BAC AND BEER: OPERATIONALIZING DRUNK DRIVING LAWS IN A RESEARCH METHODS COURSE EXERCISE*

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JOHN UPDIKE (1962) ONCE called beer "that mythical college brew." Undoubtedly students' drinking preferences and consumption patterns have changed considerably since his college days. Current tastes seem to run more to Alabama Slammers, Singapore Slings and other shot drinks, and less to Pabst and Miller. But it still seems a pretty fair assumption that current college students have at least a passing familiarity with beer and its short-term effects on their cognitive and motor abilities.

This paper describes an exercise that builds on such experience. It was used in a research methods course but could be adapted for a social problems or statistics course. In a research methods course the exercise demonstrates two main points: 1) problems with clarifying the legal idea of drunk driving, even though there has been a major legal change to clear up this working definition; and 2) the process and challenges of operationalizing research concepts and turning them into variables—a core set of topics for a methods course.

Grounding a research methods course. This exercise is part of a broader effort to make a research methods course more interesting to students by injecting content around social problems. A typical research methods course might sequentially cover the logic of scientific inquiry, benchmarks of scientific quality, different types of research tools, and how to read journal articles (Taylor 1994). These topics, however, often strike students as vague and largely irrelevant. As a former student of the first author once put it: "There are two kinds of knowledge. The things that are in all those books and journals in the library. And what I know to be true, because it happened to me or my friends." Helping students see the connections between principles and practices of research methods and issues of daily living and current policy is always a significant challenge for the instructor.

Such connections may be strengthened in several different ways in a research methods course, including a common research project (Ransford and Butler 1982), integrating computer applications with such a project (St. George 1978; Takate and Leiting 1987), or documenting how research strategies described in journal articles have changed over time (Booth 1984). Close oversight of students' successive paper drafts for such projects becomes daunting for the instructor, however, as the class size balloons past 20 to 30 students.

In larger classes, alternate techniques include: 1) demonstrations on specific issues such as clustered sampling (Singleton 1989); 2) in-class exercises, completed either individually or in small groups, to illustrate any number of points (Dorn 1989); 3) discussing course grading in the context of measurement error (Hedley 1978); 4) using sourcebooks to simultaneously learn about current levels of social problems and practice decod-

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Editor's note: The reviewers were, in alphabetical order, Susan Harris, Nelson Kofie, and Susan Takata.
ing graphical and tabular information displays (Forde et al. 1991); 5) mass questionnaires to describe students; and 6) experiments nested within questionnaires (Lorenz & Bruton 1996).

At our institution, our home department has separated research methods and statistics into two courses, and allocated statistical reasoning, computer skills, and data handling to the latter offering. This precludes asking students in the former course for extensive involvement in data collection, data input, analyses, or statistical testing. In addition, both undergraduate offerings enroll 40 to 90 students per course, precluding individual-based projects requiring frequent instructor input.

The first author has adapted his undergraduate research methods course to this situation in three ways. First, the course has been re-focused on two specific social problems, drunk driving and guns, and linking those topics to research methods content using a spiral technique (see below). Second, students complete a mass questionnaire early in the semester touching on topics linked to the two specific issues. Third, throughout the semester, we conduct in-class exercises related simultaneously to one of the focus issues, specific research methods content, and students’ experiences. This note describes one of these exercises, the “results” of the exercise additional details on the problem addressed, the relevance of those details to questions of problem selection, and ways to adapt such an exercise to different courses.

The problem. Despite students’ familiarity with beer and its short-term effects, they and other adults may find it extremely difficult to gauge when they have had so much beer—or any other alcohol—that it would be illegal for them to get behind the wheel of a vehicle and drive. This is the problem of notice; you may not know when you are committing the crime.

It is hard to know if you are driving illegally in part because current drunk driving laws are strict liability per se laws (Jacobs 1989:73-74). If you are pulled over and breathalyzed and your blood alcohol content exceeds the maximum permitted in your state, you are per se guilty of drunk driving and subject to arrest (Jacobs 1989: 73). No guilty mind (mens rea) is required, nor is evidence that you were driving dangerously or poorly (Jacobs 1989: 75). “All but 2 states (Massachusetts and South Carolina) and the District of Columbia have per se laws defining it a crime to drive with a blood alcohol concentration (BAC) at or above a proscribed level, usually 0.10 percent” (Insurance Institute for Highway Safety/Highway Loss Data Institute 2000). Prior to the introduction of per se DUI laws, drunk driving arrests depended on subject driving behavior, demeanor during a traffic stop, and performance on field sobriety tests such as walking a straight line (Jacobs 1989:65-70). In court, the defendant could contest the officer’s description in each of these three areas. Per se laws were intended to render these disputes irrelevant. But in general, per se laws are “rare and controversial,” and for drunk driving they may be “clearly inappropriate” because the offense is so serious (Jacobs 1989: 75). In short, although the legal standard may be clear, it is hard for someone to know whether they are following that standard unless they opt not to drink at all before driving.

Blood alcohol content (BAC) is hard to subjectively estimate in part because it depends on a number of factors: the amount of alcohol ingested, the time during which it was ingested, weight, and sex (Frezza et al. 1990; Greenfield 1988). (See Appendix A.) The more alcohol consumed in a shorter period of time by a lighter weight person, the higher the resulting BAC. In addition, body mass and metabolic differences between men and women result in the same amount of alcohol, leading to a higher BAC among women (Frezza et al. 1990).

The central issues addressed by the exercise depend on the course; introductory course material preceding the exercise could vary accordingly. In a research methods course, the central issue is operationalization. How is the construct (drunk driving)
operationalized (via per se laws). And what are its attendant problems? Why did policy makers opt for this operationalization (was it intended to be less vague)? And, how do we illustrate a major problem with this definition of a crime (you don’t know exactly when you are breaking the law)? It was hoped that through the exercise students would better appreciate that although the legal standard as operationalized was clear, it may not be clear to most citizens, including themselves. Student variation in responses would constitute prima facie evidence of such uncertainty. In addition, although it was not an express purpose of the exercise, sex differences were of interest.

Respondents. The exercise was administered in a large, urban university with a diverse population. That diversity was reflected in the class (n=80 students enrolled) itself. Beginning-of-the-semester questionnaires (n=65) showed that students’ ages ranged from 18 to 51 (mean=22.8; median=21); the group was 52 percent male; home residences ranged from rural (6.3 percent) to small town (12.5 percent), to medium-sized (25.0 percent) and large cities (56.3 percent). Ethnic groups represented included white (48.3 percent), African American (38.3 percent), Asian (6.7 percent), and Latino/a (3.3 percent), with 3.3 percent identifying themselves as bi- or multi-ethnic. Political orientations (as identified on questionnaires) ranged from conservative (3.2 percent) to extremely liberal (3.2 percent), with the typical class member classifying himself or herself as “somewhat liberal.”

Preparation. Preparation for the exercise included readings, class discussion, and reports on class members’ drinking and driving. Readings covered general background on the DUI problem, per se laws (Jacobs 1989, especially chapter 6), research methods topics of construct validity, operationalization, measurement, and relationships between indicators and constructs (Taylor 1994: chapters 3 and 6). Class discussion reviewed legal definitions of drunk driving before and after the advent of per se laws, and obtained students’ reactions to the “old” and “new” drunk driving standards. Particularly helpful were comments from police officers in the class on how they conducted DUI stops. We reviewed constructs, variables, the process of operationalization, and ways to go about assuring that the variable represented the construct intended. Results from the beginning-of-the-semester class questionnaire were reported out, covering two items in particular: the reported frequency of serving as a designated driver (about 45 percent reported doing so at least once in the past twelve months), and the frequency of driving within an hour of having a couple of drinks (see results reported below). For both questions, we talked about the limits of how these questions operationalized designated driving and drunk driving respectively.

The exercise. The exercise was administered as follows. We handed out 3 X 5 cards, and asked students to record on the card their sex, weight to the nearest five pounds, and the answer to the following question:

You are out drinking with your friends. You are going to be drinking twelve-ounce beers for two hours. Estimate the number of beers you will need to consume in two hours such that at the end of that period your BAC would be at or just over .10 percent, the legal standard for drunk driving in [name of three states surrounding the school].

Students were told to think about plain 12-ounce beers: no light beers, no malt liquors, no stout, and so on. In response to student questions, it was emphasized that the point was not how well you would drive, but the BAC level, in accordance with current per se laws.

In short, students were asked to supply a correct answer—the number of beers that would result in their “just” breaking the law were they to get behind the wheel at the end of the two hour period. They were allowed to confer with one another for a minute or so if they wished to draw on one another’s expertise. They were instructed not to put
any identifying information on the cards. From the supplied data, variables were transformed into ounces of ethanol and kilograms, then used to calculate blood alcohol content (see Appendix A).

**Results.** A handout and a data table were prepared based on the results and reviewed in the next class. The following results were reported. Sixty-seven complete responses were supplied for the exercise (27 females, 40 males). The number of beers ranged from 1 to 10, (mean=4.15, median=4.00, sd=1.68). Weight reported ranged from 95 to 245 pounds (mean=162.34, median=160.00, sd=33.52). There were differences by sex. Males estimated a significantly higher number of needed beers (mean=4.6 beers) compared to the women (mean=3.5 beers; t(df=65.67)=2.85; p < .01, two tailed). But since the males weighed significantly more, this difference is not that surprising (mean male weight=178.6 pounds, mean female weight=139.1 pounds, t(df=59.4)=5.89, p < .001). The men did not estimate a higher number of beers after controlling for the weight difference. After controlling for the weight difference between the males and females, the number of beers estimated was about the same (t = -1.07, p > .25). Although it was not reported at the time, controlling for weight showed that women only estimated .52 fewer beers than men, a non-significant (p < .30) difference.

The handout also described how the formula (Appendix A) considered sex, weight, time, and amount of alcohol. The displayed histogram and accompanying statistics for the BAC variable showed that BAC averaged .076 percent (median=.074 percent) and ranged from zero to .17 percent (sd=.042). So the “average” student underestimated the number of beers “needed” to elevate his or her BAC level to .10 percent. Three quarters of the respondents (n=51) provided answers that were too low, yielding BAC estimates of below .10 percent; 16 or 25 percent provided answers generating a BAC level of .10 or higher. Some of the latter answers were well above .10 percent. Thirty-six point eight percent of the participants generated BAC levels “around” .10 percent, between .08 and .12 percent. So again, even though the formula “controls” for sex and weight, and the type of alcohol and time were constant for all, sizable variation in BAC levels resulted. That variation (as suggested by the first author in class) was generally a result of students’ difficulties estimating BAC levels, and constituted prima facie evidence of a problem with how the legal standard has been operationalized.

Also included in the handout and discussed in class were scatterplots of N of beers by BAC, reported separately for males and females (Figures 1 and 2). Discussion points included: Is this a positive, negative, or zero relationship between beer and BAC? And in what ways do the graphs show that men estimated more beers than women? Students were also encouraged to try and find their own “spot” on each graph. A second handout listed the individual data for N of beers and resulting BAC levels, sorted by student sex and by weight within sex, without any identifying information. Students were encouraged, as we looked at the two scatterplots, to find the data point corresponding to their information. This suggestion resulted in numerous questions and comments during class, evidence of significant student interest. After class, several students approached the first author seeking confirmation of where they were on the respective scatterplot. (One reviewer has suggested their inquiries imply the results were not clearly explained. The first author prefers to interpret them as evidence of the instructor’s approachability, the students’ desire to check their conclusions, and the difficulty of communicating successfully to all students in a classroom of students.)

The handout to students also noted that interestingly enough, the women respondents in the class were more likely to generate a BAC of .10 or over with their beer estimates. Whereas only four of the 40 males (10 percent) provided answers generating a BAC above .10 percent, 12 of the 28 women, or 42.8 percent, provided answers
Figure 1. N of Beers and BAC Estimates: Men

Figure 2. N of Beers and BAC Estimates: Women
generating a BAC above .10 percent. (LR chi squared (1) = 11.9; exact p < .001.) Women's estimated number of beers compared to the men's, was not as low as they "should" have been given the average weight difference, and the metabolic differences by sex (see below). After controlling for weight differences, women's average estimate was only about a half a beer lower than the men's average.

In short, the presentation highlighted the divergence of answers, even after controlling for weight differences, underscoring Jacobs' point that it is hard to know when you are breaking per se drunk driving laws, and the methods problems surrounding operationalization. The presentation also showed rough parity of sex on estimated N of beers "required," after controlling for weight differences. It also showed, however, that despite the rough parity, the BAC impacts were higher for women, a point made elsewhere in the college student drinking literature (see below).

Students' evaluations. Following the presentation and discussion of results, students provided evaluation data by responding on another set of 3 X 5 cards to three questions: (1) What was the main point you learned from the exercise? (2) How helpful was the exercise for illustrating the problems with implementing per se laws? and (3) What important questions remained unanswered? These data were also processed. For the evaluation data, we applied a rough content coding scheme to their answers about the main point and follow-up questions. The content coding did not apply inter-rater reliability checks.

Sixty-four students present on the day the results were explained completed an evaluation card; 62 provided answers to all the questions. Generally, students seemed to find the exercise helpful. In response to the question "How useful was the exercise?" (not at all/somewhat/very), 32 (53.3 percent) saw it as somewhat useful and 27 (45 percent) saw it as very useful, with the remainder (n=3) seeing it as "not at all" useful.

In response to the question "What was the main point of the exercise?" 10 students (16 percent) commented that it was hard to know how much you can drink before you should not drive. Thus, about one eighth of the students directly connected the exercise and the reading, keying in on the notice problem with per se laws and the difficulties of operationalizing drunk driving. Only a minority of students spontaneously reflected on the theme of legal vagaries. Had we directly queried on this topic, perhaps more students would have acknowledged that that point was demonstrated.

The remaining responses failed to clearly connect the exercise with the assigned, problem-specific readings, but it was not known if students had completed the assigned readings by the date of the exercise. Another 22 or 35.5 percent commented that the relationship illustrated connections between BAC, weight, and sex. And another 16 or 25.8 percent saw the main point as sex differences in BAC levels. Six students each (9.7 percent each) thought the purpose was either to underscore why we should not drink and drive, or to illustrate how to read and interpret data. This last response reflects an appreciation for an important course goal, but not one that was directly tied to the social problem being investigated. Clearly, students drew different "take away" lessons from the exercise.

In response to the question, "What is the most important remaining question?" 22 (42.3 percent) wanted to know more about the mechanics, for example, to actually follow through an example so they could see how the calculations were derived.

Possible improvements. Additional discussion points for elaboration in future iterations could include policy initiatives to remedy the problem of the potentially confusing legal standard. A couple of students mentioned bars where you could blow into a tube before leaving to check your BAC. Students could design a quasi-experiment evaluating a law that mandated such "breath checks" be installed in all bars. Consideration could be given to issues of potential implementation
failure, gauging effectiveness, and estimating cost-effectiveness.

Questions. Is it helpful to spend so much time grounding students in specific issues? The approach described here reverses what has been advocated for content-focused courses—grounding them by using more research methods and statistics (Gulley 1982; Johnson and Steward 1997; Markham 1991). Injecting content into the methods course provides a common set of issues around which to structure discussions of major ideas in research methods. These content-based issues help students see that there are data limitations when you are trying to answer important questions (Schutt, Blalock, and Wagenaar 1984).

Why the focus on two specific issues? By grounding research methods topics in two specific social problems, a spiral approach can be applied. The spiral approach has been widely documented in secondary school science education for at least three decades (Downing 1995; Murphy 1973). The central idea is that students are repeatedly exposed to the same topics or core ideas. With each return to a topic, they bring greater understanding of and insight into the surrounding complexities. In short, they learn some the first time around and learn more deeply the second time around.

How do you decide which problems to select? Basically, you want to look for problems that are sizable, socially important, and familiar to the students. The first author chose drinking and driving because it was thought that students do a lot of both, although hopefully not at the same time. Recent evidence on college drinking, and on drinking and driving, provides details on the prevalence of these problems.

College students’ drinking is relatively frequent. Surveys completed in 1993 (n=17,592) on a nationally representative sample of campuses found that 84 percent of students reported drinking during the academic year, 70 percent reported drinking in the last 30 days, and over 44 percent qualified as binge drinkers (Wechsler 1996). For men, binge drinking was defined as five drinks in a row, for women it was four drinks in a row (Wechsler et al. 1995b). Fraternity/sorority membership strongly predicted binge drinking (Wechsler 1996). Less powerful predictors included a party-oriented lifestyle, and engaging in more risky behaviors (Wechsler et al. 1995a). Beyond personal factors, context proved influential. Actual student drinking and binging patterns, and perhaps even more importantly, views about alcohol consumption norms, varied dramatically across schools; those norms strongly influenced drinking patterns, net of other individual-level factors (Perkins and Wechsler 1996). Levels of drinking at American colleges may be higher than at Western European institutions (Sell and Robson 1998), but different units of measurement and different survey techniques make definitive statements difficult.

Given that drinking is relatively frequent among college students, it is not surprising that drinking and driving is as well. A 1995 nationally representative sample of 4,609 undergraduates 18 years or older found that about one in four undergraduates (27.4 percent, +/- 2.1 percent) reported at least once drinking alcohol and then subsequently driving a car or other vehicle in the last 30 days (Wechsler 1996). The prevalence rate was higher for men (33.2%) than women (22.8%). The students who participated in this exercise look somewhat similar. When asked at the beginning of the semester “in the past year, since February 1999, have you on at least one occasion had at least two or three drinks and then driven a car within an hour afterward?” 30 percent reported they had, and the percentage of men (39.4%) was higher than women (19.4%).

Given these drinking and driving patterns, what do DUI arrest patterns look like? With the advent of per se laws, and increases in the minimum age for alcohol purchase from 18 to 21, the number of DUI arrests has declined from a high of 1.61 million in 1983 to 986,000 in 1997 (Maguire and Pastore 1999: 366, Table 4.27). The DUI arrest rates for 21 and 22 year old, college-age
drivers entitled to legally purchase alcohol have also declined from 1990 to 1996 (Greenfield 1998:12). But the DUI arrest rates for 21 and 22 year olds are still the highest for any age group. Further, 21 and 22 year olds are over-represented among DUI arrestees. Although drivers this age represent, respectively, 1.6 percent and 1.7 percent of licensed drivers, they each represented, in 1996, 3.6 percent of DUI arrests (Greenfield 1998:11). Overall, although the drunk driving problem is not as acute as it was 20 years ago—assuming no change in arrest practices—it is still a sizable problem, and drivers of college age are disproportionately involved.

Such a problem background makes DUI an excellent candidate for course inclusion, and increases the chances that including such an issue would enhance student interest. End-of-semester assessments suggest this goal may have been achieved. When shown the statement “because of this class I am more interested in the problem of drunk driving than I was at the beginning of the semester,” 50 out of 72 responding, or 69.4 percent agreed. In the same assessment, 56 out of 66 or 84.8 percent disagreed with the statement “I think this course would have been a lot more interesting if the professor had just concentrated on research methods, and NOT spent so much time teaching us about guns and drunk driving.”

Applications to other courses. The exercise might apply to other courses such as social problems or statistics. A social problems application could focus on problem definition or attitudinal ambivalence. The first thread highlights the persistent fuzziness often surrounding definitions of a societal problem (as reflected here in the variation of students’ responses) even as society moves its “ruler” and attempts to define the trouble more clearly, illustrating the dynamic aspect of social problems (Henslin 1996:4). The second thread might connect the difficulties of citizens knowing when they are lawbreakers with Americans’ continuing ambivalence about harsh penalties for those convicted of drunk driving, even when death results. That ambivalence surfaces in national poll data (see Table 2.95 in Flanagan and Maguire 1992:347). Roper Poll results from 1983, 1989, and 1992 showed that between 58 and 68 percent of households supported a “long jail term of one year or more” in a situation where a drunk driver caused an accident resulting in one or more deaths. If the drunk driver caused the accident and one or more persons were injured, 20 to 24 percent of households supported a long jail term, but 23 to 26 percent supported a “short jail term of 30 days or less.”

In a statistics course, one might discuss at more length topics such as the calculation of new variables using the formula for BAC for N of beers, BAC and weight, means, medians, skewness, medians and means by sex, and t tests of mean differences by sex. In a more advanced statistics class, one could also cover topics of partialling for weight, and the residual N of beers variable after partialling for weight.

SUMMARY

The exercise illustrated in a concrete way that current per se laws intended to deter drunk driving are inherently vague even though legally clear. These vagaries appeared in the wide range of resulting BAC levels—levels that control for weight and sex—resulting from students’ estimates of the number of beers “needed” to get to a BAC level of .10 percent, the legal standard for DUI in most states, including the three states surrounding the campus. The pedagogical points of the exercise in a research methods context are that: it illustrates the process of operationalizing a construct in a policy-relevant context that is also familiar to the students; it shows uncertainty may continue to surround such an operationalization, even when the indicator agreed upon was intended as a policy improvement over an earlier approach; and it suggests these methodological issues may have significant social implications for how society thinks about responding to the problem. The exer-
cise is potentially applicable to statistics or social problems courses.

APPENDIX A. CALCULATING BLOOD ALCOHOL CONTENT

The formula used is BAC(h) = [(A/(r*p))/10] - (h*k) where

BAC(h) = Blood alcohol concentration at time h (in hours)
A = grams of ethanol consumed which is equal to [(liquid ounces of alcohol) * (.82)]/0.035
r = reduced body mass (.68 for males; .55 for females)
p = weight in kilograms (pounds/2.2046)
h = hours drinking
K = estimated rate at which body metabolizes ethanol (.015 ounces per hour)

1 ounce of ethanol is equal to
* 24 ounces of beer
* 7 ounces of wine
* 2 ounces of 100 proof (50%) liquor

Source: (Greenfield 1988)

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