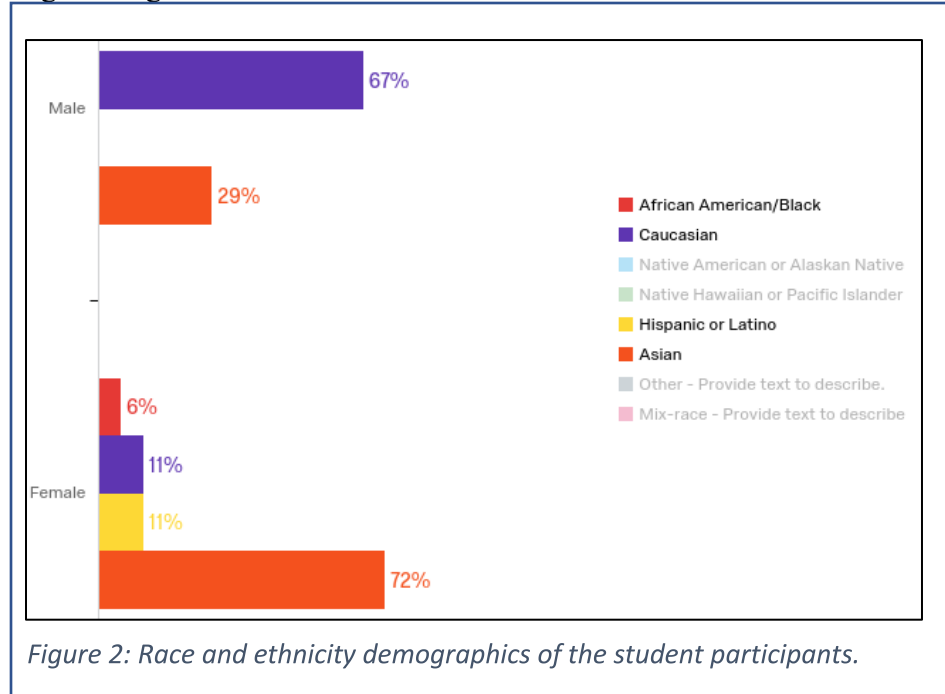## II.   Description of the engineering educational tool

Undergraduate engineering students (Freshman through senior level) participated in the on-campus study that focused on an engineering educational game that emphasized truss structural stability topics covered in the traditional undergraduate Statics curriculum. The goal of the game is to assist students in developing engineering intuition on how truss structures behave when subjected to loads. The software tool is based on finite strain theory that enables the user to visual material and geometric nonlinearities and dynamic movement of failed structure. Users play the game by positioning bars and joints to construct a truss structure that is able to support an external mass and the weight of the truss structure itself. The structure the player builds must consist of joints and bars, where the bars are connected via the joints. The players win nut(s) based the player's ability to create a structure of minimal weight and structural stability. Participants manipulate the weight of the truss by adjusting the thickness of the bars. Participants visualize the success or failure of their structure real time, as the structures visibly collapse or maintain their position at the completion of the truss. The collapse of the structure is punctuated with clanging sounds associated with the collapse of the structure. The tool is designed to give engineering intuition, which may be interpreted as incorporation of inquiry-based learning elements to develop student insight into how structures behave under mechanical loading. No visual or auditory hints or clues are provided during the game. And, no instruction pertaining game rules are provided.

III.   Research Design

The overall goal of this project is to understand how engineering educational games and apps may inherently embed elements of engineering norms of knowing, thinking and doing that reflect and perpetuate climates and cultures of inequality, which preclude or stifle the formation of under-represented minority women engineers. Towards achieving this goal, a Mixed Method Sequential Exploratory Research Design was proposed and approved by the Institutional Review Board at a Tier 1 institution of higher education, located in the Northeastern region of the US. The data described herein is the

Figure 1: Gender demographics of the participants in the initial phase of the engineering education software study.

work-in-progress of a multiple-year study. All participants in the study are undergraduate engineering students from this diverse institution within the School of Engineering. Students provided demographical information such as age range, gender, sexual orientation, ethnicity, undergraduate major and experience with online learning tools within an engineering classroom. This information was correlated to questionnaire questions. The gender and racial/ethnic diversity of the participants are provided in Figure 1 and Figure 2. Thirty-nine students who participated in the study first played the engineering game for 20 minutes, then completed a Likert-type scale questionnaire, and finally participated in a focus group to discuss their perceptions of the game as an engineering educational learning and motivational tool. During the focus group questionnaire questions were discussed in more detail and the preliminary discussion of topics described in the *Technology Acceptance Model* (TAM) [31] – [33], i.e. perceived usefulness and ease-of-use of the game were discussed. The Likert-scale ranges included: Strongly Agree (1), Agree (2), Somewhat Agree (3), Neither Agree nor Disagree (4), Somewhat Disagree (5), Disagree (6) and Strongly Disagree (7). Focus group participants were assigned into groups based on gender and availability of schedule date/time, where each group consisted of 4 – 6 participants.

Figure 2: Race and ethnicity demographics of the student participants.

The questions from the questionnaire are provided in Table 1. All survey questions were examined as a function of race/ethnicity and gender with the aim of elucidating differences in trends associated with student perception as a function of these groups.

Table 1: Representative questionnaire questions.

Q1: Which topics of engineering were explored in this game? (Select all that apply) - Statics - Dynamics - Thermodynamics - Mechanics of Materials - Composite structures
Q2: Were there any aspects of the game that you found distracting to your learning of the concepts? Explain. - Strongly agree.

- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q3: The learning lessons or goals of each challenge are defined in enough detail to play the game.
- Strongly agree.
- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q4: Playing the game made me feel like an engineering.
- Strongly agree.
- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q5: Playing the game increased my confidence in my engineering skills.
- Strongly agree.
- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q6: I understood the engineering topics each level of the game was teaching me.
- Strongly agree.
- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q7: I got frustrated playing this game.
- Strongly agree.
- Agree.
- Somewhat agree.
- Neither agree nor disagree.
- Somewhat disagree.
- Disagree
- Strongly disagree

Q8: I would improve this game by (complete the sentence). You may select more than one option.
- Adding a story line.
- Adding avatars/characters.
- Making the images look more like real life.
- Adding opportunities to compete against other players while playing.
- This game is fine the way it is.
- Adding more explanation to the challenges.
- Changing the rewards from nuts to something else.
- Give any other feedback.

IV.   Results and Discussion

The preliminary results for this work-in-progress are presented herein. Thirty-nine undergraduate engineering students participated in this study. The demographical information pertaining to gender, intersectionality and race/ethnicity of the populations studied are presented in Figure 3 and Figure 4. The data presented is an initial step towards the exploration of perceptions of intersectional groups' perceptions and experiences of engineering educational serious games, juxtapose student populations traditionally represented in the US engineering educational system. The responses of this population to an online engineering educational game were recorded and a focus group was held to understand their experiences and observations regarding the game. A questionnaire was developed to address aspects of each of the research questions.

Research Question 1: What aspects of the engineering game motivate/demotivate students?

Students were asked if there were any aspects of the game that they found to be distracting on the questionnaire and during the focus group. The responses were quantified on a scale of Strongly Agree (1), Agree (2), Somewhat Agree (3), Neither Agree nor Disagree (4), Somewhat Disagree (5), Disagree (6) and Strongly Disagree (7).The female and male responses to this question are presented in Figure 3 and Figure 4.

Were there any aspects of the game that you found distracting to your learning of the concepts? Explain. (Male responses)
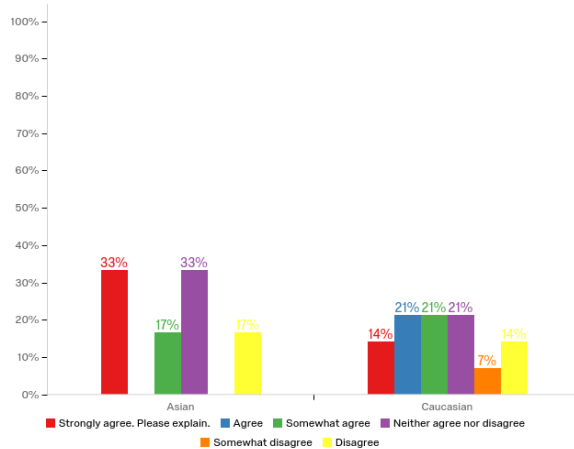
Were there any aspects of the game that you found distracting to your learning of the concepts? Explain. (Female responses)

Figure 3: Male responses to the general question of distracting elements of the game.
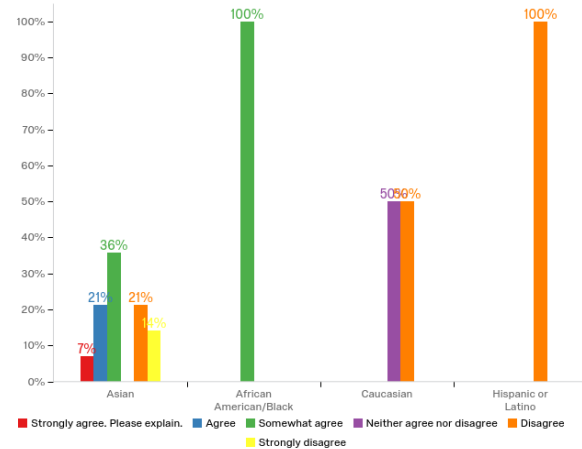
Figure 4: Female responses to the general question of distracting elements of the game.

 Over 64% and 100% of the Asian and African American female participants, respectively responded that there were aspects of the game that they found to be distracting (somewhat agree or higher) as opposed to their Caucasian and Latina counterparts. 42% of the women (8 put of

19) and 40% of the men (8 out of 20) who were distracted by components of the game highlighted in the focus group discussions that the clanking sounds distracted them. In particular, structures that failed the loading conditions crashed (visibly on the screen) and a clanging crash sound accompanied the crash (auditory sound). Many respondents stated that the clanging sounds associated with failed attempts heightened their feelings of frustration when they were unable to achieve the next level in the game (3 out of the 8 who cited sound). Similarly, male respondents noted distraction from sound impacted their ability to focus on the game, wherein some indicated that this may be a factor that influenced their game performance (3 out of the 8). In Table 2, the minimum, maximum, mean, standard deviation, variance and count of responses as a function of gender are presented. This table indicates that on average male respondents found aspects of the game to be more distracting (3.25$\pm$1.64) than their female counterparts (4.16$\pm$1.9).

Table 2: Overview of the responses pertaining to game distraction.

Were there any aspects of the game that you found distracting to your learning of the concepts? Explain.						
Minimum	Maximum	Mean	Std Deviation	Variance	Count	Gender
1	7	4.16	1.9	3.61	19	Female
1	6	3.25	1.64	2.69	20	Male
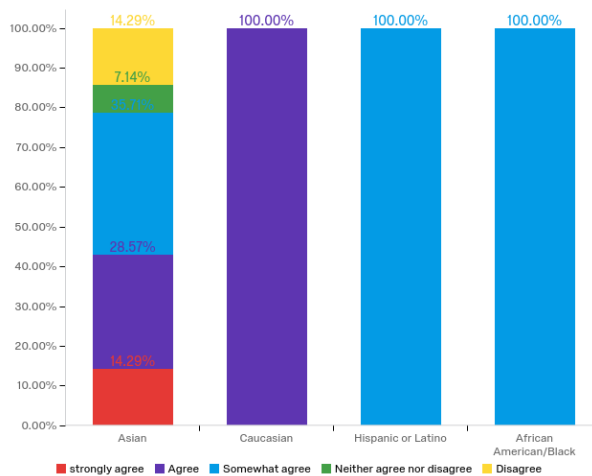
Figure 5: Female responses to the question of whether playing the game made them feel like an engineer.
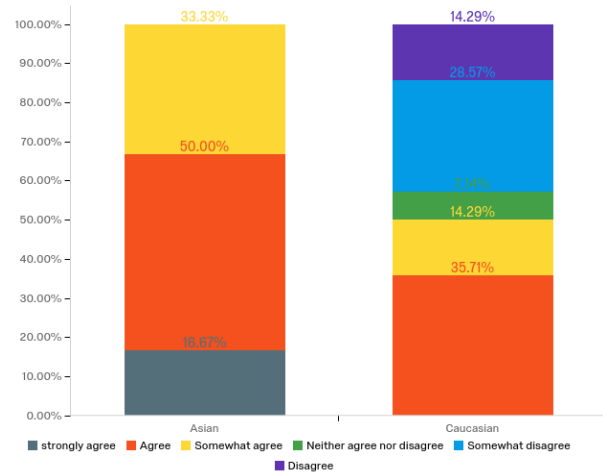
Figure 6: Male responses to the question of whether playing the game made them feel like an engineer.

Participants were also asked to rank whether the game made them feel like an engineer using a Likert scale to elucidate possible links between game play and perception of one's self as an engineer. The responses to this question are provided in Figure 5 and Figure 6.

In Table 3, the minimum, maximum, mean, standard deviation, variance and count of responses as a function of gender are presented. This table indicates that on average male respondents found that the game made them feel more like an engineer to a lower degree (3.25 ± 1.51) than their female counterparts (2.84 ± 1.31).

Table 3: Overview of the responses pertaining to whether the game impacted respondents' feelings of being an engineer.

Playing the game made me feel like an engineer.						
Minimum	Maximum	Mean	Std Deviation	Variance	Count	Gender
1	6	3.25	1.51	2.29	20	Male
1	6	2.84	1.31	1.71	19	Female

Students were also asked to rank their level of frustration while playing the engineering educational game. The results are shown in Table 3. Many participants cited issues with game structure and layout that prohibited them from making structural designs that they knew would be more successful but, were unsuccessful in drawing on the screen. Both groups described this as frustrating and as a limitation in their overall performance. Student focus group responses regarding frustration level was attributed to three primary themes: 1) lack of instruction or hints to indicate rational for failed engineering structure (stated 32 times in focus group); 2) successful designs that rendered more nuts but were unrealistic/unsafe (stated 6 times in focus group) and 3) game design that limited ease of drawing design structures on the screen (stated 10 times during focus group). Of these themes, students expressed concern over an engineering tools that did not directly engage the student with guidance while playing. Students linked these categories to feelings of being demotivated or detrimental to their ability to learn from the game due to these obstacles (10 times in the focus group discussions).

Research Questions 2: Does playing the game influence students' confidence in their engineering abilities?

Participants were also asked whether the game influenced their confidence in their abilities as an engineer, which has been shown to be a factor in the formation of engineers, and women and under-represented engineers. The responses from both male and female respondents are provided in Figure 7 and Figure 8. There were no obvious trends regarding student's assessment of their increase in confidence in the engineering abilities as shown in Table 4.

Table 4: Overview of students' assessment of the increase in confidence in their engineering skills after playing the game.

Playing the game increased my confidence in my engineering skills.						
Minimum	Maximum	Mean	Std Deviation	Variance	Count	Gender
1	6	4	1.38	1.89	19	Female
2	7	3.9	1.51	2.29	20	Male

Playing the game increased my confidence in my engineering skills. (Male)
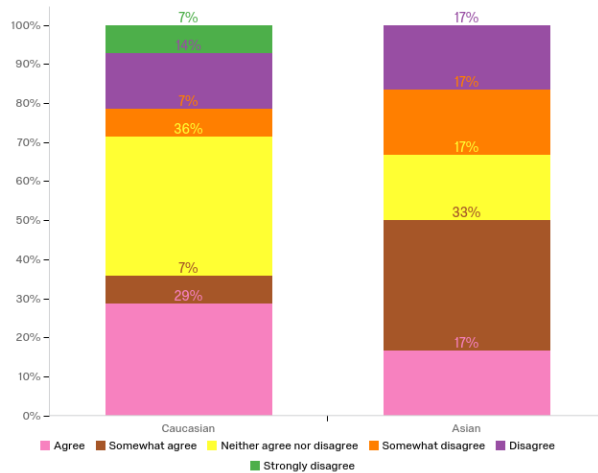
Playing the game increased my confidence in my engineering skills. (Female)

Figure 7: Male responses to whether the game influenced their confidence in their engineering skills.
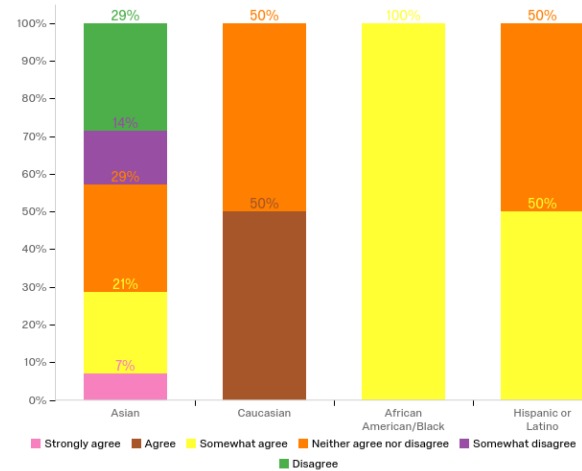
Figure 8: Female responses to whether the game influenced their confidence in their engineering skills.

<u>Research Questions 4: Are engineering topics introduced in the game understood by and transparent to the student?</u>

Students were asked several questions to understand whether the salient engineering topics where clearly articulated in the game. For example, students were asked to select each of the engineering topics, e.g. Statics, Dynamics, Thermodynamics, Mechanics of Materials and Composite Structures were incorporated in the game. The responses of the students are detailed in Figure 9 and Figure 10. In addition, a comprehensive overview of selected engineering topics is provided in Table 5. Although all respondents correctly indicated that aspects of Statics were depicted in the game, some erroneously indicated that composite structures were included as topics. These responses may be indicative of students' level of education or discipline in engineering, which could have limited the exposure to more advanced topics.

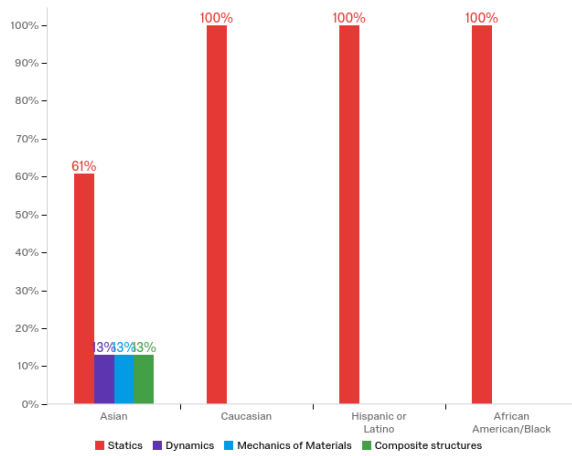Which topics of engineering were explored in this game? (Female)

Which topics of engineering were explored in this game? (Male)

Figure 9: Description of the topics covered in the game as a function of female responses and race/ethnicity.
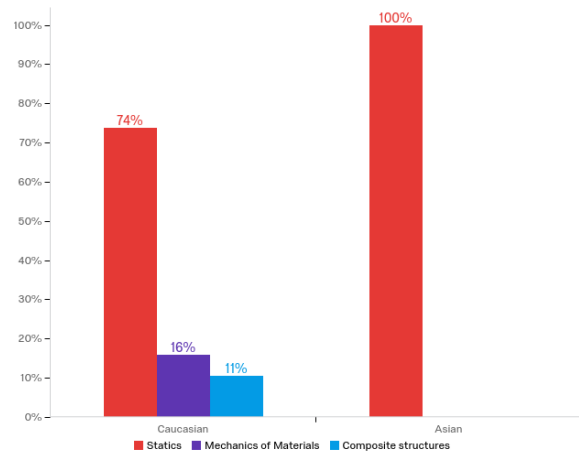
Figure 10: Description of the topics covered in the game as a function of male responses and race/ethnicity.

Table 5: Responses of participants assessment of engineering topics covered in the game.

Engineering Topics Covered in the Game				
Answer	% (Female)	Count (Female)	% (Male)	Count (Male)
Statics	19.00%	19	100.00%	20
Dynamics	15.79%	3	0.00%	0
Thermodynamics	0.00%	0	0.00%	0
Mechanics of Materials	15.79%	3	15.00%	3
Composite structures	15.79%	3	10.00%	2

Students were also asked to rank on a Likert-scale whether the learning lessons or goals of each challenge level were defined in enough detail to play the game and whether the understood the engineering topics each level of the game presented. The responses to this question are provided in Figures 11 – 14 and the statistical data is presented in Table 6.

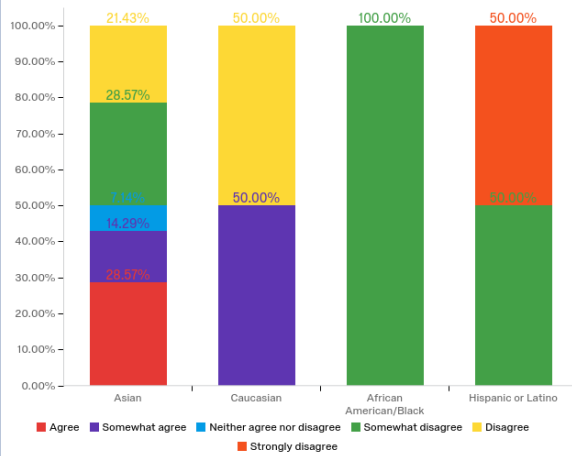The learning lessons or goals of each challenge are defined in enough detail to play the game. (Female)

Figure 13: Female response to the question of whether the learning goals were defined in enough detail.

The learning lessons or goals of each challenge are defined in enough detail to play the game. (Male)
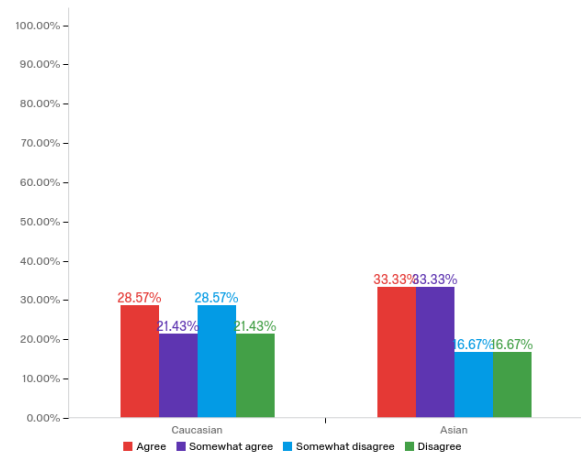
Figure 14: Male response to the question of whether the learning goals were defined in enough detail.

I understand the engineering topics each level of the game was teaching me. (Female)
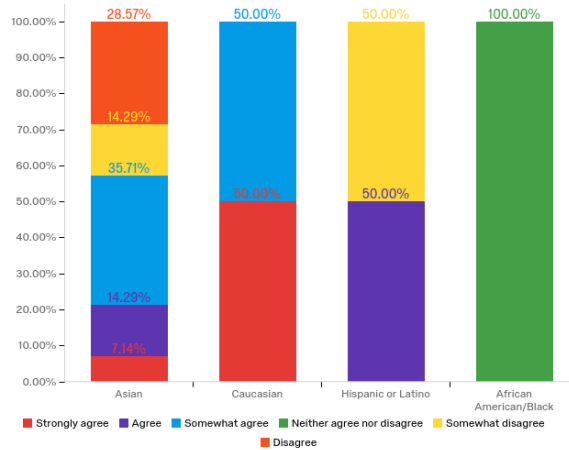
Figure 11: Female response to the question of whether they understood the engineering topics that the game was designed to teach.

I understand the engineering topics each level of the game was teaching me. (Male)

Figure 12: Male response to the question of whether they understood the engineering topics that the game was designed to teach.

Table 6: Statics pertaining the student's assessment of the game's instruction on learning lesson presentation and their ability to understand.

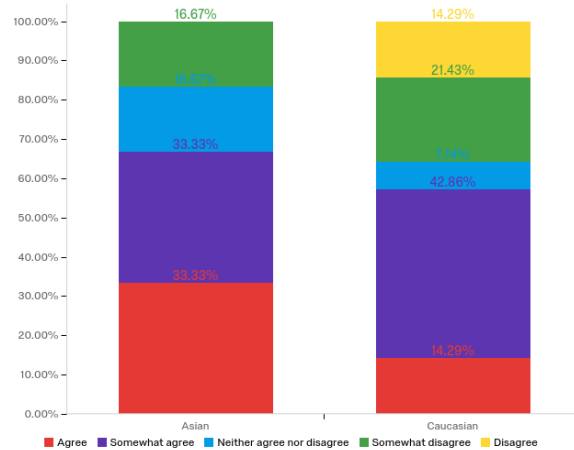| The learning lessons or goals of each challenge are defined in enough detail to play the game.						
Minimum	Maximum	Mean	Std Deviation	Variance	Count	Gender
2	7	4.32	1.59	2.53	19	Female
2	6	3.8	1.57	2.46	20	Male
I understood the engineering topics each level of the game was teaching me.						
Minimum	Maximum	Mean	Std Deviation	Variance	Count	Gender
7	12	9.63	1.66	2.76	19	Female
8	12	9.6	1.28	1.64	20	Male

On average, both student groups did not deem the level of information presented to be enough to adequately play the game. In addition, majority of them were not convinced that the game was teaching them the topics it was designed to cover. perception of their score being related to the level at which they achieved in the game. During the focus group discussion student attributed their success in the game to learning how to "game the game" versus development of engineering skills in cases where students reached high challenge levels (10 stated during focus group discussion). In addition, 9 out of the 39 participants asserted that some people without an engineering background at all would be able to achieve some level of success in going to higher levels by trial and error (8 participants out of 39).

Students were asked how they might improve the game and asked to select from the options provided below.
- Adding a story line.
- Adding avatars/characters.
- Making the images look more like real life.
- Adding opportunities to compete against other players while playing.
- This game is fine the way it is.
- Adding more explanation to the challenges.
- Changing the rewards from nuts to something else.

Table 7: Comprehensive overview of the responses from students regarding how they would improve the game.

Suggested Improvement to the Game	%Male	Count (Male)	%Female	Count (Female)
Adding a story line.	10%	2	21%	4
Adding avatars/characters.	15%	3	21%	4
Making the images look more like real life.	10%	3	21%	4
Adding opportunities to compete against other players while playing.	55%	11	37%	7
The game is fine the way it is.	0%	0	5%	1
Adding more explanation to the challenges.	80%	16	84%	16
Changing the rewards from nuts to something else.	10%	2	26%	5
Give any other feedback.	35%	7	21%	4

The most salient finding from Table 7 is that over 80% of both male and female participants deemed inclusion of explanations to game challenge descriptions are needed. In addition, male students (~55%) and female students (37%) thought that the game would be improved if there were opportunities to compete again other players. While 26% of the female participants thought that nuts as a reward should be changed to something else, several participants in the focus group did not realize they could obtain more than one nut per challenge (6 out of 39 participants), while others did not know why some designs rendered more nuts than other designs (over 15 statements recorded from transcriptions). This further illustrated the fact that participants were not completely sure in how the game was scored or points (nuts) rewarded. Hence, some students who did not achieve higher levels attributed their lower score levels to issues pertaining to the lack of clearly articulated game rules for game (20 statements based on transcriptions). However, many suggested that inclusion of thematic levels and story lines may have illustrated and enhanced their understanding of technical material, as this could influence aspects of boundary conditions and possible solutions to problems (21% of females on the questionnaire and 6 statements recorded in transcripts from the focus group discussion).

V. **Conclusions and Next Steps**

This work-in-progress summarizes the findings of a small sample size of participants (39) regarding their assessment of an engineering education tool. Both the focus group discussion and questionnaire were used to glean preliminary answers to the research questions. Due to the limited number of participants, concrete conclusions cannot be made. However, the responses obtained will be used to modify the questionnaire and design method to better understand the rationale behind aspects of distraction and motivation in game design. In addition, inclusion of additional students in the study is needed to ascertain how specific parameters influence the formation of engineering students as they engage in educational gaming. These preliminary findings suggest that students expect reinforcement and introduction of technical content when using video and serious games as educational tools. In addition, preliminary findings suggest

that inquiry-based instruction is most effective when incorporated with a multifaceted schema of tools, e.g. additional sources of information, feedback on successful and failed attempts, opportunities to review evidence, provision of explanations to explain predictions and communication of results and findings. In addition, preliminary results indicate that students have different expectations of engineering educational serious games versus games design for entertainment. Insights such as these will be used to further develop and modify the questionnaire.

References

1.   Martin-Gutierrez, J., et al., *Do Video Games Improve Spatial Abilities of Engineering Students?* International Journal of Engineering Education, 2009. **25**(6): p. 1194-1204.
2.   Adams, D.M., C. Pilegard, and R.E. Mayer, *Evaluating the Cognitive Consequences of Playing Portal for a Short Duration.* Journal of Educational Computing Research, 2016. **54**(2): p. 173-195.
3.   Philpot, T.A., et al., *Using games to teach statics calculation procedures: Application and assessment.* Computer Applications in Engineering Education, 2005. **13**(3): p. 222-232.
4.   Pantoja, M., *Designing a New Video Game App as an aid for Introduction to Programming classes that use C Programming Language.* Proceedings of the Head'17 - 3rd International Conference on Higher Education Advances, 2017: p. 10-16.
5.   Graham, T.C.N. and W. Roberts, *Toward quality-driven development of 3D computer games*, in *Interactive Systems: Design, Specification, and Verification*, G. Doherty and A. Blandford, Editors. 2007. p. 248-+.
6.   Jimenez-Hernandez, E.M., et al., *Methodology to construct educational video games in software engineering.* 2016 Fourth International Conference in Software Engineering Research and Innovation - Conisoft 2016, 2016: p. 110-114.
7.   Long, J.N., L.S. Young, and Asee, *Multiplayer On-Line Role Playing Game Style Grading in a Project Based Software Engineering Technology Capstone Sequence*, in *2011 Asee Annual Conference & Exposition.* 2011.
8.   Mitre-Hernandez, H.A., et al., *Decreasing Rework in Video Games Development from a Software Engineering Perspective*, in *Trends and Applications in Software Engineering*, J. Mejia, et al., Editors. 2016. p. 295-304.
9.   Murphy-Hill, E., T. Zimmermann, and N. Nagappan, *Cowboys, Ankle Sprains, and Keepers of Quality: How Is Video Game Development Different from Software Development?* 36th International Conference on Software Engineering (Icse 2014), 2014: p. 1-11.
10.   Musil, J., et al., *Improving Video Game Development: Facilitating Heterogeneous Team Collaboration through Flexible Software Processes*, in *Systems, Software and Services Process Improvement*, A. Riel, et al., Editors. 2010. p. 83-94.
11.   Ozcelik, E., N.E. Cagiltay, and N.S. Ozcelik, *The effect of uncertainty on learning in game-like environments.* Computers & Education, 2013. **67**: p. 12-20.
12.   Sutherland, J.N., *Towards a software engineering methodology for video games development: object orientation as an approach for specification analysis.* Vsmm 2000: 6th International Conference on Virtual Systems and Multimedia, ed. H. Thwaites. 2000. 569-576.
13.   Whitehead, J., C. Lewis, and Ieee, *Workshop on Games and Software Engineering (GAS 2011).* 2011 33rd International Conference on Software Engineering (Icse), 2011: p. 1194-1195.
14.   Morsi, R., S. Mull, and Ieee, *Digital Lockdown: A 3D Adventure Game for Engineering Education*, in *Frontiers in Education Conference.* 2015. p. 316-319.
15.   Ye, E., et al., *Enhancing software engineering education using teaching aids in 3-D Online Virtual Worlds*, in *2007 37th Annual Frontiers in Education Conference, Global Engineering : Knowledge without Borders - Opportunities without Passports, Vols 1- 4.* 2007. p. 87-+.

16.   Smith, S. and S. Chan, *Collaborative and Competitive Video Games for Teaching Computing in Higher Education.* Journal of Science Education and Technology, 2017. **26**(4): p. 438-457.

17.   Callaghan, M.J., et al., *Using Game-Based Learning in Virtual Worlds to Teach Electronic and Electrical Engineering.* Ieee Transactions on Industrial Informatics, 2013. **9**(1): p. 575-584.

18.   Chang, Y.Z., et al., *Evaluation of a video game adaptation for mechanical engineering educational laboratories*, in *2016 Ieee Frontiers in Education Conference.* 2016.

19.   Joiner, R., et al., *Digital Games, Gender and Learning in Engineering: Do Females Benefit as Much as Males?* Journal of Science Education and Technology, 2011. **20**(2): p. page 182.

20.   Pejic, P., et al., *3D VIRTUAL MODELLING OF EXISTING OBJECTS BY TERRESTRIAL PHOTOGRAMMETRIC METHODS - CASE STUDY OF BARUTANA.* Tehnicki Vjesnik-Technical Gazette, 2017. **24**: p. 233-239.

21.   Choudhury, A.A. and J. Rodriguez, *A New Curriculum in Fluid Mechanics for the Millennial Generation.* Ieee Revista Iberoamericana De Tecnologias Del Aprendizaje-Ieee Rita, 2017. **12**(1): p. 48-51.

22.   Coller, B.D. and Ieee, *Work in Progress - A Video Game for Teaching Dynamics*, in *2011 Frontiers in Education Conference.* 2011.

23.   Coller, B.D. and Ieee, *A Video Game for Teaching Dynamic Systems & Control to Mechanical Engineering Undergraduates*, in *2010 American Control Conference.* 2010. p. 390-395.

24.   Coller, B.D. and M.J. Scott, *Effectiveness of using a video game to teach a course in mechanical engineering.* Computers & Education, 2009. **53**(3): p. 900-912.

25.   Coller, B.D. and D.J. Shernoff, *Video Game-Based Education in Mechanical Engineering: A Look at Student Engagement.* International Journal of Engineering Education, 2009. **25**(2): p. 308-317.

26.   Kosmadoudi, Z., et al., *Engineering design using game-enhanced CAD: The potential to augment the user experience with game elements.* Computer-Aided Design, 2013. **45**(3): p. 777-795.

27.   Okutsu, M., et al., *Teaching an aerospace engineering design course via virtual worlds: A comparative assessment of learning outcomes.* Computers & Education, 2013. **60**(1): p. 288-298.

28.   Crenshaw, K., *MAPPING THE MARGINS - INTERSECTIONALITY, IDENTITY POLITICS, AND VIOLENCE AGAINST WOMEN OF COLOR.* Stanford Law Review Vol 43, No 6, July 1991: In Memoriam: Carl Bernhardt Spaeth; Women of Color at the Center, ed. K.V. Haynes and M.A. Lona. 1993. 1241-1299.

29.   Crenshaw, K., *Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics.* The University of Chicago Legal Forum, 1989. **140**: p. 139-167.

30.   Kirn, A., et al. *Intersectionality of non-normative identities in the cultures of engineering.* in *2016 ASEE Annual Conference & Exposition.* 2016. New Orleans, LA.

31.   Bourgonjon, J., et al., *Parental acceptance of digital game-based learning.* Computers & Education, 2011. **57**(1): p. 1434-1444.

32.   Bourgonjon, J., et al., *Students' perceptions about the use of video games in the classroom.* Computers & Education, 2010. **54**(4): p. 1145-1156.

33.   *Databytes*, in *ASEE Connections*, T. Grose, Editor. 2016, American Society for Engineering Education: Washington, DC.