Ethical Climate in Multidisciplinary Teams: Development of the TECS

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Abstract

One way to empirically evaluate team ethics is through ethical climate, which is defined as the procedures, policies, and practices in regard to moral or ethical concerns seen in the workplace. Peers and supervisors may influence individuals' perceptions of ethics and moral situations, which will lead to a shared understanding of how the group should think about moral situations. The current researchers adapted the concept of ethical climate and brought it to interdisciplinary student teams. Teams on lengthy projects often face ethical problems, and the researchers developed a tool to address some of the unique considerations for ethics in interdisciplinary teams. Researchers developed the Team Ethical Climate Survey (TECS) to measure student team ethical climate. This instrument was adapted in part from the Ethical Climate Questionnaire, which includes scales of team interest, laws and codes, personal morality, rules and procedures, and self-interest scales. Authors also included care, interdisciplinary professional ethics, dealing with adversity, and shared decision-making scales. This paper presents the results of research to date on the ethics component of a collaborative effort involving team-based project programs at four universities funded by NSF under a Transforming Undergraduate Education in Science (TUES) Phase 2 grant.

The following paper discusses the development of the TECS scale for interdisciplinary teams. More specifically, it focuses on an exploratory factor analysis conducted on TECS data in order to determine if the developed test scales emerged as factors with the student data. The data were collected for 521 undergraduate students involved with long-term (semester length or longer) interdisciplinary team projects. The TECS was administered at the midpoint of the semester. Results indicated that five factors emerged: team interest (alpha=.91), self-interest (alpha=.79), personal morality (alpha=.55), discussion of issues (alpha=.74), and differences in values (alpha=.71). The authors suggest future developments for the TECS and its use in the classroom. Additional findings and insights of interest are explored, and implications for engineering faculty and professionals are provided.

Key Words: ethics, interdisciplinary teams, engineering education, STEM, assessment, test development

Introduction

Since the Accreditation Board of Engineering and Technology (ABET) called for a greater emphasis on engineering ethics education[1], researchers, and teaching professionals have incorporated applied ethics into the engineering curriculum.[2] Typical ethical interventions incorporated into the engineering curriculum include using ethical frameworks, case studies, engineering ethical codes, philosophical writings, service learning activities, online ethics tutorials, and lectures on moral philosophy.[3] These interventions tend to put most of the emphasis on teaching the pedagogy and neglect the long-term practical application. Moreover, most of the work on applied ethics has focused on individual level development.[4] Little attention has been paid to how students think about ethics and make decisions at a team level. This lack of emphasis on different levels of ethical understanding may not be reflective of how applied ethics are used in real life situations.

Creating assessments for engineering ethics has presented a significant challenge. Assessments are often created for single interventions and cannot be applied consistently across the curriculum.[5] Little research has focused on how to effectively assess ethical interventions in the engineering curriculum. Furthermore, there has been no emphasis on assessing ethics at the team level in engineering or multidisciplinary teams. The goal of the present research is to enhance the research on interdisciplinary team ethics and advance the measurement and utility of team ethics in the classroom to prepare engineering students for the real world.

Measuring Team Ethics

Many college courses require students to work on short term or long term project teams. Engineering is no exception, and ABET has required the engineering curriculum to improve interdisciplinary team learning. As a result, more engineering and STEM courses have increasingly included team projects.[6] With team projects comes the unique issue of team level ethics. Individuals do not make decisions in a vacuum, and their ethical considerations may be influenced by team members, support from team leaders or supervisors, and other factors.[7] Individuals also bring in their previous moral backgrounds and sensibilities, and these individual influences may interact to shape the ethical climate that develops in the team.

One way to measure ethics at the team level is through ethical climate. Ethical climate is a type of work climate that looks at the extent to which teams, departments, or whole organizations think about ethical issues (e.g. what are the implications of building a bridge outside a municipal zone).[8] Ethical climate has been measured at departmental or the organizational level in past research.[9] Ethical climate is influenced by organizational policies, support from management, informal attitudes about ethical behaviors, and other factors. Potential outcomes include ethical outcomes (e.g. ethical behavior, engaging in helping behaviors), dysfunctional outcomes (e.g. turnover, misreporting behaviors), organizational commitment, and satisfaction (e.g. job, team, department).[10]

One of the more widely used measures of ethical climate is the Ethical Climate Questionnaire (ECQ) developed by Victor and Cullen.[9] In the Victor and Cullen theory of ethical climate, each ethical climate type, or ways of thinking about the ethical issue at hand, is based on levels of analysis (individual level, the organization, or society) and the type of ethical consideration used. Being an applied ethical model, egoism, benevolence, and principle ethics are included.[9] Past researchers have found five consistent ethical climate types.[11-12] These include instrumentality, benevolence, independence, rules, and laws and codes (see Table 1). Employees can use multiple ethical climates in decision-making. Measures of ethical climate emphasize that certain climate types are relevant in different contexts (i.e. ethical problem occurs internally in the team, the issue relates to laws).[13]

Most of the past research on ethical climate has been based in organizational research. However, it has some potential use in researching teams. Teams may develop a set of rituals, practices, a shared language and ways of cohesive thinking similar to an organizational department. The Ethical Climate Questionnaire has been tested on undergraduate teams with mixed success.[14] However, it is possible that the ECQ is missing questions about fundamental interdisciplinary

team issues, such as questions relating to sharing different perspectives from individuals' fields or majors. Therefore, a new measure was created to expand the climate types to include those potential team climate types.

Table 1

Ethical Climate types supported by past research

	Individual	**Local**	**Cosmopolitan**
Egosim	Instrumentality		
Benevolence	Benevolence		
Principle	Personal Morality	Rules	Laws and Codes

The present researchers created a tool for assessing ethical climate in interdisciplinary project teams. The Team Ethical Climate Scale (TECS) incorporated the five validated climate types observed in past research and supplemented them with four climate types that may be unique to interdisciplinary teams. New test items were written based on the ECQ scales self-interest, benevolence (or team interest), laws and codes, personal morality, and rules and procedures. The four scales unique to teams included: care, interdisciplinary professional ethics, dealing with adversity, and shared decision-making scales. The TECS instrument was given to student teams to measure the number and nature of the scales that emerged in the data collection.

Table 2

TECS Subscale Definitions and Sample Items

Scale Name	**Definition and Sample**
Friendship/Team Interest	Definition: make decisions based on what is best for the team's interests *Sample item:* my team shares a common understanding of "right and wrong."
Laws and Codes	Definition: put emphasis on laws and codes when making ethical considerations *Sample item*: only rarely does my team discuss how laws or codes apply to our project.
Personal Morality	Definition: consider ethical issues from an individual's moral codes *Sample item:* even though I am part of a team, I decide for myself what is ethical.
Rules and Procedures	Definition: emphasis on making ethical decisions based on rules set by the program or school *Sample item:* sometimes a team has to do things that bend the rules
Self-Interest	Definition: consideration of self before the team or community *Sample item:* people in my team mainly put themselves before the team.

Care	Definition: team interdependence, comprehension of situational context, and not exploiting vulnerable communities or stakeholders *Sample item:* my team thinks about what impact our work will have on the community at large
Interdisciplinary Professional Ethics	Definition: individuals bring in the ethics of their profession/ major to the team discussions *Sample item:* on my team, we believe that every student can bring a unique perspective when making ethical decisions
Dealing with Adversity	Definition: how the team makes decisions under stressful situations *Sample item:* When the project is behind schedule, we sometimes make decisions without thinking them through completely.

Method

The sample consisted of undergraduate students (*N*=521) from three mid-size Midwestern and East coast universities. At the time of data collection, the students at each institution were participating in a team-based semester-long class in which each team planned and executed an applied project. The course at School 1 (*n*=406) consisted primarily of engineering students (with different engineering specifications). The classes in School 2 (*n*=66) and School 3 (*n*=49) included interdisciplinary teams that primarily drew upon STEM fields. Participants included first year undergraduates (*n*=147), second years (*n*=92), third years (*n*=86), fourth years (*n*=183) and students from other years (*n*=13).

The participants were directed to complete an online survey on the Qualtrics website by their instructors or through a general recruitment email from the researchers. Participants were instructed to answer general demographic information, such as major, school attended, years in school, and the number of semesters taking the multidisciplinary project course. The next step included a small battery of ethics surveys including the TECS. The participants filled out the survey outside of class. An incentive for participation in one school was entrance into a raffle to earn a small cash prize. The other schools did not offer an additional incentive.

The current version of the TECS has 62 total items over nine ethical dimensions including: Friendship, Laws and Codes, Personal Morality, Rules and Procedures, Self-Interest, Team Interest, Caring, Interdisciplinary Ethics, and Adversity. Table 2 provides a definition and sample question for each ethical dimension of the TECS. For a complete list of the items, see Appendix 1.

An exploratory factor analysis (EFA) was used to measure the ethical climate as perceived by the student team participants. EFA is a statistical technique used to reduce a large number of variables (i.e. items) into a smaller number of meaningful categories or dimensions, which are referred to as factors. It is a commonly used tool for test development.[15] In order to do an initial evaluation of the factor analysis, an unrotated factor solution was examine the scree plot, the

number of eigenvalues over one, and the proportion of variance. The researcher can look at the Kaiser Criterion, which states that eigenvalues greater than 1 are unique factors. However, the eigenvalue over 1 criteria is a general, somewhat arbitrary, rule of thumb and needs to be considered along with additional information in order to be interpreted accurately.[15] The scree plot is a graphical depiction of each eigenvalue. One interprets the scree plot by drawing a line through the place of the plot where the values flatten out, and counting the number of factors above the line. This gives the researcher a rough estimate of the potential number of factors.

After the researcher has found an initial solution, one can generate and interpret a number of alternative solutions in order to find an ideal solution. When interpreting the EFA, the researcher looks at each solution to see that all variables are represented, there are meaningful rather than random components, and each component has clean loadings. One may interpret the factor loadings with Thurstone's three rules for simple structure. There are multiple solutions that can explain the data equally well, so the researcher needs to choose the solution that is easiest to interpret. Thurstone stated that when evaluating the data pattern, the researcher should ensure that any column should have a few large loadings and the rest close to zero, any row should have one large loading and the rest close to zero, and any two columns should have different patterns of high and low loadings.[16]

After the initial solution has been examined, the researcher specifies the number of factors to rotate. The researcher can interpret the number of factors by examining the data. The data may suggest that there are a specific number of factors in a solution, but this needs to be theoretically interpretable. If the solution does not make sense, another solution may provide a better fit. There may be multiple solutions that are potentially plausible. Because of these issues, several factor solutions are examined in order to ensure that the final factor solution chosen is appropriate based on empirical and theoretical consideration.

Results

An EFA was run with the Maximum Likelihood Extraction method with Promax rotation in SPSS v.20. Maximum likelihood was used because of the large sample size. The initial EFA showed 12 potential unique dimensions with eigenvalues over 1.00. This indicated that there were 12 potential ethical climate factors. However, the scree plot showed fewer potential dimensions (see figure 1). The twelve potential (1 factor solution-12 factor solution) solutions were extracted and rotated in order to be interpreted. Each solution was evaluated with the criteria from Thurstone's three rules for simple structure.

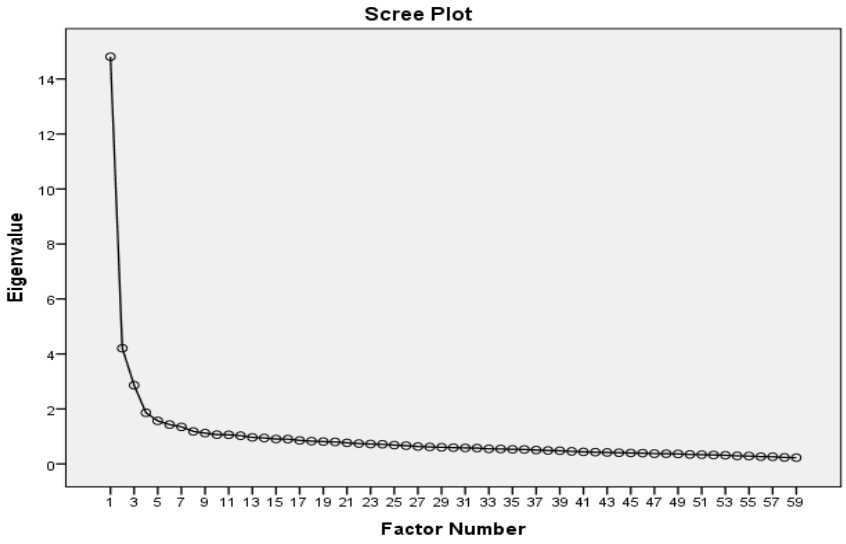

Figure 1. Exploratory Factor Analysis Scree Plot

After each rotated solution was run, the analysis were interpreted in order to find the best solution. The pattern matrix in each solution was interpreted because the factors were correlated. The pattern matrix provides the partial correlations between a variable and each factor controlling for other factors, resulting in the unique correlations. The rotated solution, as shown in Appendix 1, yielded five interpretable factors. The solutions with 6-12 factors were not ideal because they generated factors with one item or two items, the items loaded onto one main factor, or the factors that emerged had no theoretical or logical linking. For example, several solutions produced factors in which a number of conceptually disparate items were linked together. Solutions with 1-4 factors lumped together a large amount of information, and the factors are not distinguishable. In the chosen five-factor solution, team interest accounted for 25.10% of the item variance. Self-interest accounted for 7.13% of the item variance. Discussion of issues accounted for 4.85% of the item variance. Differences in values accounted for 3.16% of the variance. Personal morality accounted for 2.65% of the variance. The total variance explained by the five factor solution accounted for 42.89%. Cronbach's reliability estimates are reported in Table 3.

Table 3

Reliability estimates for each TECS dimension

Scale	# Items	Alpha
Overall	59	0.91
Team Interest	11	0.79
Self-Interest	9	0.83
Discussion of Issues	7	0.74
Differences in Values	5	0.71
Personal Morality	3	0.55

Discussion

The present study provides initial evidence that ethical climate is relevant to undergraduate interdisciplinary project teams. We reported on a new survey tailored to measure the potential ethical considerations of interdisciplinary student teams. We were interested in categorizing the ethical concepts that students value as most important when they make decisions. Although this instrument is still being refined, we were able to see some of the ways that students in teams think about ethics. The students did not use all the ethical climate types as predicted by the researchers, but some different climate types emerged. The personal morality climate was the same as predicted in the TECS scale. Likewise, team interest is similar to the friendship/team interest scale. The self-interest scale finding is similar to the ECQ self-interest/egoism self-interest climate type. The other two scales: discussion of issues and differences in values were unexpected findings. The items relating to the process of teams talking about the moral problems that are occurring or may occur were put into this category (e.g. "On my team we talk about how we make ethical decisions"). Likewise, the differences in values factor came about because items about disparate ideas about appropriate ethical behaviors (e.g. "Sometimes our different moral standards cause disagreements in my team") were clustered together. This may have been found because students may not have a sophisticated understanding of ethical principles or moral underpinning and are instead categorizing items based on the process of making ethical considerations. Another interesting finding is that there were no factors based on rules, laws, or codes. Personal morality was the only distinguishable moral principle category.

Additionally, Cronbach's reliability estimates were found for each of the five TECS factors. The overall test reliability was high (α=91). All but one of the scales had alpha values over the acceptable level of .70. The personal morality scale had a low value (α=.55), but it is possible that the value was so low because only three items loaded onto that scale in the EFA. The researchers wrote four new items to the personal morality scale of the TECS in order to improve the scale for future use.

One of the greatest challenges in measuring ethical climate is to measure intact team data. So far the researchers have obtained responses from a small percentage of team members in each project team. While this can provide the researchers will a base level of information about how students generally consider the issue, it is more reflective of psychological climate (the perceptions of an individual about the ethical climate) rather than a formed team level ethical climate. By getting data from a larger percentage of the teams, future researchers will better be able to determine the climate types that are important for teams.

Conclusion

One insight generated during this project include practical uses for the TECS. The TECS was created as a diagnostic tool to be used to determine which types of ethical climate are most important to specific teams. However, a second use emerged throughout the research project. The TECS may also be used as a part of the educational process. Instructors can use the TECS in the class to enhance learning by having students go through the TECS in teams and discuss how the questions apply to their team projects. Are they discussing the issues? Are people

hesitant to ask questions? Do they tend to use their personal moral beliefs? How cohesive do they think they are? Can they come together more often to think about the consequences of their actions? These are a few potential discussion questions that can be explored as a team.

The TECS is still in development. The current researchers have added four items to the instrument and plan to administer the revised version in the next testing cycle. Additionally, the researchers have developed a short form of the TECS to be administered. A shorter form may be more practical to administer at multiple points during a project cycle because it takes a short amount of time to complete. The researchers plan to gather more team level data in order to more effectively measure the instrument. Future researchers may give the instrument to engineering professionals to see which ethical climates emerge and see which climate dimensions are more relevant to experts. Engineering education needs to think beyond individual ethical reasoning. Ethical climate is one way in which the moral considerations of teams can be assessed.

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Appendix 1

Exploratory factor analysis of TECS

Exploratory Factor Analysis of TECS					
	Factor				
	Team Interest	Self Interest	Discussion	Value Differences	Personal Morality
TECS 1: One of the great things about my team is that I really like my team members.	.83	-.08	-.07	.02	-.14
TECS 11: My team follows state and federal laws.	.25	.03	-.04	.29	.29
TECS 12: Professional standards are very important for my team.	.31	-.01	.35	.05	-.02
TECS 14: Only rarely does my team discuss how laws or codes apply to our project.	-.27	.33	.52	.03	-.19
TECS 19: On my team, people are constantly thinking about whether a decision violates the law.	.02	.01	.51	-.14	-.05
TECS 2: My teammates and I watch each others' backs.	.55	-.05	.09	.11	.10
TECS 20: When making decisions, members discuss how things are done based on their professional code.	.11	-.09	.50	.06	-.01
TECS 23: My team members make decisions based on their own personal moral beliefs.	-.01	-.02	-.02	-.35	.50
TECS 25: Even though I am part of a team, I decide for myself what is ethical.	-.02	-.15	-.13	.04	.38
TECS 26: My ethical principles are more honed than the team's principles.	-.08	-.17	.11	-.25	.21
TECS 27: I believe in following my own moral principles when I am part of a team.	.19	.09	-.16	-.33	.58
TECS 28: My team allows people to make decisions based on what he or she thinks is right or wrong.	.23	-.26	-.06	.11	.24
TECS 30: On my team, we decide what to do based on rules set by my school.	.21	-.22	.20	.25	.11
TECS 32: People on my team follow a common set of rules in getting things done.	.49	-.12	.18	.15	-.08

TECS 33: On my team, everyone seems to be following their own set of rules.	.08	.62	-.06	-.13	-.02
TECS 37: My team members are all out for themselves.	-.35	-.51	.15	-.05	.01
TECS 38: I expect most people on my team to look after themselves first.	.11	-.64	-.07	.18	.03
TECS 39: Most people on my team think of everyone's issues before their own.	-.45	-.04	-.05	.28	-.01
TECS 4: My team is unfriendly and uninviting.	.34	.12	-.12	.44	-.13
TECS 40: People in my team mainly put themselves before the team.	-.33	-.41	.11	-.18	.23
TECS 41: People in my team are more concerned with their personal goals than with the team's goals.	-.34	-.27	.04	-.22	.28
TECS 42: On my team, each person decides what is ethical.	.01	-.23	.02	-.10	.29
TECS 43: On my team, I make decisions based on what is best for me.	-.06	-.66	.01	.21	.04
TECS 45: On my team, people are motivated by their self-interests first then by the interests of others.	-.21	-.38	.07	-.09	.20
TECS 46: I can count on my team members to put team interests above their own.	.80	.14	.05	-.32	-.06
TECS 47: Most of my team members are not committed to team success.	.35	.26	-.07	.27	-.11
TECS 48: My team is focused on what is best for the team as a whole.	.67	-.08	.06	-.01	-.03
TECS 5: People in my team seem to genuinely care about their team members.	.89	.04	-.01	-.17	-.03
TECS 51: People on my team would look the other way if they thought something was improper.	.11	-.66	.04	-.03	-.25
TECS 52: My team doesn't spend much time discussing the morality of any of our choices.	-.11	.24	.64	-.10	-.32
TECS 53: Most people on my team wouldn't speak up if the group was making a decision that was wrong.	-.05	.11	.03	.54	-.11
TECS 54: My team shares a common understanding of “right and wrong.”	.41	-.10	.15	.23	.05
TECS 55? My team has a lot of different ideas about to approach moral issues.	.25	-.16	.31	-.36	-.04
TECS 6: When needed, my team members are willing to back each other up.	.39	-.07	.04	.38	.08
TECS 61: My team thinks about what impact our work will have on the community at large.	.15	.25	.32	-.06	.12
TECS 62: On my team, we listen to each other when we need to make decisions about moral issues.	.33	-.03	.23	.15	.09
TECS 63: We can bring our issues to the team and make a decision together.	.55	.17	-.01	-.05	.27
TECS 64: We talk about the ethical issues from the perspective of our majors.	.04	-.16	.58	-.12	-.04
TECS 65: We use the ethical codes from our different fields of study when making decisions.	-.01	-.02	.53	.02	.12
TECS 66: On my team, we believe that every student can bring a unique perspective when making ethical decisions.	.37	-.03	.32	.04	.08

TECS 67: A few people on the team decide the right thing to do.	.14	.33	.04	.13	-.17
TECS 68: When the project suffers from any sort of set back, we still make an ethical decision.	.25	.13	.03	.16	.25
TECS 69: Sometimes there is not enough time to think about the moral consequences of our actions.	-.27	.56	.17	.24	.07
TECS 7: On my team, we talk about how to make ethical decisions.	.13	-.14	.81	-.14	-.33
TECS 70: When something on the project goes wrong, we still do the right thing.	.24	.30	.12	.05	.33
TECS 71: My team takes morality seriously.	.25	.13	.25	.12	.06
TECS 72: My team members and I disagree on a lot of important decisions.	-.15	-.44	.09	-.12	.03
TECS 73: We understand why the rules are in place.	.30	-.01	.20	.16	.16
TECS 74: Helping those who are less fortunate is a major goal of our project.	.14	.01	.38	-.15	-.01
TECS 75: We depend on one another to accomplish our goals.	.62	.04	-.11	-.10	.10
TECS 76: We consider the context of the situation when we are dealing with ethical issues.	.03	.12	.56	.01	.06
TECS 77: When the project is behind schedule, we sometimes make decisions without thinking them through completely.	.08	-.40	-.18	-.30	.15
TECS 79: Cheating is a problem on my team.	-.05	.04	.14	-.69	.02
TECS 8: On my team, we decide together what actions to take.	.78	.04	-.07	-.03	.08
TECS 80 Sometimes our different moral standards cause disagreements in my team.	.07	-.07	.18	-.68	.14
TECS 81: Sometimes my team has to bend the rules to get things done.	-.14	.43	.01	.39	.01
TECS 82: My team members and I share a common set of moral values.	.36	-.16	.21	.33	-.05
TECS 83: I sometimes have trouble understanding my team members' thinking about the ethical issues we face.	-.05	-.04	.07	-.64	.20
TECS 84: My team members and I have important differences in our moral values.	.07	.11	.04	-.68	.22
Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization.					
a. Rotation converged in 10 iterations.					