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Curriculum Infusion through Case Studies: Engaging Undergraduate Students in Course Subject Material and Influencing Behavior Change

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Abstract. This study investigated infusing health promotion topics into an engineering course via problem-based case studies and lecture to assess student learning and self-reported behavior. Junior-level systems engineering students in two sections participated: one section with 52 students and one with 36. One section received a celebratory drinking case; one received distracted driving case and a lecture about hazardous drinking. Student ability ratings related to the course subject matter generally improved with both cases. The lecture appeared to enhance health promotion knowledge. Students self-reported behavior change with both cases. Case studies as a form of curriculum infusion for health promotion topics show promise. The use of case studies overall was well-received by students and coupled with lecture material can increase student health promotion knowledge and behavior change.

Keywords: Curriculum infusion · Health Promotion · Systems engineering education

1 Introduction

Curriculum infusion (CI) is a pedagogical approach that integrates health-based information into academic courses that may not traditionally focus on health-related topics [1]. It has the potential to leverage the socially-situated experiential model of learning by incorporating relevant examples that actively engage students [1] [2]. Integrated curriculum could be introduced through problem-based case studies that provide an opportunity to learn, retain, and think critically about the content [3].

The goal of this study is to investigate the use of integrated problem-based case studies to provide health promotion information in an undergraduate engineering course, a discipline generally void of health promotion content. To evaluate the health promotion content, one case study involved the analysis of university-specific survey data regarding an annual high-risk celebratory drinking event [4]. The second involved the analysis of national data on texting and driving. Two sections of a junior-

level system engineering course were selected based on the course content requiring data analysis and on the pedagogy, which already included several case studies.

This study addresses the hypotheses that infusing health promotion topics into academic courses will increase student interest, engagement, and overall learning of health-related material in a non-health promotion-related academic course. It also addresses hypotheses related to the academic course content with regards to student ability in the academic content. The study also compares the learning of high-risk drinking related information via lecture and through a case study.

2 Methods

The study institution's Institutional Review Board for Human Subjects gave approval.

2.1 Participants

A required junior-level systems evaluation course included case studies as part of its curriculum and was offered with one section of 52 students and another with 36. Participation in the case study analyses was part of the graded homework assignments. Students were assigned teams to analyze the data. The health promotion lecture in one section was part of the scheduled class period. Participation in the pretest, posttest, and the course evaluation was optional and not part of the students' final grades.

2.2 Instruments

Celebratory drinking case. The celebratory drinking (CD) case involved a university-specific high-risk drinking practice in which approximately 20% of seniors participate. The case described social norms marketing [5] and highlighted a social norms intervention at the university. The case included specific health promotion content on general safety information, local emergency room (ER) procedures, risks of mixing alcohol with energy drinks, identifying the signs of alcohol overdose, and handling a situation when someone is ill from alcohol. The latter text stated to closely monitor the person for four signs of alcohol overdose and to call for help when needed.

The case text described a survey about student drinking norms and related behaviors associated with the high-risk drinking event and student perceptions of others' drinking behaviors. De-identified survey data from 1,335 respondents were included. Students were to analyze data to identify the value of potential social norms marketing interventions by considering: a) is the CD event worthy of university resources? b) how many students attempt it? c) does when a student learns about it impact participation? d) are there misperceptions associated with it such that social norms marketing may help? e) are there positive and negative consequences of participating in it? and f) are there sub-populations for whom the answers to the questions above change?

The assignment requirements included submission of a presentation tailored to a student affairs client (not a statistician). For the statistical analysis requirements, the teams needed to provide backup documentation for all statistical tests conducted.

Distracted driving case. The distracted driving (DD) case involved a national sample. The National Highway Traffic Safety Administration (NHTSA)'s General Estimates Systems (GES) data identify highway safety problem areas, provide a foundation for regulatory and consumer information initiatives, and form the basis for cost and benefit analyses of highway safety initiatives [6].

The case included access the GES data and to determine whether DD is deserving of investment by auto insurance companies. To reduce the negative effects of DD, the instructions required students to identify where resources should be targeted with questions including: a) what types of distracted driving are the most prevalent? b) are crashes involving distracted driving more severe and do different types of distraction lead to different crash severities? c) are injuries from crashes involving distracted driving more severe and involve more people who are injured? d) do crashes involving distracted driving occur at different speeds than non-distracted driving? e) are there any sub-populations for whom the answers to the questions above change?, and f) how may potential underreporting of crashes affect the meaning of the results?

The assignment required similar deliverables as the CD case.

Pre and posttests. A pretest and an identical posttest were administered one week prior to each case study and immediately following assignment completion respectively. To address academic content, students provided ability ratings with respect to the learning objectives. The ratings addressed evaluating data and applying basic data-cleansing methods, identifying when to use various statistical tests, and managing time effectively as a team. To test health promotion knowledge, students were asked about local emergency room (ER) procedures, the risks of mixing alcohol with energy drinks, and identifying the four signs of alcohol overdose.

End-of-course evaluation. Seven questions were added to the standard end-of-semester course evaluation. Students compared the CD (or DD) case study to other case studies in the course and provided level of agreement with the following:

- I learned something new about alcohol or drinking (distracted driving) in the Celebratory Drinking (Distracted Driving) case.
- I have changed my drinking (driving) behavior because of things I learned from doing the Celebratory Drinking (Distracted Driving) case.
- I have talked to others about things I learned about drinking (distracted driving) from the Celebratory Drinking (Distracted Driving) case

Students rated their level of agreement with three statements comparing the CD/DD case to the other cases by filling in the appropriate blank. The Celebratory Drinking(Distracted Driving) case was (Much Less, Less, About the Same As, More, Much More): a) Interesting; b) Engaging, and c)Relevant to me personally.

Students rated their use of outside resources (Many Fewer, Fewer, About the Same As, More, Many More) for the statement "Compared to other cases in this course, I researched ___ outside resources for the case." This measure attempted to address any additional effort students were willing to exert.

2.3 Protocol

Students could voluntarily participate in a pretest on Survey Monkey. Faculty randomly assigned five to six students to each group (10 groups for the CD case and 7 for the DD case). A health promotion professional presented health promotion knowledge including answers to the posttest to the DD group on the assignment day. The CD group could obtain this information from the case. After the assignment, students were invited to participate in the voluntary posttest administered via Survey Monkey. The pre- and posttests were coded to identify responses for paired analysis while maintaining anonymity. The anonymous and voluntary end-of-course evaluation was administered through the standard method as with all university courses.

2.4 Independent variables

There were two independent variables: health promotion topic (CD and DD) and timing of responses (pretest vs. posttest). The topic variable differentiated the case topics and the delivery mode of the risky drinking material (CD: case; DD: lecture).

2.5 Dependent variables

Systems evaluation learning objective ability ratings. Pretest and posttest ability ratings identified change in self-reported ability regarding course learning objectives.

Health promotion learning objective knowledge. For the health promotion knowledge concerning the signs of alcohol overdose, the number of correct selections was collected in the pretest and posttest periods. For how to deal with an intoxicated friend, the number of correct responses was collected pretest and posttest. In the course evaluation, ratings using a five-point scale addressed level of agreement regarding learning something new about hazardous drinking or distracted driving and about talking to others about the new knowledge.

Behavior change. The end-of-course evaluation collected ratings using a five-point scale with respect to level of agreement with statements regarding changing drinking or driving behavior based on new knowledge learned.

Case study measures. The end-of-course evaluation collected ratings regarding the case studies with respect to level of interest, engagement, personal relevancy, and use of outside sources as a proxy for willingness to work harder.

2.6 Data Analysis

The Wilcoxon signed-rank test compared pretest and posttest responses within each health promotion topic group. The Mann-Whitney test compared pretest and posttest scores across the groups and the course evaluation scores across the groups. A test of

proportions compared correct answers across the groups for the signs of alcohol overdose and for helping an intoxicated friend.

Where n is the number of subject pairs, Z for the Wilcoxon Signed Rank test was calculated as [7]:

$$z = \frac{V - \left(\frac{n(n+1)}{4}\right)}{\sqrt{\frac{n(2n+1)(n+1)}{24}}} \quad (1)$$

Where n_1 and n_2 are the number of subjects in each group, Z for the Mann-Whitney test was calculated as:

$$z = \frac{W - \left(\frac{n_1 n_2}{2}\right)}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}} \quad (2)$$

Effect sizes associated with the Mann-Whitney and Wilcoxon Signed Rank tests were calculated as:

$$r = \frac{z}{\sqrt{N}} \quad (3)$$

where z is the standardized value of the test statistics from the Mann-Whitney test (W) and the Wilcoxon Signed Rank test (V) and N is the total number of subjects [8].

Effect sizes from the tests of proportions were calculated using Cohen's h:

$$h = 2\sin^{-1}\sqrt{p_1} - 2\sin^{-1}\sqrt{p_2} \quad (4)$$

where p_1 and p_2 are the two proportions being compared [9].

3 Results

3.1 Sample

48 and 50 students in the CD group and 36 and 34 in the DD group completed the pretest and the posttest respectively. 46 students in the CD group and 33 in the DD group completed both the pretest and posttest, and remain for analysis. There were 52 end-of-course student evaluations from the CD group and 35 from the DD group.

3.2 Systems Evaluation Learning Objectives

Addressing health promotion information in a case does not interfere with the ability of the students to learn the subject matter of the course. From the pretest to the posttest, self-reported ability ratings in both groups indicated significant improvement in all academic learning objectives except for using the Wilcoxon signed-rank test statistic and managing time effectively while working in a team (Fig. 1). For the Wilcoxon signed-rank test statistic, students in both groups reported median ratings of 3 in the

posttest, perhaps due to not considering the use of the test during the case study analysis and thus not gaining experience. For team skills, students in both groups reported median ratings of 4 in the pre- and posttests. There may not have been enough focus on team skills to raise self-reported knowledge from the relatively high base value.

After completing the cases, the DD group tended to rate their abilities higher than the CD group for several dependent variables (Fig. 1). This difference did not appear to be due to a systematic bias toward higher ratings in the DD group as a comparison of pretest scores across the two groups only showed a statistically significant difference with respect to the Wilcoxon signed-rank test statistic ratings (Fig. 1). Perhaps the national automotive data set provided a richer experience for data analysis as there were more samples and potential factors as compared to the CD set.

3.3 Health Promotion Learning Objectives

Knowledge of the best options for dealing with an intoxicated friend. In the pretest, many knew the correct option for dealing with an intoxicated friend (pretest in Fig. 2). There were no significant differences between the pre- and posttests for the CD group. For the DD group, there was a significant improvement in knowledge for the correct option (pretest vs. posttest: DD in Fig. 2). Compared to the CD group, the DD group had significantly higher posttest knowledge ratings for the correct option for dealing with an intoxicated friend (right side in Fig. 2).

Knowledge of the four signs of alcohol overdose. At the start of the study, 13% in the CD group (median pretest score of 1) and no one in the DD group (median pretest score of 0) knew all four signs of alcohol overdose. A Mann-Whitney test indicated that more students in the CD group had prior knowledge of the signs of alcohol overdose ($p = 0.005$; $W = 1027.5$). In the posttest, 17% of the students in the CD group and 30% in the DD group knew all four signs of alcohol overdose. While there was no statistical difference indicating learning between the pre- and posttests in the CD group, the difference in the DD group was significant ($p < 0.001$; $V = 14$). Thus, the original knowledge advantage for the CD group did not transfer to the posttest.

Taking ill friends to the emergency room. In the pretest, most students knew to take an ill friend to the ER if alcohol related illness from celebratory drinking is suspected. 89% (41 of 46) in the CD group and 79% (26 of 33) in the DD group indicated agreement or strong agreement with the statement “If you or your friends are hurt or ill from alcohol, it is important to go to the (local) Emergency Room (ER).” A Mann-Whitney test comparing the agreement levels with the statement found no significant difference between the groups.

In the posttest, 87% (40 of 46) in the CD group and 97% (32 of 33) in the DD group indicated agreement or strong agreement with the statement. There was a trend toward higher posttest levels of agreement for the DD group ($W = 601.5$, $p = 0.071$). A Wilcoxon signed-rank test for the DD group indicated a significant increase in the level of agreement with the statement between the pre and posttests ($V = 9$, $p = 0.010$).

Question		Group	Pretest			Posttest			Pretest v. Posttest	Pretest v. Pretest	Posttest v. Posttest
			Mean	SD	Median	Mean	SD	Median			
If given an unknown data set, please rate your ability to evaluate data quality and apply basic data-cleansing methods		CD	3.17	0.80	3	3.72	0.69	4	**p < 0.001,**V=36**,** r=0.355		**p= 0.021**,W=554,r=-0.230
		DD	3.09	0.77	3	4.06	0.56	4	**p < 0.001,**V=9.5**,**r=0.429		
If given a data set, please rate your ability to identify where (and if) ___ could be used to analyze those data	one of the many forms of t-tests	CD	3.48	0.86	4	3.94	0.61	4	**p < 0.001**,V=24,r=0.332	.	**p = 0.003**,W=499, r=-0.291
		DD	3.67	0.78	4	4.36	0.60	4	**p < 0.001**,V=7,r=0.369		
	one of the many forms of ANOVA	CD	3.15	0.79	3	3.63	0.57	4	**p < 0.001**,V=46,r=0.343	.	**p = 0.014** W=541.5 r=-0.243
		DD	3.39	0.83	3	4.00	0.75	4	**p<0.001**,V=28.5,r=0.332		
	the Wilcoxon signed-rank test statistic	CD	2.59	0.96	2.5	2.74	0.77	3	.	**p = 0.039** W=559.5 r=-0.223	**p = 0.017** W=538 r=-0.247
		DD	3.06	1.03	3	3.18	0.73	3	.		
	one of the many forms of tests of proportions	CD	2.76	0.99	3	3.78	0.89	4	**p < 0.001**,V=50,r=0.464		
		DD	3.06	0.79	3	4.03	0.73	4	**p < 0.001**,V=15,r=0.402		
	a contingency table/chi-square test statistic	CD	2.57	0.89	3	3.41	0.86	3	**p < 0.001,**V=52**,**r=0.438		
		DD	2.61	0.66	3	3.58	0.90	4	**p < 0.001,**V=35**,**r=0.386		
	the Kruskal Wallis test	CD	1.61	0.68	1.5	3.24	0.82	3	**p < 0.001**,V=0,r=0.575		**p = 0.011** W=515.5 r=-0.273
		DD	1.82	1.01	1	3.73	0.94	4	**p < 0.001**,V=0,r=0.482		
	the Mann Whitney test	CD	1.37	0.61	1	3.43	0.75	3	**p < 0.001**,V=0,r=0.595		**p = 0.039** W=565.5 r=-0.216
		DD	1.46	0.67	1	3.79	0.86	4	**p < 0.001**,V=0, r=0.538		
Please rate your ability to manage time effectively on a team		CD	4.09	0.46	4	4.13	0.50	4			--
		DD	4.00	0.66	4	4.03	0.47	4			

Fig. 1 Self-reported ability ratings for course learning objectives (1=no ability; 2=little ability; 3=moderate ability; 4=good ability; 5=excellent ability)

	Pretest				Posttest				Pretest v. Posttest: DD	Posttest CD v. DD
	CD	%	DD	%	CD	%	DD	%		
Give coffee	46	100	32	97.0	46	100	33	100		
Let sleep it off alone	43	93.5	32	97.0	45	97.8	33	100		
Make throw up	43	93.5	27	81.8	44	95.7	33	100	**p=0.010,**Z=-2.57,h=-0.881	
Sit and watch person*	41	89.1	26	78.8	44	95.7	31	93.9		
Give food	31	67.4	19	57.6	29	63.0	32	97.0	**p<0.001,**Z=-3.82,h=-1.419	**p<0.001,**Z=-3.55,h=-0.957
Give water	13	28.3	4	12.1	17	37.0	22	66.7	**p<0.001,**Z=-4.53,h=-1.199	**p=0.009,**Z=-2.60,h=-0.604

*Correct answer

Fig. 2. Options for dealing with intoxicated friend (CD: n=46; DD n=33)

Emergency room confidentiality for alcohol-related visits. About two-thirds of the students knew about confidentiality at the ER at the start of the course. For the pretest, 67% (31 of 46) in the CD group and 64% (21 of 33) in the DD group indicated agreement or strong agreement with the statement "The (local) Emergency Room (ER) respects confidentiality for an alcohol-related visit and does not contact parents, administration or police." A Mann-Whitney test found no significant differences between the pretest levels of agreement of the groups.

In the posttest for the CD group, 13% (6 of 46) strongly agreed and another 27 agreed with the statement (72% (33 of 46) total); for the DD group, 52% (17 of 33) strongly agreed and none agreed (79% (26 of 33) total). This difference between the groups was significant ($W = 516.5$, $p = 0.010$). While there was no significant difference in agreement between the pre- and posttests for the CD group, there was for the DD group ($V = 12$, $p = 0.003$).

Risks of mixing energy drinks and alcohol. Most students knew about the risks of mixing energy drinks with alcohol at the start of the course. For the pretest, 83% (38 of 46) in the CD group and 85% (28 of 33) in the DD group indicated disagreement or strong disagreement with the statement "Drinking alcohol mixed with an energy drink poses no additional risks compared to drinking alcohol alone." There was no significant difference between the two groups.

For the posttest, 87% (40 of 46) in the CD group and 76% (25 of 33) in the DD group indicated disagreement or strong disagreement with the statement. There were no significance differences for either group from the pretest to the posttest. There was a trend towards a difference between the groups ($W = 598$, $p = 0.077$) in posttest responses. It is not clear why the DD group performance declined from the pretest.

Self-reported "learning something new about the case topic." The cases appeared to support learning about health promotion topics. In the end-of-course evaluation about three-quarters of the students reported that they learned something about the topics. 71% (37 of 52) in the CD group indicated strong agreement or agreement that they learned something new about risky drinking, and 77% (27 out of 35) indicated strong agreement or agreement that they learned something new about distracted driving. There was no statistical difference in the ratings between the two groups.

Self-reported discussion of case topic learning with others. There was evidence that the reach of the health promotion knowledge stimulated conversation about the topics beyond classroom boundaries. 50% (26 of 52) in the CD group indicated strong agreement or agreement that they talked to others about what they learned about drinking; in the DD group, 49% (17 out of 35) indicated strong agreement or agreement that they talked to others about what they learned about distracted driving. There was no statistical difference in the ratings between the two groups.

3.4 Behavior Change

Self-reported impact on student behavior. Some students self-reported that as a result of completing the case studies, they changed their behavior. For the CD group, 8% (4 of 52) indicated strong agreement or agreement that they changed their drinking behavior as a result of completing the CD case, while 17% (6 out of 35) reported changing their driving behavior as a result of completing the DD case. The DD group provided significantly higher ratings than the CD group ($W = 663$; $p = 0.024$).

3.5 Case Study Measures

Self-reported interest. The CD group rated their case as interesting. Specifically, 54% (28 of 52) in the CD group rated their case "More" or "Much more" interesting than other cases, while 37% (13 out of 35) in the DD group rated their case "More" or "Much more" interesting. There is also a trend ($W = 1086.5$; $p = 0.100$) for students to rate the CD case as more interesting as compared to the DD case. This may have been due to the university-specific focus of the CD case.

Self-reported engagement. Some students rated the cases engaging. Specifically, 44% (23 of 52) of those who participated in the CD group rated it "More" or "Much

more" engaging than other cases, and 40% (14 out of 35) of the DD group. There was no statistical difference in the engagement ratings between the two groups.

Self-reported personal relevance. Some students rated the cases as personally relevant. Specifically, 52% (27 of 52) of those who participated in the CD group rated it "More" or "Much more" personally relevant than other cases, as did 40% (14 out of 35) of the DD group. There was no statistical difference in the personal relevance ratings between the two groups.

Self-reported use of outside resources. Compared to other cases, some students reported that they tended to use more outside resources for either case. 15% (8 of 52) of those who participated in the CD case rated using "More" or "Many more" outside resources than for other cases, and 29% (10 out of 35) rated using "More" or "Many more" outside resources for the DD case. There was no statistical difference in the outside resource ratings between the two cases.

4 Discussion

This study investigated infusing health promotion topics into an academic course via case studies to see if increased student learning of and interest in health promotion-related material can occur while not interfering with student ability in the academic content. The study also sought to compare the learning of health promotion-related information via lecture and through a case study. A study was conducted in two sections of the same engineering course where students completed different case studies and gained knowledge related to risky drinking through different pedagogy.

The results support that the case studies on the health promotion topics did not interfere with student learning of the course subject matter. Ability ratings related to the subject matter generally improved with both cases. This is especially important if the academic faculty are not be willing to "sacrifice" students learning the topics they are teaching to "make room" for health promotion information.

With respect to learning the health promotion knowledge, many (three-quarters) self-reported learning something new via the case studies and about half reported discussing this new knowledge with peers outside of the classroom. The measured learning of specific declarative health promotion knowledge was superior with the course lecture as opposed to the case study. The CD group learned the health promotion information through the text of the case study, while the DD group received an in-person discussion from a health educator. The finding that the case study was less effective may have been due to the case study design as the health promotion information was not a focus of the analysis and was not highlighted in the materials. The CD addressed in the case study focuses on a practice among seniors, while the students in the class were juniors. A case study involving a CD more prevalent among all students may provide different results. Future work should investigate better methods for including the health promotion knowledge in the cases and for supporting more active learning.

Faculty teaching academic courses do not want to introduce cases that deter student interest and this concern was not an issue herein. This study supports the hypothesis that there will be an increase in interest and engagement in topics of health promotion. For example, over half of the CD group reported that the case was more interesting and personally relevant than other cases in the course.

A positive finding was self-reports of changing behavior based on the cases. While the percentage of the students was not high (8% for the CD group and 17% for the DD group), any positive behavior change is considered successful, especially considering the limited time period during which the case study occurred. Additionally, the CD addressed a practice among seniors. It is possible their work with the case study may influence their decision to engage in the practice the following year.

Research on the use of case studies in academic courses with the infusion of health promotion topics would be of value to the academic and student affairs communities.

This exploratory study does have limitations that should be addressed in future work. It included confounds between the case study topics, delivery methods of celebratory knowledge delivery (live presentation and case study narrative), and size and type of the case study datasets. Future work should uncouple these confounds to determine better case study designs.

Another limitation was the small sample size used. New experimental designs will be required in future work. A larger population would allow for more power and certainty in the overall results. A post-hoc analysis indicates a minimum sample size of 450 participants is needed to achieve power of 0.8 on four outcome measures. Barriers are associated with achieving a large sample: most notably that upper level engineering courses are rarely this size.

No follow-up occurred after the semester. Future work should include a plan to contact students the following year to address future learning and behavior change and longer-term follow-up.

In conclusion, case studies as a form of curriculum infusion for health promotion topics show promise. The use of case studies was well-received and was coupled with a positive impact on student self-reported behavior change.

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