Measuring team-member effectiveness in Australia and the United States

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Structured abstract

BACKGROUND
Following surveys and reports in Australia and the United States of America that indicate teamwork skill deficiencies in engineering graduates, engineering accreditation in both countries requires the development of teamwork skills as one of the outcomes of the bachelor's degree.

PURPOSE
The purpose of this research is to compare and contrast measurements of team member effectiveness collected in Australia and the United States of America using a common measurement instrument.

DESIGN/METHOD
The Comprehensive Assessment of Team-Member Effectiveness (CATME) was developed by US researchers, based primarily on a definition of teamwork published in US journals, and validated in multiple studies in US institutions of higher education. Nevertheless, the instrument has been used widely outside the United States. Team-member effectiveness data have been collected and released at hundreds of institutions in the United States of America, resulting in 3,364,989 ratings of a student at a US institution by another student at a US institution and 942,433 self-ratings. Three universities in Australia released de-identified data for research purposes, comprising 14,488 ratings of one student by another and 4,461 self-ratings. The ability to measure cultural differences is limited by the fact that institutions in both the Australia and the US enrol students from various countries and cultures, and no personally identifying information is available.

RESULTS
Cultural differences might be expected in what team member behaviours are desired, in how those behaviours are described in the measurement instrument, in the team member behaviours observed, and in how students respond to a peer evaluation instrument. Nevertheless, the pattern of ratings observed in the two countries is remarkably similar.

CONCLUSIONS
A variety of explanations for the observed similarity is discussed, and future research is suggested that would provide evidence to narrow the possible explanations. Measures of inter-rater agreement and results of team-based measures gathered in Australia and the United States of America such as interdependence, cohesion, conflict, and satisfaction may reveal differences that cannot be observed from the basic measures discussed here. Subsequently, this work will contribute to a more intentional research effort to seek a definition of teamwork that is more global and that is validated in a broader international context.

KEYWORDS
Teamwork assessment, global competency

Introduction

The need for the development of teamwork skills in engineering programs was a natural outgrowth of changes to the way engineering is practiced. This was highlighted in reports in the United States (ASEE 1996, ASEE 1987, NRC 1985) and Australia (IEAust 1996, Webster 2000) and led to changes to the criteria for accrediting engineering programs in both countries. Engineering accreditation in Australia and the United States requires the development of teamwork skills as one of the outcomes of the bachelor's degree. Specifically, accreditation by Engineers Australia includes the outcome "an ability to function as an individual and as a team leader and member in multi-disciplinary and multi-cultural teams" and the related outcome "an ability to communicate with the engineering team" (Engineers Australia, 2008). In the United States, ABET includes the criterion, "an ability to function on multidisciplinary teams" (Engineering Accreditation Commission 2012).

Measuring team-member effectiveness is important in the context of both assessing the outcomes above and adjusting team marks according to individual contributions to the team. The most common challenge in student teams is social loafing—when students exert less effort because they know that others on the team will compensate. In various literatures, social loafing is known by other terms such as hitchhiking, the passenger syndrome, and free-riding.

In the Australian engineering education literature, much of research related to teams is focused on problem-based learning, but there is some focus on the measurement of team-member effectiveness (Brodie 2008, Aravinthan, Fahey & Worden 2005, Willey & Gardner 2007, Wandel & Willey 2011, Willey & Gardner 2008a, Willey & Gardner 2008b). Early work in the area of measuring team skill development in engineering was conducted at RMIT by Brown developed an autorating system from a single-item rating behaviourally anchored rating system (Brown 1995). This work spurred a branch of literature in the United States (Kaufman, Felder & Fuller 2000, Ohland & Layton 2000, Ohland & Finelli 2001, Layton & Ohland 2000, Ohland, Layton, Loughry & Yuhasz 2005) that ultimately led to the development of the Comprehensive Assessment of Team-Member Effectiveness described here (Ohland et al. 2012).

A longer discussion of the literature on the importance and challenges of measuring team skills is provided in our earlier work and elsewhere (Ohland et al. 2012), but is not relevant to the present discussion. Here, we are concerned with the literature related to the ideal teamwork characteristics, actual behaviours, and peer evaluation behaviours of team members in Australia and in the United States—questions related to the culture of engineering, teamwork, and evaluation in those two countries.

Engineering Culture in Australia and the United States

Downey and Lucena (2005) have described how the culture of a society interacts with and shapes the culture of engineering within that society. They have developed extensive curricular materials to educate students about differences in the practice of engineering in different world cultures to give students a greater understanding of global engineering practice and to equip them with global competencies (GlobalHUB 2013). While modules have been developed exploring the history and culture of engineering practice in various countries, no module has been developed for Australia.

The culture of engineering has been described in gendered terms by many researchers (Godfrey & Parker 2010), so the place of women in society is relevant to understanding the culture of engineering. Tonso described how male engineering students in the United States engaged in behaviours that would be offensive to most women (and some men) in and out of the classroom (Tonso 1996, Tonso 2006).

Stevens and colleagues described engineering culture in terms of a lifestyle and a meritocracy of difficulty (Stevens, Amos, Jocuns & Garrison 2007). That work did not report

gender differences in the prevalence or impact of these cultural beliefs, but if we combine Dryburgh's (1999) finding (studying Canadian engineering students) that engineering students tend to exclude from tem activity those perceived to lack good technical skills with the experiences of women in engineering teams recounted by Tonso (1997), it seems that the cultural belief in a meritocracy of difficulty has a negative impact on the climate for women, particularly through the dynamic of working in teams.

Australia recognised women's rights ahead of the United States, with Australia granting women the right to vote and stand for election 1903 vs. 1920 in the US. Australia elected a female Prime Minister in 2010, whereas the United States has yet to elect a woman to its highest office. Based on this societal context, it might be expected that the climate for women in engineering in Australia would be better than the climate in the United States. Nevertheless, in a study contemporary with Tonso's work, McLean and colleagues observed similar behaviours among male engineering students in Australian classrooms (McLean, Lewis, Copeland, Lintern & O'Neill 1997, Lewis, McLean, Copeland & Lintern 1998). To the extent that the culture of engineering is gendered, therefore, there is no clear evidence as yet that suggests that the cultures in Australia and the United States are different in that sense.

Leonardi, Jackson, and Diwan (2009) studied engineering students in the United States and described a variety of cultural issues, some of which affecting how they work in teams. Many of their findings follow from the belief in a meritocracy of difficulty—if a student values the difficulty of engineering work as part of one's engineering identity, then even if that student recognizes that working collaboratively is an easier path to learning, collaboration is less desirable. It is not surprising therefore, that Leonardi and colleagues found that students prefer "Completing work alone" to avoid relying on others. This work practice is a challenge to team-based learning environments. Another of their findings, a student's preference for "Ensuring one's contribution stands out", also challenges collaboration as it discourages a true synthesis of the work of individuals, preferring a simple division of labour that is less well integrated, but makes it easier to identify the contribution of individual members.

In a study of engineering students in New Zealand, likely Australia's closest cultural neighbour, Godfrey and Parker (2010) identified six cultural dimensions of engineering: An Engineering Way of Thinking, An Engineering Way of Doing, Being an Engineer, Acceptance of Difference, Relationships, and Relationship to the Environment. Godfrey and Parker found similar issues of gender in the cultural discourse to those found in studies of engineering students in other countries. Godfrey and Parker reported that the longer-serving New Zealand faculty tended to believe that new faculty from Australia, Great Britain, and the United States had similar attitudes and values – in essence, a shared culture of engineering education. They found that diversity was least accepted when it challenged common notions of "Being an Engineer".

No definitive study could be found comparing and contrasting the culture of engineering in Australia and the United States. Based on these various studies conducted in a single national context, we have no cause to hypothesize that team behaviours and rating behaviours in Australia would be different from those in the United States. This work, therefore, will serve to generate questions for further study.

Methods

The Comprehensive Assessment of Team-Member Effectiveness (CATME) was developed by US researchers (CATME 2013a), based primarily on a definition of teamwork published in US journals (Loughry, Ohland & Moore 2007), and validated in multiple studies in US institutions of higher education (Loughry, Ohland & Moore 2007, Ohland et al. 2012). Nevertheless, the instrument has been used widely outside the United States (CATME 2013b). Team-member effectiveness data have been collected and released at hundreds of institutions in the United States of America, resulting in 3,364,989 ratings of a student at a US institution by another student at a US institution and 942,433 self-ratings.

Accounts to use the CATME system are free for academic use (CATME Project 2013) and at the time of publication had been granted to 32 academic staff affiliated with 12 Australian institutions (CATME 2013c). These 32 academic staff and the students they teach span academic disciplines, including engineering, management, organizational behaviour, health sciences. Two of the 32 academic staff using the system are affiliated with university teaching centres, and may be facilitating the use of the system in any class offered by the institution. For this study, the data from these multiple disciplines are pooled, because the characteristics of an effective team member in the extant literature transcend multiple disciplines and the instrument itself has been validated in the context of multiple disciplines.

Expectations of student privacy result from a complex combination of national and state laws, institutional policies and practices, and the personal preferences of academic staff. To accommodate this diversity of expectations, while the data collected for academic purposes all reside on a server at Purdue University, academic staff need not release those data for research purposes (CATME 2013d). Three universities in Australia released de-identified data for research purposes (Bond, Monash, and QUT), comprising 14,488 ratings of one student by another and 4,461 self-ratings. There are 15 academic staff using the system at these three universities, primarily affiliated with management, but also including one staff member affiliated with a university teaching centre, so it is likely that some of the students were enrolled in engineering and that some of the data were collected in engineering classes. This further level of detail is unavailable for the protection of student privacy, but is not needed for this initial study.

The ability to measure cultural differences in team expectations and behaviour is certainly limited by the fact that institutions in both the Australia and the US enrol students from various countries and cultures – so in neither case is the data collected from a homogeneous sample from a single country and culture. This limitation would serve to suppress the ability to measure any effect that might exist, with the average of any sample of mixed nationality and culture regressing toward the overall population mean. Again, no personally identifying information is available to control for this effect.

The CATME system can collect other peer-evaluation data (where each student provides a rating for each team member) as well as team-based measures (where each team member provides one rating of the team), this work focuses on the five primary peer evaluation categories. These five constructs are those that are included by default whenever a CATME survey is created and those that have been validated in multiple studies of use of the CATME system (Ohland et al. 2012). These five categories are (1) Contributing to the work of the team, (2) Interacting with teammates, (3) Keeping the team on track, (4) Expecting quality, and (5) Having related knowledge, skills, and abilities, and they are measured using a behaviourally anchored rating scale. For comparing rating distributions, each of the five behavioural levels of each category is converted to a numeric value from one to five.

Results

Table 1 shows a statistical summary of the ratings given by students of Australian and US universities. Pairs of columns allow comparison of the Australian and US statistical parameters. There is no need for statistical comparison using t-tests—there is no meaningful difference between the statistical parameters collected in Australian classrooms and those collected in US classrooms. This is particularly notable give that there is variation across the five behavioural categories and by rating target (others vs. self)—in both the Australian and the US data, the self-ratings are higher than the ratings of others and there is less variability in the self-ratings that is likely a result of range restriction since the mean self-rating is so high.

In noting the higher mean for self-ratings, it is tempting to believe that students are inflating their self-ratings in a self-serving attempt to achieve some academic advantage—in the eyes of the instructor and in any kind of grade adjustment that the instructor might make for

contributions to the team. Research shows that there is another likely explanation of the inflation of self-ratings. Kruger and Dunning (1999) found that unskilled people consistently overestimate their skill level, whereas skilled people consistently underestimate their abilities. Noting that many of the students using the system are novices with respect to their team skills, the phenomenon documented by Kruger and Dunning is sufficient to explain the consistently higher self-ratings.

Table 1: Statistical summary of ratings of students of Australian and US universities

Sample size AU: 14,488 ratings of others, 4,461 self-ratings US: 3,364,989 ratings of others, 942,433 self-ratings	Mean rating of other team members		Standard deviation of ratings of other team members		Mean of self-ratings		Standard deviation of self-ratings	
Rating category	**AU**	**US**	**AU**	**US**	**AU**	**US**	**AU**	**US**
Contributing to the work of the team	4.10	4.12	0.99	0.97	4.30	4.33	0.76	0.70
Interacting with teammates	4.19	4.17	0.90	0.91	4.40	4.37	0.71	0.68
Keeping the team on track	4.06	4.07	0.98	0.96	4.30	4.30	0.76	0.72
Expecting quality	4.15	4.16	0.89	0.91	4.31	4.33	0.75	0.71
Having related knowledge, skills, and abilities	4.24	4.24	0.87	0.88	4.37	4.39	0.73	0.69

It is possible for two datasets to have similar statistical parameters, but to have different distributional characteristics (Anscombe 1973), so Table 2 shows the detailed ratings distribution for each category and rating target. Although many of the observable differences will be statistically significant due to the large sample sizes, these differences do not indicate any variability in the characteristic rating distribution and are of no practical significance.

Table 2: Detailed ratings distribution of students of Australian and US universities

		Per cent of students choosing each rating (number assigned to behavioural description)				
Rating category	**Rating target**	**1**	**2**	**3**	**4**	**5**
Contributing to the work of the team	AU other	2	5	17	32	44
	US other	3	4	14	37	42
	AU self	0	1	14	37	47
	US self	0	1	10	43	45
Interacting with Teammates	AU other	1	4	16	34	45
	US other	2	4	14	39	42
	AU self	0	1	11	35	53
	US self	0	1	10	42	48
Keeping the Team on Track	AU other	2	6	17	35	41
	US other	3	4	15	40	39
	AU self	0	1	15	37	47
	US self	0	1	12	43	44
Expecting Quality	AU other	1	4	18	35	43
	US other	2	3	15	38	42
	AU self	0	1	15	36	48
	US self	0	1	12	41	47
Having Related Knowledge, Skills, and Abilities	AU other	1	3	14	34	47
	US other	2	3	12	37	46
	AU self	0	1	13	34	52
	US self	0	1	10	40	50

Conclusions

Differences in the rating behaviours of students of universities in Australia and the United States could accrue based on cultural differences in (1) conceptions of appropriate team behaviour, (2) interpretations of the behaviourally anchored rating scale used to measure team-member effectiveness, and (3) biases in assigning ratings. Nevertheless, there is high congruence in the rating patterns of students of Australian and US institutions. One explanation of this congruence is that the cultural difference between Australia and the United States along these three spectra is minimal. This would be consistent with the lack of any differentiation in the culture of engineering based on the available literature. Other explanations are possible, however.

An alternate explanation of the congruent rating pattern would be that the CATME instrument does not measure team-member effectiveness, but rather measures some other construct that has no cross-cultural variability between Australia and the United States. The validation of the instrument in prior studies including concurrent validity with other measures of team-member effectiveness suggests that this is not the case (Ohland et al. 2012).

A more positive alternative explanation would be that the development of the CATME peer evaluation instrument serendipitously resulted in a measure that is cross-culturally valid, at least in the cultures of Australia and the United States. Although the aggregate distributions are highly congruent, it is possible that there are cross-cultural differences in ratings by gender and/or ethnicity, but demographic data are unavailable to protect student privacy.

Future research is needed to narrow the possible explanations of the observed congruence. Further study of quantitative data in the CATME system is possible, including multilevel measures of inter-rater agreement and other parameters as well as the data gathered on team-based measures such as interdependence, cohesion, conflict, and satisfaction, and study of those additional data may reveal differences that cannot be observed from the basic measures discussed here.

The continuation of this work is expected to contribute to a more intentional research effort to seek an understanding of teamwork recognizes cultural differences. Only a careful mixed-methods study is likely to provide a clear understanding of differences between the desired team behaviours in Australia and those in the United States.

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