Board 73: Implicit Attitudes in Engineering: Coding, Marketing and Bias

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Abstract

Some of the most difficult to teach and measure student learning outcomes are those associated with societal awareness and impact. Many engineering classes are already oversaturated with technical material leaving the discussion of current events and social changes that impact our everyday lives for general education courses. This tendency is reinforced by cultural aspects of engineering emphasizing technical skills over social awareness. This leaves topics such as workplace diversity and bias out of engineering courses making it more difficult for students to see it as important. While improvements in diversity have been seen in engineering over recent years, and despite evidence of the importance of diversity in engineering design and for the financial success of companies, there are still hidden ways in which humans slow this progress. As a strongly gender biased discipline, these hidden barriers called implicit attitudes will likely require more than a passing comment or suggestion for students to attend some on-campus event, it will involve introspection and sometimes time to adjust one's world view.

This Work-In-Progress details the development of a module in an introductory coding course that couples social psychology with fundamental code based learning outcomes. This is accomplished through the introduction of implicit association tests (IATs), which allow for the measurement of subconscious attitudes. An implicit attitude test measures the time it takes for a person to categorize words and or images. Average response times are shorter when the items being categorized match subconscious attitudes and longer if they do not match. This type of test can also be used for measuring brand awareness, an important marketing quantity. The lesson plan involves assisting students setting up the framework of the implicit association test, allowing students to select brands to measure brand awareness for and then using the Project Implicit platform to encourage students to explore their own implicit biases [3]. The primary goal of this module is to improve awareness of implicit attitudes and their potential effects on engineering teams while simultaneously learning basics of coding.

Introduction

According to the dual process model of cognition, there are two types of decision making processes that humans utilize to navigate the vast amount of information they are exposed to on a daily basis [1]. In life and throughout evolutionary history, quicker reactions have been advantageous to survival, whether recognizing and leaving a dangerous environment or having intuition for a solution to a design problem. This first system is automatic, subconscious and is created as a sum of experiences. The second system is typically considered active thought or the conscious weighting and evaluation of factors in a decision. This type of reasoning takes a great deal more effort and energy to complete.

Implicit attitudes are considered to be some of the constructs that make up the first and automatic decision making system. These attitudes can be measured using a psychological test known as an implicit association test, or IAT, which uses reaction time measurements while classifying words and/or images to different categories [2, 3]. Figure 1 shows the general procedure for a five-part IAT. The first two parts train the test taker to categorize words and/or images 'properly' into groups chosen by the tester (i.e. Male or Female associated names into Male or Female categories, also objects associated with a certain field, Bridge with Engineers or Lab coat with a Scientist). These two parts acclimate a user to the system of categorizing by pressing a key on the left hand side of the keyboard or 'e' key and a key on the right hand side of the keyboard or 'i' key. Incorrect responses in this task are highlighted usually by a large red X showing up on the screen to guide the test taker to follow the characterization scheme and encourage take time to be correct rather than fast. These sections will usually have 20 individual stimuli to categorize.

The third part measures the reaction time for combining the two previous tasks into a single categorization. As shown in Figure 1, pressing the 'e' key is now the correct response for either male or engineering names and words respectively, while pressing the 'i' key is now the correct response for female names or science related words. Incorrect keypresses are not counted toward the final score as it is unclear if proper categorization was being completed. Typically this section will have 20-40 individual stimuli to categorize.

The fourth part of the IAT is used to retrain the test taker as one of the two categories are swapped (i.e. male and female change sides and correct key presses). This swap sets up the fifth and final part measuring the reaction times for categorizing the same names and words with the complementary pairings of categories. This section will usually have 20 individual stimuli to categorize.

The reaction time differential between parts 3 and 5 is indicative of the ease of which the test taker is able to correctly categorize one associated pair of categories with another. For the IAT outlined in Figure 1, males with engineering and females with science versus females in engineering and males with science. In other words, the larger the differential in reaction times the greater the automatic preference (bias). This section will usually have 20-40 individual stimuli to categorize. While a single IAT may see data biased slightly by the amount of training or the order in which the groups are presented, the presentation order is randomized for each test taker allowing the comparison to an average reaction time differential averaged over many participants.

	Implicit-Association Test	Left ‘e’ Example	Right ‘i’ Example
Part 1	Sorting 1 (Practice) • Images or words presenting concepts sorted into categories	Male “Robert”	Female “Rosie”
Part 2	Sorting 2 (Practice) • Images or words presenting evaluations sorted into categories	Engineer “Bridge”	Scientist “Beaker”
Part 3	Test 1* • Sorting both concepts and evaluations simultaneously	Male/Engineer “Tim” or “Airplane”	Female/Scientist “Tina” or “Lab coat”
Part 4	Sorting 3 (Practice) • Sorting both concepts and evaluations simultaneously	Female ”Shanice”	Male “Shawn”
Part 5	Test 2* • Sorting both concepts and evaluations simultaneously	Female/Engineer “Laura” or “Circuit”	Male/Scientist “Liam” or “Reaction”

Figure 1: Implicit-Association Test Structure – Schematic of a five part implicit-association test (IAT). The left column contains a brief explanation of each part with the center and right columns indicating the ‘correct’ responses. Incorrect responses are not incorporated into the average reaction times for parts 3 and 5. Average reaction times are calculated for the following groupings: 1, part 3 ‘e’ with part 5 ‘i’ and part 3 ‘i’ with part 5 ‘e.’ A relative comparison of these times indicates an implicit or subconscious association stronger with one of the two pairings of gender and discipline [3, 2]. *Data is collected only for parts 3 and 5. These parts are sometimes subdivided into 2 parts each.

While a staple in psychology courses, implicit attitudes also have broad implications in engineering such as design bias [4], algorithmic bias [5, 6], hiring/management bias [7], as well as other types of workplace bias [8]. These ethically and economically relevant topics to all fields of engineering can be difficult to integrate into courses that are already laden with content and technical skill development [9]. On the other hand, students find stand-alone ethics training less relevant to their field [10]. The most common method for balancing these opposites is integrating a module into an engineering design course that uses a case study approach. The topics covered are canonical (i.e. Space Shuttle Discovery O-rings) and are almost always associated with ethical behavior in regards to job performance [11]. However, this approach can leave more common topics such as workplace diversity and assessment bias out of engineering courses making it more difficult for students to recognize its importance. As spelled out in the ASEE Code of Ethics, it is imperative not only to practice but also to teach students fair treatment of others including fair assessment of their work. This necessitates understanding implicit biases and how they can affect decision making processes [13]. While improvements in diversity have been seen in engineering over recent years [12], and despite evidence of the importance of diversity in engineering design and for the financial success of companies [7], implicit attitudes and implicit biases slow this progress.

This Work-In-Progress details the development of a module in an introductory coding course that couples social psychology with fundamental coding learning outcomes. This is accomplished through the introduction of implicit association tests (IATs) followed by the structured development of one of these tests in MATLAB. Students are encouraged Improving awareness is one of the most effective means of counteracting implicit attitudes and is thus the primary goal of this module with a secondary goal of providing material for ABET accreditation processes.

Lesson Plan

As shown in Figure 2, the implicit association test module coincides with the essential coding topics of functions, loops and selection statements, each corresponding to one week of course material and practice. The module lies approximately in the middle of a 1-credit first-year engineering course (110 minutes per week for 14 weeks). This course is required in all engineering majors at Wentworth Institute of Technology, a small private university in Boston, Massachusetts, USA. Approximately, 700 students take this course each year split between fall and spring semesters. The students who take the course are predominately male; The overall school population is approximately 80% male identified. The successful completion of the course is required for graduation.

Each class session is comprised of an interactive follow-me style lecture component introducing the fundamental syntax for the week's content. This is interspersed with extension examples for students to practice independently, coding a similar task given specified parameters. This is typically discussed between nearby students and presentation of their successful solutions is highly encouraged. The second half of each lecture is devoted to introducing the IAT, contextualizing the day's coding topic within the IAT and applying the newly learned material to the next stage of construction of the IAT.

	Coding	Implicit Attitudes	Assessment
Week 1	Functions • Presenting stimuli • Measuring reaction time	Introduction • Definitions • Task fundamentals	Pre-Survey
Week 2	Loops • Repetitive tasks • Five tasks	Marketing Discussion • Common techniques	Course Learning Outcome 1
Week 3	Selection • Error checking • Binning results	Bias Discussion • Types of bias	Course Learning Outcome 2
Week 4	Data Analysis and Presentation • Basic statistics • Bar graphs	Summary • Contextualizing results • Resources • Further learning	Course Learning Outcome 3 Post-Survey

Figure 2: Lesson Plan – Four week plan to introduce and compile the components of an IAT with the associated coding topics.

The first week of the module begins with students completing the pre-survey which measures their baseline knowledge of implicit attitudes, if they have previously taken any psychology courses and has them complete a rating of hypothetical situations by level of potential bias. Once completed, functions are introduced and practiced before the overall structure and purpose of the IAT is presented. The remaining in-class time is spent building two functions for the essential tasks of presenting a stimuli and measuring the resulting reaction times.

Table 1: Questions for Pre-Survey

	Question/Statement	Output Type
1	Have you or are you currently taking a psychology course?	Yes/No
2	Do you recall learning about implicit attitudes in any previous class (including high school)?	
2a	If yes, please briefly describe or define implicit attitude in your own words.	Short Answer
3	For the following scenarios, rate the objectivity of the character(s).	
3a	"A hiring manager chooses the top 5 candidates for a job opening and after interviewing each hires the one that best fits with the office culture."	Objectivity Likert
3b	“An engineer selects their colleagues to train a new facial ID algorithm.”	Objectivity Likert
3c	"A professor grades papers for students after looking up their grades in previous classes."	Objectivity Likert
3d	"A judge sets bail for a person accused of a crime using an automated system that predicts flight risk and chance of future lawbreaking."	Objectivity Likert
3e	"A group of designers test a new product on themselves to make sure it works."	Objectivity Likert

During the second week of the module, after a 10 minute quiz on writing the input-output line of a function, for loops are introduced and discussed as a means of implementing the repetitive nature of stimulus presentation and the five parts of the IAT. After students practice basic loop development, the utilization of the IAT as a means of measuring the success of a marketing campaign is introduced. Students choose competing brands (i.e. Coca Cola versus Pepsi), locate images to use in the test and combine the loops with their previously created functions for the presentation of the stimuli (images and words). At the end of this class, students are encouraged to explore their own implicit attitudes using the Project Implicit platform [3].

The third week of the module begins with a 10 minute quiz on loop construction followed by the introduction of selection statements (if/else and switch/case). After these are practiced, their context in the IAT for error checking (when a user hits an incorrect choice) as well as grouping results into proper bins for obtaining an average reaction time for the proper tasks. A brief discussion of different types of bias is attempted during the class. Again, at the end of this class, students are encouraged to explore their own implicit attitudes using the Project Implicit platform [3].

The final week starts with a quiz on selection statements, followed by a summary of the IAT module that focuses on contextualizing the results of an IAT, support resources on campus and ways to get involved with initiatives to address implicit bias. Students are then given a work period to build the data presentation portion of their IATs as an annotated bar graph (covered previously in the course). The post-survey is requested to be completed during this final session.

The post-survey offers a similar hypothetical situation section on potential bias and for students who completed one of the Project Implicit tests online asks them about their expected versus actual score and emotional reaction to their score. This survey will also request ratings for the stigma associated with having an implicit attitude.

Table 2: Questions for Post-Survey

	Question/Statement	Output Type
1	Please briefly describe or define implicit attitude in your own words.	Short Answer
2	For the following scenarios, rate the objectivity of the character(s).	
2a	"A hiring manager chooses the top 5 candidates for a job opening and after interviewing each hires the one that best fits with the office culture."	Objectivity Likert
2b	“An engineer selects their colleagues to train a new facial ID algorithm.”	Objectivity Likert
2c	"A professor grades papers for students after looking up their grades in previous classes."	Objectivity Likert
2d	"A judge sets bail for a person accused of a crime using an automated system that predicts flight risk and chance of future lawbreaking."	Objectivity Likert
2e	"A group of designers test a new product on themselves to make sure it works."	Objectivity Likert
3	Did you complete an IAT via the Project Implicit website during the last 4 weeks?	Yes/No
3a	If yes, which of the following best describes your emotions reading the results? Neutral Happy Sad Angry Fearful Disgusted Surprised	Multiple Choice
3b	If yes, how likely are you to share the	Likert

Data Analysis

The analysis of the results will look at the correlation between the course learning outcome (scores on quizzes) as well as the change in answers to the potential bias situations in the pre- and post-surveys. The emotional reaction and presumed stigma of having a high bias score will also be measured. The surveys and outcome measurements are summarized in Figure 3. Results on the course learning outcomes will be compared to previous iterations of the course in order to test if the addition of the IAT material had any effect. Inversely, the effect of having technical assignments concurrently with learning about implicit attitudes will also be investigated. A scaling will be developed to utilize a measure of the increase of awareness as an assessment rating for ABET student learning outcomes 4 and 5.

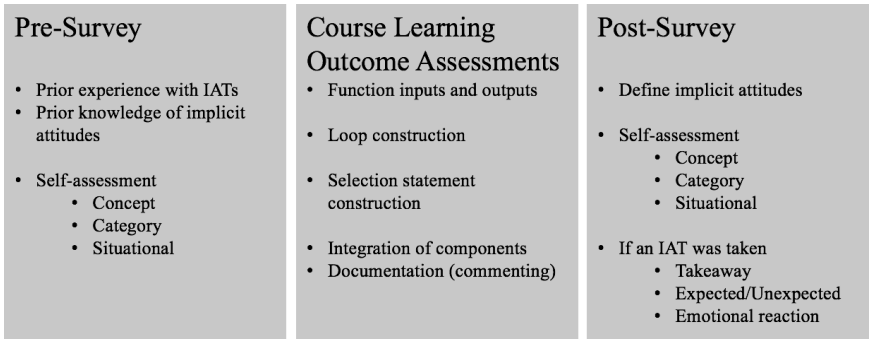

Figure 3: Survey contents and course learning outcome assessments as part of the completion of the module.

While the current iteration of this module is planned to begin in early February 2019, prior iterations have helped guide its development. Previous iterations used less class time and posed the IAT as a coding challenge where context was not given about what the students were building. Students enjoyed the self-paced challenge but very little time was spent on understanding or contextualizing implicit attitudes.

Conclusion

This Work-In-Progress details the design of a 4 week (8 hour) set of classes where coding topics are intermingled with activities designed to increase awareness of implicit attitudes and their implications. The coding exercises built into each week showcase examples of how the concepts (functions, loops and selection statements) can be used in the development of an implicit association test. Data collection is ongoing.

Human Subjects Statement

Data collection was performed after informed consent received from participants following IRB approved methods and questions at Wentworth Institute of Technology (#2018-21).

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