Making engineering education more inclusive through the power of defaults

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***Abstract*— As part of a larger project to assess what marginalization looks like in engineering student teams in the classroom, an opportunity evolved to measure gender and race/ethnicity more authentically and more safely than is commonly done. This paper describes the design of these authentic questions and how students responded to them. In the case of the race/ethnicity question, the paper compares student responses to the new question to their responses to an earlier question that had no option to select multiple identities and no opportunity to write in a free-text response. This process makes visible the students who were likely harmed by the old question design, emphasizing the importance of an authentic measurement.**

Keywords—gender, race, ethnicity, measurement

I. Introduction

The authors constitute the leadership team of the I-MATTER project (Identifying Marginalization and Allying Tendencies to Transform Engineering Relationships, NSF award #1936778). [1] The primary goal of that project is to improve the ability of instructors and researchers to detect, manage, and study marginalizing interactions to improve team experiences for all team members.

II. The CATME System

A. Overview

CATME is a system of web-based tools that support teamwork in education. The system was developed with support from the National Science Foundation (NSF) award #0243254 [2] and enhanced via NSF award #0817403 [3]. The system includes two primary components – a peer evaluation instrument and a system for criterion-based team formation.

B. The Peer Evaluation System

The Comprehensive Assessment of Team Member Effectiveness (CATME) is a research-based instrument for self-and peer-evaluation measuring behaviors necessary for effective team functioning. [4] CATME was designed and translated into a behaviorally anchored rating scale with five dimensions: Contributing to the Team's Work, Interacting with Teammates, Expecting Quality, Keeping the Team on Track, and Having Relevant Knowledge, Skills, and Abilities. CATME Peer Evaluation collects data and gives feedback to instructors and students, improving ease of rating, speed of analysis, confidentiality, and timeliness of feedback.

C. The Team-Maker System

Team-Maker is a tool in the CATME system that instructors can use to form teams based on criteria they choose. Instructors survey students to collect data that they can later use in the team formation process. They can choose from a set of system questions, create their own questions using a set of built-in question types, or review "community questions" that have been shared by other instructors with the opportunity to adopt a version of those questions. There is evidence that Team-Maker can form teams more quickly, more consistently, and with a better fit to the criteria than an experienced instructor. [5]

From its initial deployment, the Team-Maker system has offered four question types:

- Numeric
- Multiple choice, choose one
- Multiple choice, choose multiple
- Free text

III. Team-Maker's Original Gender Question

From its first release (before it was incorporated into the CATME system), Team-Maker had a System question soliciting gender. The question presented to students was:

Fig. 1. Team-Maker gender question prior to Fall 2022.

The measurement of gender is complex and multifaceted [6], and this question wording is problematic for multiple reasons. The original intent of the "Other/Prefer not to answer" option was to provide a choice for people with minority gender identities, while at the same time leaving some ambiguity in that choice by conflating it with the "Prefer not to answer" part of the response. This ambiguity was designed intentionally to protect students who did not identity as either "Female" or "Male", but were also uncomfortable sharing details of their identity with their instructor. Yet while the choices presented offer an "Other" option, the presentation primarily approaches gender as a binary, excluding multiple gender identities [7].

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The use of "Other" as a choice is also harmful; by not allowing students to see their identity represented in the question construction, the question places the student outside the community of students being surveyed, "othering" them [8]. This lack of representation is a ***microaggression***, harassment affecting health and well-being, coined to describe the treatment of Black people [9] that can be classified in a taxonomy [10] that has been generated to other marginalized groups – women and non-binary and gender non-conforming people in this case [11, 12]. In Sue's taxonomy [10], the absence of a person's gender identity is a microinvalidation, an instance in which that person's lived experience is invalidated.

IV. Pilot Gender Question Used in Fall 2022

To address the shortcomings of the earlier gender question, it was necessary to develop a new question type in the Team-Maker interface – a question that allows a student to select one or more of a set of options and also to have the option of entering an identity not listed. With this new question type, a new question to collect gender identity was piloted in Fall 2022 in a first-year engineering class at a large, Midwestern, predominately white university.

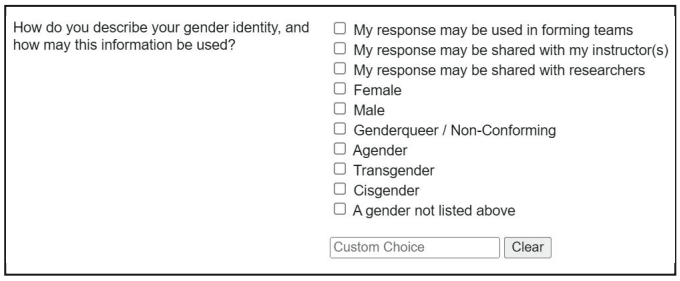

Fig. 2. Team-Maker gender question piloted in Fall 2022.

Based on the concern described earlier to give students agency regarding who they share their gender identity with, the pilot question gave students very precise control over how the data would be used. This level of control exceeded that specified in the Institutional Review Board protocol approved for the ethical treatment of human subjects' data collected using the CATME System, but was appropriate for this pilot study. Table I shows how students responded to the consent options (the first three check boxes in Fig. 2).

TABLE I. Consent Responses for Fall 2022 Gender Question

Number of instances	Consent responses		
	Team Formation	***Instructor view***	***Research Use***
1071	Y	Y	Y
113	Y	Y	N
3	Y	N	Y
49	Y	N	N
15	N	Y	Y
21	N	Y	N
1	N	N	Y
520	N	N	N

Full consent was the most common consent combination with 59.7% of the 1793 students allowing their responses to be seen by the instructor and used for team formation and research. The next most common response was complete non-consent, an option chosen by 29% of students. A total of 1236 students (68.9%) consented to have their response used for team formation, 1220 (68.0%) consented to have their instructor see their response, and 1090 (60.8%) consented to having their data used for research purposes. For the remainder of this discussion, we consider only the responses from those who consented for research use. The various response combinations are shown in Table II, with commas separating multiple selections.

TABLE II. Responses from Consenting Students

Number of instances	Response combination[a]
281	F
26	F,C
1	F,non-Hispanic white
1	F,Q
1	F,T
1	F,Thai
705	M
59	M,C
1	M,C,White!
1	M,Indian
2	M,Q
7	Q
1	Q,T
2	Researchers
1	X,Nonbinary

[a.] F=Female, M=Male, T=Transgender, C=Cisgender, Q = Genderqueer / Non-Conforming

The responses in Table II include 311 choosing "Female," of whom only two also identified as transgender or genderqueer / non-conforming. We anticipate that this likely means that the remaining 309 are cisgender females. Although a non-binary gender question format is preferred by both cisgender and gender-diverse samples, with gender-diverse individuals overwhelmingly—and not surprisingly—preferring this question format [13], only 26 (8.4%) of those identifying as female also identified as cisgender. This is consistent with cisnormative behavior, where identifying only using the binary (female or male) is considered sufficient [14]. Similarly, 768 respondents identified as Male, of whom only one identified as Transgender, and 60 of the remaining 767 (7.8%) explicitly identified as Cisgender.

Although some students were confused by the presentation of a fill-in option and filled in race/ethnicity information rather than gender, the number of instances where that occurred (four) was small, so we made no change to the question on that

basis. The consent process, however, was difficult to manage; three separate consent options created 8 consent combinations, and we decided that a new approach would be useful.

V. Team-Maker's Revised Gender Question

The only consent feature that was needed for the new question was to allow students to determine whether their instructor would see their response, because that has the potential to cause harm depending on the instructor. Using the data in team formation does not have the potential to cause harm because even in the event that the same criteria are used to form teams – even if the only criterion used to form teams is gender identity, Team-Maker's algorithm begins forming teams with a random team configuration, so the instructor would not be able to deduce a student's response from the resulting team configuration. For further details on Team-Maker's algorithm, see [5]. Research consent through the system is also not needed, because any research use of the data would need to have an approved IRB protocol that would either permit the instructor to collect the data without consent or the instructor would have to have student consent to view the student's response. Other uses of CATME data for research use the data after it has been deidentified. As a result, a new consent feature was developed in CATME that can be applied to any Team-Maker question. The "Choice" option (highlighted in Fig. 3) allows the student to determine if the instructor can see their response. The "Share" option does not present students with the consent choice, and the data are automatically shared with the instructor. The "Hide" option automatically hides the student response from the instructor – the student is informed that their response will not be shared. Student responses are not shared with teammates in any case.

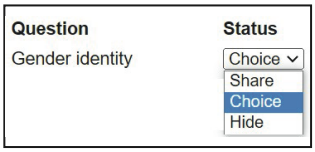

Fig. 3. New consent feature developed in Spring 2023.

Using this new consent feature, a new question to measure gender identity was developed based on our experience with the pilot in Fig. 2. The new question is shown in Fig. 4, with the consent option of "Choice" enabled and with the response set to share with the instructor by default.

Fig. 4. Team-Maker gender question used in Spring 2023.

The responses collected using the question in Fig. 4 are shown in Table III. For this work, we report the data that would be available to the instructor. A total of 1566 students were surveyed (one section did not participate), 18 students did not respond, and 196 students hid their response(s) from the instructor. A greater variety of responses was received, likely because consent defaulted to sharing the response(s) with the instructor and more responses were collected.

TABLE III. Responses to Spring 2023 Gender Question

Number of instances	Response combination[a]
358	F
14	C,F
8	A,F
2	X,F
2	Q,F
894	M
42	C,M
19	A,M
3	X,M
1	Q,M
2	T,M
1	C,A,M
1	C
1	A
1	Genderfluid,X,Q
3	Q
176	*hidden*
19	*hidden*,*hidden*
1	*hidden*,*hidden*,*hidden*

a. F=Female, M=Male, C=Cisgender, T=Transgender, Q = Genderqueer / Non-Conforming, A = Agender, X = An identity not listed, *hidden* = response not shared with instructor

As before, a large number of students identified exclusively using the binary "Female" and "Male" choices. Of the 384 students identifying as female, 12 also claimed one or more of the queer identities, while only 14 chose "Cisgendered" (3.8% of those choosing "Female" but not choosing a queer identity). Among the 962 students identifying as male, 26 also claimed one or more of the minority gender identities, and only 42 chose "Cisgendered" (4.5% of those choosing "Male" but not choosing a queer identity). Students responding as female or male alone or in combination with a cisgender identity accounted for the vast majority (84.5%) of responses. Students who chose not to share their response(s) accounted for another 12.7% of responses, so only 2.8% of respondents chose one or more of the minority gender identities. It is therefore possible that approximately 240 students would have been harmed by the earlier question (those sharing a minority gender identity and those who did not share their response). No students entered fill-in responses that suggested they were offended by the question, although that would not justify harming others.

VI. Team-Maker's Original Race/Ethnicity Question

Team-Maker's original race/ethnicity question, shown in Fig. 5, was typical of many instruments that have been used in research. Due to the limitations in Team-Maker's question types as mentioned earlier and due to the low representation of individual multi-racial combinations, this question's design is consistent, if problematic, with many other instruments by preventing participants from reporting a multiracial identity and by combining data from all multiracial subgroups together into a single category (here, "Other/Mixed-heritage") [15,16].

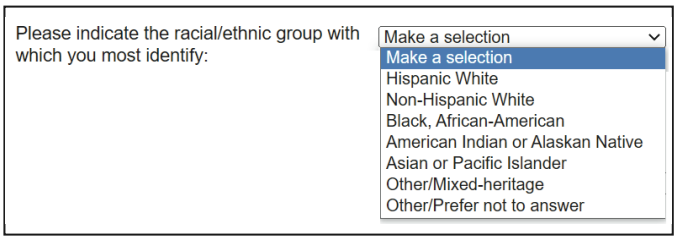

Fig. 5. Team-Maker race/ethnicity question used prior to Spring 2023.

Just as in the case of Team-Maker's earlier question measuring gender, this question both invalidates and others respondents who do not identify according to one of the choices. With the new question type and consent feature added in the process of improving the gender question, we embarked on updating Team-Maker's race/ethnicity question as well.

VII. Team-Maker's Revised Race/Ethnicity Questions

Fig. 6 shows the Spring 2023 implementation of the primary race/ethnicity question. Because race is socially and historically constructed [17], there is no internationally universal set of racial/ethnic groupings [18]. Nevertheless, an overwhelming majority of the usage of CATME and Team-Maker occurs in the United States, so the race/ethnicity choices have used the OMB-based groupings based on race in the U.S.

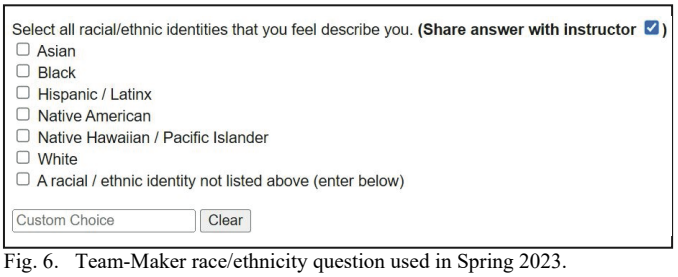

Fig. 6. Team-Maker race/ethnicity question used in Spring 2023.

Note that certain identity groupings, such as African-American and Asian-American, are not listed explicitly. Team-Maker has a separate question identifying international students, so the category "Black" is intended to include both domestic and international Black students. Each of these groupings masks further important differentiation. For example the category "Asian" includes both international students from Asia and Asian-Americans, and there is significant diversity among Asian-Americans – 1990 Census data identified 57 subgroups, the largest of which were Chinese Filipinos, Japanese, Asian Indians, Koreans, and Vietnamese [19]. There is similar variation within every other racial category, a legacy of the social construction of race.

TABLE IV. Responses to Spring 2023 Race/Ethnicity Question

Number of instances	Response combination[a]
273	A
3	B, A
17	B
63	H
5	H, A
1	H, B
1	H, W
1	NA
1	NH, A
838	W
50	W, A
6	W, B
1	W, B, A
49	W, H
2	W, H, A
1	W, H, B
3	W, NA
1	W, NH, A
5	X
1	Egyptian, W
3	Middle Eastern, X, W
1	Middle Eastern, Arab, X
5	Middle Eastern, X
4	Arab, X
1	persian, X
3	Indian, A, X
1	South Asian, X
1	SWANA/MENA(Middle Eastern), X
192	*hidden*
15	*hidden*, *hidden*

a. A=Asian, B=Black, H=Hispanic/Latinx, NA=Native American, NH = Native Hawaiian / Pacific Islander, W=White, X=A racial/ethnic identity not listed above [response shown if provided], *hidden* = response not shared with instructor

This reveals that there are 124 multiracial students who would have been forced to choose one of those more problematic categories, "Other/Mixed Heritage", or "Other/Prefer not to answer". A further 25 had an identity that was not listed and could not enter it in the previous version. Thus the earlier question would have led 149 respondents (11.1% of those sharing their response with the instructor) to experience othering or the microinvalidation of not being represented. The results also remind us that we should have included "Middle Eastern / North African" as a choice [20].

VIII. Comparing Fall 2022 and Spring 2023 Responses

It would be inappropriate to intentionally collect race/ethnicity data in a historically consistent way that would also cause harm to students due to othering or microinvalidation just to compare those data to the results using the new question design. In this case, however, the new question was introduced between the first and second course of a two-course sequence, so data were collected from the same group of students using both question designs. This allows us to compare the responses from students who responded to the race question the Fall 2022 survey and who shared their response with the instructor in the Spring 2023 survey. That comparison reveals that 69 students were specifically invalidated by the Fall 2022 survey question. Those included 4 minoritized students whose response did not include their minoritized identity and 40 whose response did not include their non-minoritized (Asian or White) identity, and 10 students with at least one minoritized identity and 15 students with no minoritized identity who chose to be othered rather than choosing a response that invalidated part of their identity.

IX. Spring 2023 Open-Ended Race/Ethnicity Question

To provide students further agency, including the ability to acknowledge the demographic subgroups mentioned earlier, we added a second fill-in question that would allow respondents to clarify their racial/ethnic identity in their own words. The resulting question is shown in Fig. 7.

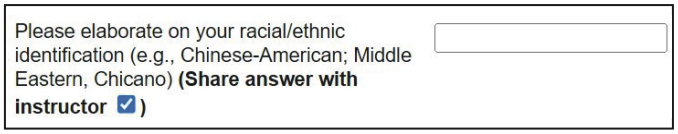

Fig. 7. Team-Maker fill-in race/ethnicity supplement from Spring 2023.

The results from this question show that many students took it quite seriously, with responses such as "4th generation Irish" and "CHN-JPN-VNM-Hawaiian". Conversely, many white students asserted their position as normative with 359 responses that were variations of "I'm just a white guy" and "Just plain white" and even "Very white". There were also U.S.-centric nationalistic responses such as "American" and related variations (142 responses). Only two students had what seemed to be facetious responses: "Taylor Swift, I think" and "whiter paper". No non-white students entered similarly dismissive responses. The more careful study of the entire corpus of fill-in responses is a subject for further study, and it is likely that the way that the instructor introduces the survey to students would considerably affect the quality of the responses received.

X. The Power of Defaults

The power of defaults to influence people to do things a particular way has been demonstrated in numerous environments [21,22]. Defaults in CATME have already been used to change user behavior. For example, a video designed to help users with login issues had been published [23], but had only been watched by a small number of users; most users with questions instead emailed the CATME support team to ask for help. In contrast, when the system was modified to suggest the user view the video in response to a failed login attempt, views of that video — "Logging in as a student user" on the CATME YouTube channel — soared; the video was watched more than 11,000 times in the month after the change. Making these new questions the default system questions will lead many to used the new questions without thinking – although any user can create their own question to measure gender and racial/ethnic identity (or use the old system questions during a grace period), using the new questions will require no additional effort.

XI. Conclusion

This study lays bare the scale of the issue – it quantifies how many students are misidentified due to the limitations of historical data collection practices, which causes harm and results in inaccurate data that are used in research. It does not assess the harm to each student. Due to students withholding consenting in the Fall 2022 gender identity question or withholding instructor visibility in the Spring 2023 gender identity and race/ethnicity questions, the exact number of students harmed by the earlier question versions cannot be precisely estimated, but the numbers are staggering when considering that over 338,000 students have responded to Team-Maker's earlier gender question and over 260,000 students have responded to the earlier race/ethnicity question.

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