Work-in-Progress: A 'Cards Against Humanity'-style Card Game for Increasing Engineering Students' Awareness of Ethical Issues in the Profession

Prof. Daniel D. Burkey, University of Connecticut

Daniel Burkey is the Associate Dean of Undergraduate Programs and Associate Professor-in-Residence in the Department of Chemical and Biomolecular Engineering at the University of Connecticut. He received his B.S. in chemical engineering from Lehigh University in 1998, and his M.S.C.E.P and Ph.D. in chemical engineering from the Massachusetts Institute of Technology in 2000 and 2003, respectively. His primary areas of interest are chemical vapor deposition and engineering pedagogy.

Prof. Michael F. Young, University of Connecticut

Dr. Young (http://myoung.education.uconn.edu/) received his PhD from Vanderbilt University in Cognitive Psychology and directs UConn's 2 Summers in Learning Technology program. He is the author of nine chapters on an ecological psychology approach to instructional design and has authored more than two dozen peer reviewed research papers. His work has appeared in many major journals including the Journal of Educational Computing Research, the Journal of the Learning Sciences, the Journal of Research on Science Teaching, Instructional Science, and Educational Technology Research and Development. Mike's research concerns how people think and learning, and specifically how technology can enhance the way people think and learn. His NSF-funded project, GEEWIS (http://www.geewis.uconn.edu/), focused on streaming real-time water quality pond data via the Internet and providing support for the integration of this authentic data into secondary and higher education science classrooms. His approach features the analysis of log files, "dribble files," that maintain time-stamped listing of navigation choices and lag time. This approach has been applied to hypertext reading (Spencer Foundation grant), videodisc-based problem solving (Jasper project), and online navigation (Jason project). Recent work concerns playful learning using video game, card games, and board games aligned with national teaching and learning standards.

©American Society for Engineering Education, 2017

Work-in-Progress: A 'Cards Against Humanity'-style card game for increasing engineering students awareness of ethical issues in the profession.

Background and Motivation:
Engineering design solutions across all engineering disciplines frequently have major, long-lasting impacts on societal development. Since the process of technical *innovation* occurs in increasingly complex social exchanges, engineers are frequently confronted with social and ethical dilemmas in their professional lives. Yet, many engineering curricula do not incorporate study of these issues in formal ways into engineering education. Many widely publicized failures of complex engineering systems can be traced back to lapses in judgment on either ethical or societal impact axes, including the Volkswagen Diesel Engine scandal,[1] the BP Gulf Oil Spill,[2] the *Challenger*[3] and *Columbia*[4] space shuttle disasters, and more recently, the Flint, Michigan Water Crisis.[5]

In this work, the authors seek to explore the application of game-based and game-inspired learning to engineering ethics education. Giving students the opportunity during their education to recognize the wider social and ethical impacts of the profession - through multimedia simulation, role-playing games, case-based learning, and review of other, fictionalized cases - can give them opportunities to reflect on the need to identify complex situations in future settings, as well as a safe environment in which to explore, make mistakes, and discuss the broader ramifications of various engineering decisions in authentic contexts. Ultimately the goal is to better prepare young engineers to tackle ethically the current and future challenges that have tended to be underemphasized in traditional engineering curriculums.

Thus, broadly, our study asks "**What impact does giving engineering students authentic but playful role-playing experiences in the context of examining the ethical, social, and societal impacts of engineering solutions have on their knowledge, attitudes, and abilities to act ethically as engineers?"**

As most engineering curricula focus on technical expertise, and not on in-depth examinations of the ethical, societal, or broader impacts of engineering solutions, how does giving students a cross-disciplinary opportunity to explore these issues via non-traditional educational vectors (in this case, game-based or game-inspired education) impact their professional formation and their identity as an engineer? As Herkert discussed, there have in general been three approaches to ethical education for students in technical professions:[6]

- A standalone course in ethics, often times taught by a philosophy instructor or other non-technical staff.
- Incorporation of ethical instruction modules into classes, often times either at the freshman level or the capstone design level.
- A hybrid approach, consisting of a blend of these two approaches.

This hybrid approach is currently what is employed at our university. All engineering majors are required to complete a course in philosophy & social ethics, taught by the philosophy department, which has a course description: “Topics may include the nature of the good life, the relation between social morality and individual rights, and practical moral dilemmas.” As this course is taught as a general education course and is open to all university students, it does not specifically address engineering ethics or ethical or social justice topics as applied to engineering scenarios. Anecdotally, engineering students typically criticize the course for its lack of relevance to the engineering disciplines, and Walther, Kellam, Sochacka, & Radcliffe showed via focus group interviews that this type of separate ethical education, taught by non-engineering faculty, “conveys the sense that this content was not part of professional engineering, since it was isolated from the rest of the curriculum…”[7] While some departments have a dedicated seminar course on ethical and societal impact issues, such as in the computer science department, this practice is not widespread, and most departments include a discussion of ethical and societal issues in modular form, and most often in the capstone design course in the senior year.

A number of review articles have recently been written synthesizing the impact of game-based educational elements on both student attitudes as well as learning. Clark, Tanner-Smith, & Killingsworth synthesized many recent studies on games in the K-16 educational space across multiple disciplines.[8] Their work, which covered literature on digital games from 2000 to 2012, incorporated work from other meta-analyses on the subject, including those by Vogel, Vogel, Cannon-Bowers, Bowers, Muse, & Wright[9] (spanning from 1986-2003), Sitzmann[10] (spanning from 1976-2009), & Wouters, van Nimwegen, van Oostendorp, & van der Spek[11] (spanning from 1990-2012), all of which demonstrated that some student learning benefited significantly from game-based instruction as compared to similar non-game instruction. Additionally, they found that the ***type*** of game elements incorporated into the instruction also had a distinct and significant impact on the student outcomes. A separate review by Young, Slota, Cutter, Jallette, Mullin, Lai, Simeoni, Tran, & Yukhymenko broadly surveyed the use of video games in the K-12 educational space, and identified over 300 papers that attempted to relate the use of video games to academic achievement.[12] Their findings emphasized that game-based research must become more situated to understand it in relation to individual differences in player goals and intentions, rather than the broad impacts of game mechanics on students across the board. Lastly, a recent review by Bodnar, Anastasio, Enszer, & Burkey, focusing only on the engineering disciplines in the 2000-2015 time frame, found that game-based instruction in the engineering disciplines generally had positive impacts on student outcomes, both attitudinal and knowledge-based.[13] Thus, from the wide body of literature, it can be taken that game-based educational tools, when designed and implemented well, can produce significant gains, both cognitive and attitudinal. Both Clark *et al*. and Young *et al*. found some value in game *narratives* and Young, Slota, Travis, & Choi have recently described the potential of game narrative to support creativity and innovation within the constraints of classroom learning.[14]

In addition to overall improvement in nascent engineers’ ability to appreciate the diverse social and ethical contexts for engineering solutions, it has been suggested that providing engineering

content in contextualized formats can differentially appeal to traditionally underrepresented minorities in engineering, specifically women,[15,16] and that resulting group diversity can lead to greater diversity and creativity in solutions proposed. Du and Kolmos noted that female students more often approach knowing and learning in ways that are characterized as as 'connective', either with other people or with society at large, and that this method of learning is not well supported by traditional lecture-based content that dominates many engineering programs.[15,17,18] Specifically, Du and Kolmos, citing the work of both Du[19] and Mosby,[20] suggested that "…assessment measures which require a broader range of skills identified by employers in practice match the preferences by female students: ***the interest in social implications, the concern for human needs and environmental issues, the consideration of context and relationships and the preference for collaborative learning*** (emphasis ours).[15]

The idea of teaching ethics raises the question of just what impact classroom instruction can have on the moral and ethical thinking of college freshman. In many other instances, such as binge drinking, dating relationships, and study self regulation, it is clear that the reflective judgment of students is not always fully developed during college. King and Kitchener suggested that there is hope that classroom instruction can impact ethical and moral judgment.[21] But, in the Carnegie Foundation review of engineering ethics teaching at 40 engineering schools, Colby and Sullivan described that engineering faculty are often quite skeptical as to whether anything can be done to change the ethical behaviors of their students.[22] This may be due to the complexity of ethical judgments that often involve reasoning as well emotional responses.[23] For example, Damasio pointed out that emotion and feelings are essential to the processes of rational judgment.[24] This conclusion was based on clinical studies of patients with lesions to the pre-frontal lobes, each of whom exhibits a clear link between the loss of emotion and feeling and an inability to reason. Also, there is some reason to believe that prefrontal cortex is not fully developed until at least age 25, calling further into question the value of undergraduate classroom assignments aimed at improving ethical judgments (e.g., Aamodt & Wang 2008).[25] In general there is reason for hope, as some assessment instruments have shown growth from educational interventions. We turn to this topic of assessment next.

In terms of assessing how students perceive ethical and moral situations, one of the most widely-used instruments for measuring students' ethical or moral reasoning is the Defining Issues Test 2 (DIT-2),[26,27] that was developed in the 1970's and takes as its basis Kohlberg's Moral Development Theory.[28] The DIT-2 is administered by evaluating participant responses to a series of moral or ethical dilemmas (six in the original DIT, five in the DIT-2) according to a rubric. The DIT-2 instrument is valuable for a number of features, including 1.) The ability for it to differentiate both age and educational level, 2.) the ability to differentiate longitudinal changes in attitudes over a period of time, and 3.) demonstrated sensitivity to moral education interventions.

However, in terms of assessing ethical or moral behavior with respect to a specific field or discipline, it falls short, in that it was primarily developed to measure or assess *general* moral development and not the specific ethical considerations that may be related to engineers'

expertise or the target of engineering educators. One of the concepts that is of specific interest to engineers is the idea of *microethics* vs. *macroethics*; the former focusing on how a professional engineer interacts with various constituents, such as fellow engineers, supervisors, or clients, and the latter concept focusing on larger-picture concerns, such as how the engineer's proposed designs or solutions impact society as a whole.[29]

To address these assessment shortcomings, we have identified an alternative instrument that has been specifically designed to measure ethical and moral baselines in engineering students. Developed at Purdue University by Zhu, Zoltowski, Feister, Buzzanell, Oakes, & Mead, the Engineering Ethical Reasoning Instrument (EERI)[29] uses the DIT-2 structure as a starting point, but replaces the more general scenarios used in the DIT-2 with ones that have been contextualized to student-based engineering design projects. Participants in the EERI are also asked to respond to a specific ethical question that is tied to the scenario in question, as well as explaining their reasoning and ranking the relative importance of various items to their decision making. The Purdue team has validated the instrument via a variety of methods, including statistical analysis, expert review, direct observation, and semi-structured interviews.

Methods:
In Spring 2017, we have a mixed engineering discipline introductory course with approximately 350 students as a study population. As freshmen, these students have had no previous collegiate level instruction in ethics, or specifically, engineering ethics. To determine a baseline, we intend to administer the EERI instrument to the class prior to our engineering ethics instructional intervention.

For the intervention, we have developed a 'Cards Against Humanity' (CAH)-type card game focused on ethical, societal, and social questions within an engineering context. For those not familiar with the 'Cards Against Humanity' game model, a group of players each draws a number of 'response cards' (White Cards). One player then draws a Black Card, that contains a question, situation, or fill-in-the-blank. The other players look at all of the potential responses they have in their hand (the White Cards), and attempt to make a response most likely to be chosen as "best" by the judge for that round. The player who read the Black Card judges all of the other player responses, makes a selection of the winning condition (in Cards against Humanity, this is usually the "funniest" or "lewdest" response combination), awards points, and then play continues with a different player drawing another Black Card and reading another scenario.

The CAH model has been adapted previously in other educational settings,[30,31,32] and Cards Against Humanity provides free templates of cards to use from their website. As discussion of ethical, societal, or social scenarios could prove to be controversial, using a game-based approach may allow participants to engage in discussion of the topics and concepts in a more playful, abstract manner, allowing freer responses and more meaningful exploration of the topics, as they are safely confined within a game construct. This may also more closely approach the engineering job conditions in which ethical reasoning is not the primary goal and

so must emerge, as it would in the CAH game, in context of other goals. This approach also allows us to evaluate the same scenarios as described in the EERI instrument in a different context. For an initial version of the game, the authors have collaboratively designed the cards based on a variety of sources, including historical, contemporary, and fictional cases or examples. This initial version of the game has been play-tested with small groups of engineering students in an informal setting (a student professional society social gathering) as well as by a diverse set of engineering faculty at a game-based educational workshop at a national engineering professional society meeting.

Table 1 shows some of the white card and black card responses that have been developed and iterated upon during the development period.

Table 1: Examples of collaboratively-developed card scenarios.

Black Situation Cards	**White Response Cards**
During final testing of my engineering senior project, evidence of ___ turned up.	Pterodactyl eggs
And the engineering ethics award goes to ___.	Eugenics
Dear Abby, my new engineering design is full of _____, what do you suggest?	Republicans
When asked to take a test for my friend, I told him I'd do what _____ would do.	Senators
When facing an ethical dilemma, what's an engineer's best friend?	Repression
Engineering ethics guidelines now prohibit ____.	Poor teamwork and bad communication
NASA engineers associated with the o-ring designs should have blamed the problem on _____.	Party poopers
When Boston's Big Dig tunnel collapsed, engineers should have told the press to investigate ____.	Lawyers
Volkswagen should have used _____ to fix their diesel problem instead of _____.	My mechanical engineering professor
Plugging the Deepwater Horizon well leak would have been so much faster if they had just used _____.	ISIS
_____ noticed the reactor going critical - won't somebody please think of _____!	The glass ceiling
When in doubt, do what _____ would do in	Genghis Khan
	Brian Boitano
	Darth Vader
	Politics
	Any administrator
	Civilian casualty
	Batman
	Standardized Testing
	The Pope
	My inner demons
	The terrorists
	A spherical cow
	The Department of Redundancy Department
	Poor quality control testing
	Gremlins
	Time travelers
	Green Engineering Paper
	The Right Hand Rule
	Social Awkwardness
	Your trusty TI-86

that situation. Because of _____ the “Days Since Our Last Accident” counter needs to be reset. _____ swears that this new formulation won’t cause any adverse side effects.	A slide rule Obviously falsified data Patent trolls Lubricating grease Industrial espionage Martin Shkreli Profit motive Your terrible powerpoint skills

As shown in **Table 1**, there are a variety of topics in both the Black Card and White Cards, and it is anticipated that different students will have different levels of familiarity with the topics, which when combined with scaffolded assignments surrounding the gameplay, should foster discussion of the topics and encourage students to learn more about topics that interest them.

Students will be introduced to the card game in one 75-minute class session mid-semester. As the introductory class is project based, students are already grouped into project units of 3-4 people, which will be ideal for game play. Students will gather in their groups, and be given a card set to play with. A typical round of Cards Against Humanity may last anywhere from 2-5 minutes, depending upon the complexity of the prompt card, and the amount of time participants spend in selecting their responses. Given the relatively simple rule set, it is expected that minimal time will be need to explain the concept, and that students can play several rounds of the game during the class period. Selected student groups will be observed by the participating faculty to inform future game revisions.

Evaluation of Game Play:
As part of the post-gameplay evaluation, students will be asked to do the following over the next several class periods:

- Pick a topic that you discovered through your playthrough of the game that you did not previously know about. Write a one-page report on the topic, with appropriate citations (not included in the one page), focused on the ethical aspects of the topic and how it relates to engineering decision making.
- Contribute at least one white card and one black card suggestion to the game and justify your reason for this addition. (This will be done through online submission via Google Forms)
- With your group, discuss your individual game card suggestions and select the pair that you most want to see included in the game.

Additionally, structured in-depth interviews and focus groups with selected participants will be conducted to delve into how and why students made the selections and gameplay choices they did. See debriefing overview at www.supportrealteachers.org/debriefing-overview.html

Possible debriefing questions for the faculty to ask:

- Why was the chosen card funny or unexpected?
- What would have been a serious answer to the prompt?
- What does the chosen response say about the principles the group was using?
- Why were/How come these choices were wrong? What lines did they cross? What are some lines that engineers shouldn't cross?
- In this game, there is a card, "Do the right thing". In Which scenario was it played in? What do you think would be the right thing to do in that same situation? Or, if the card wasn't played this round, pick a scenario and apply the card to it.

Possible Learning Outcomes/Objectives (for debriefing rubric)

- Students will describe dilemmas in their own work that apply an understanding that ethics are emergent within the context of every-day decision making.
- Students will express a disposition to engage in moral reasoning in the context of their schoolwork and engineering projects.
- Students will articulate the biases and ethical trade-offs inherent in the game play answers, and state the ethical dilemmas that would be present in analogous real settings.

Current Status:

Cards for the spring semester have been finalized and printed, and in-class gameplay is currently scheduled for early March. Prior to engaging in the gameplay, students will complete the EERI exercise, and post-gameplay they will engage in several reflection exercises as well as assignments related to the game. At the end of the semester, a follow-up application of the EERI will be administered.

Anticipated Results:

In play testing with students in small groups, it became apparent that students were not familiar with many of the engineering ethical dilemmas or situations presented, often asking questions of each other regarding the situations presented. In that sense, it seems apparent that with appropriate scaffolding and follow-up activities that the game may be a novel way of presenting students with an introduction to ethical dilemmas or situations in engineering practice. The EERI instrument has been validated to show differences or evolution in students ethical reasoning ability over time, so a chief result will be whether or not participation in this game-based intervention results in measurable growth in their abilities.

References:

1. Patel, P. “Engineers, Ethics, and the VW Scandal”, IEEE Spectrum, 25 Sept. 2015. Web. 29 March 2016. http://spectrum.ieee.org/cars-that-think/at-work/education/vw-scandal-shocking-but-not-surprising-ethicists-say

2. Hart, M. “The Ethical Lessons of Deepwater”, ASME.org, March 2011. Web. 29 March 2016. https://www.asme.org/engineering-topics/articles/engineering-ethics/the-ethical-lessons-of-deepwater

3. “Lessons from the Challenger Launch Decision: Additional Resources”, NASA, GSFC-1041R-1, 22 July 2011. Web. 29 March 2016. http://www.nasa.gov/centers/goddard/pdf/574228main_GSFC-1041R-1-Challenger(072211).pdf

4. Gehman, Jr., H.W., Barry, J.L., Deal, D.W., Hallock, J.N., Hess, K.W., Hubbard, G.S., Logsdon, J.M., Osheroff, D.D., Ride, S.K., Tetrault, R.E., Turcotte, S.A., Wallace, S.B., Widnall, S.E., “Columbia Accident Investigation Report, Volume I,” NASA, 26 Aug. 2003. Web. 29 March 2016. http://www.nasa.gov/columbia/home/CAIB_Vol1.html

5. Bates, S., “Flint water crisis: For young engineers, a lesson on the importance of listening”, NSF, 23 March 2016. Web. 29 March 2016. http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=138060&WT.mc_id=USNSF_1

6. Herkert, J., "Engineering ethics education in the USA: content, pedagogy and curriculum", *European Journal of Engineering Education*, **25**(4), 303-313 (2000).

7. Walther, J., Kellam, N., Sochacka, N., & Radcliffe, D., “Engineering Competence? An Interpretive Investigation of Engineering Students' Professional Formation.” *Journal of Engineering Education,* **100**(4), 703-740 (2011).

8. Clark, D.B., Tanner-Smith E. E, & Killingsworth, S. S., "Digital Games, Design, and Learning A Systematic Review and Meta-Analysis." *Review of Educational Research*, **86**(1), 79-122 (2015).

9. Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M., “Computer gaming and interactive simulations for learning: A meta-analysis.” *Journal of Educational Computing Research*, **34**, 229–243 (2006).

10. Sitzmann, T., “A meta-analytic examination of the instructional effectiveness of computer-based simulation games.” *Personnel Psychology*, **64**, 489–528 (2011).

11. Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D., “A meta-analysis of the cognitive and motivational effects of serious games.” *Journal of Educational Psychology*, **105**, 249–265 (2013).

12. Young, M.F., Slota, S., Cutter, A.B., Jallette, G., Mullin, G., Lai, B., Simeono, Z., Tran, M., & Yukhymenko, M., "Our Princess Is in Another Castle: A Review of Trends in Serious Gaming for Education." *Review of Educational Research*, **82**(1), 61-89 (2012).

13. Bodnar, C.A., Anastasio, D., Enszer, J.A., & Burkey, D.D., "Engineers at Play: Games as Teaching Tools for Undergraduate Engineering Students.” *Journal of Engineering Education*, **105**(1), 147-200 (2016).

14. Young, M. F., Slota, S. T., Travis, R. & Choi, B. “Game narrative, interactive fiction, and storytelling: Creating a “time for telling” in the classroom.” *In*: Garo P. Green and James C. Kaufman, eds. *Video Games and Creativity*, New York, NY: Elsevier, 200-222 (2015).

15. Du, X., & Kolmos, A., “Increasing the diversity of engineering education–a gender analysis in a PBL context.” *European Journal of Engineering Education*, **34**(5), 425-437 (2009).

16. Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P., “Active learning increases student performance in science, engineering, and mathematics**”,** *Proceedings of the National Academy of Sciences,* **111**(23), 8410-8415 (2014).

17. Hayes, E., “Social contexts.” *In*: E. Hayes and D.F. Daniele, eds. *Women as learners – the significance of gender in adult learning,* San Francisco: Jossey-Bass, 23–52 (2000).

18. Felder, R.M. “A whole new mind for a flat world.” *Chemical Engineering Education*, **40**(2), 96–97 (2006).

19. Du, X.Y., *Bringing new values in engineering education – gendered and learning in PBL*. Thesis [Ph.D.]. Aalborg University (2006).

20. Mosby, E., “Curriculum development for project-oriented and problem-based learning (POPBL) with emphasis on personal skills and abilities.” *Global Journal of Engineering Education*, **9**(2), 121–128 (2005).

21. King, P. M., & Kitchener, K. A. “Reflective judgment: Theory and research on the development of epistemic assumptions through adulthood.” *Educational Psychologist*, **39**(1), 5-18 (2004).

22. Colby A., & Sullivan W. M., “Ethics teaching in undergraduate engineering.” *Journal of Engineering Education,* **97**(3), 327-338 (2008).

23. Kohlberg, L., *Essays on moral development: A psychology of moral development. The nature and validity of moral stages.* Vol 2. San Francisco: Harper & Row. (1984).

24. Damasio, A., *Descartes' error: Emotion, reason, and the human brain.* New York: Putman Books. (1994).

25. Aamodt, S. & Wang, W., *Welcome to your brain: Why you lose your car keys but never forget how to drive and other puzzles of everyday life.* New York: Bloomsbury. (2008).

26. Rest, J., Cooper, D., Coder, R., Masanz, J. & Anderson, D. "Judging the important issues in moral dilemmas—an objective measure of development." *Developmental Psychology*, **10**, 491–501 (1974).

27. King, P.M., Mayhew, M.J., "Moral Judgement Development in Higher Education: Insights from the Defining Issues Test", *Journal of Moral Education*, **31**(3), 247-270 (2002).

28. Kohlberg, L. "Stages of moral development." *Moral education*, 23-92 (1971).

29. Zhu, Q., Zoltowski, C.B., Feister, M.K., Buzzanell, P.M., Oakes, W.C., & Mead, A.D., "The Development of an Instrument for Assessing Individual Ethical Decision- making in Project-based Design Teams: Integrating Quantitative and Qualitative Methods", Proceedings of the 121st ASEE Annual Conference & Exposition, Paper #10060, (2014).

30. "Anthropology Games", *Anthropology Games*, Web. 10 February 2017. http://www.anthropologygames.com/#!cards-against-anthropology/gv8v6

31. "Cards Against Archaeology", *Doug's Archaeology: Investigating the Profession and Research*, Wordpress.com, 12 Dec. 2015. Web. 10 February 2017. https://dougsarchaeology.wordpress.com/2015/12/12/cards-against-archaeology/

32. "Cards Against Sociology", *The Society Pages*, W.W. Norton & Co., Web. 10 February 2017. https://thesocietypages.org/cards-against-sociology/