BUILDING INTERDISCIPLINARY TEAMS THROUGH STUDENT DESIGN COMPETITIONS: A CASE STUDY

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ABSTRACT

The owner, architecture, engineering, and construction (OAEC) industries have grown increasingly complex, necessitating improvements to both design and construction procedures—requiring increased collaboration among all lean stakeholders. However, universities are often criticized for not developing essential, generic skills in their graduates, especially the ability to work collaboratively in teams. Attempting to better prepare students, academic institutions are creating vehicles to help their students acquire effective teamwork skills. Competitions, for example, have spread to almost every discipline, including the OAEC-related ones, since they have much to offer students of the built environment. The researchers assessed the participants' experience of an interdisciplinary design competition to determine if such competitions are an effective means to impart teamwork skills to future collaborative stakeholders of the built environment. Additionally, this research aimed to identify areas where educators should prioritize their efforts to better prepare students for enhanced teamwork performance. In addition to highlighting that teams should be appropriately composed of members with critical, needed skill sets, results from a post-event survey of the case study competition also suggest there is a need to teach students how to develop clear and shared goals, develop clear and understandable roles, and communicate more effectively when working in teams.

KEYWORDS

Teamwork, collaboration, OAEC / AECO, interdisciplinary competition, Lean Integrated Product Delivery / Lean IPD

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INTRODUCTION

COMPETITIONS AND THE OAEC INDUSTRY

In the owner, architecture, engineering, and construction (OAEC) [3] industries, interdisciplinary project delivery (IPD) contracts are becoming the norm. The educational approaches for these disciplines, however, have been slow to embrace this transition to a more collaborative structure (Irizarry et al., 2010). Gusmao Brissi et al. (2019) argue that changes in the education of students in the stakeholder fields offer a way to enhance collaboration in the OAEC industry. Arguably, students in these disciplines should be exposed to an education that provides the type of collaborative mindset needed for their future careers. For example, in recent years, builders and building management companies have become increasingly interested in approaches to improve quality, to reduce project risk, and to reduce conflict and waste, despite potentially high upfront costs (Nguyen and Akhavian 2019). A review of the literature suggests that Lean-Integrated Project Delivery (IPD) is an effective approach because it involves key stakeholders through mutually developed goals and shared decision-making at a very early stage in the project timeline (El Asmar et al., 2013). Lean-IPD aims to enhance project outcomes by aligning the incentives and goals of the team. It is therefore likely that teaching collaborative decision-making can improve time, cost, quality, safety, and stakeholder morale on construction projects (Kulkarni et al., 2012; Rybkowski et al., 2013).

Competition in academia has spread to almost every disciplinary field. Research has shown that competitions have much to offer to students and should be adopted by academia (Verhoeff, 1997). Guilherme (2014) argues that "competitions, in particular international competitions, test [an] architect's capacities beyond controlled systems of social relations, comfort zones, age, gender or even expertise, in a fast sublimation process, as well as induce a recognition and publicity that surpasses the investments in time, energy and financial resources..." (p. 433). Haupt et al. (2019) concluded that "teaching a design studio based on [an] architectural competition assignment shows that entering a prestigious event is a great motivation for students to undertake more difficult tasks, as well as to bring them to a successful end" (p. 342).

It stands to reason then, that interdisciplinary competitions can offer a similar opportunity to jump-start students' understanding of the need for collaborative skills, as well as respect for their partnering stakeholders on a project.

TEAMWORK

Why are certain teams successful while others are not? What attributes are required for success? Research has indicated that the existence of some key attributes is vital to successful teamwork. Tarricone and Luca (2002) concluded that there is a strong correlation between adopting some key traits by team members and how successfully they perform in terms of collaboration and developing a quality product. Strong teams do not form by accident. Team building can improve team performance in a long-term, positive, and measurable way (Land, 2019). One of the most important aspects of a team, according to the literature, is its emphasis on a single objective and a defined purpose. Furthermore, the primary disciplines historically associated with building ownership, architecture,

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[3] While the acronym AECO is sometimes used to describe the architecture, engineering, construction, and owner stakeholders, this paper instead uses OAEC to emphasize that it is the *owner's* "Conditions of Satisfaction" (CoS) that should be prioritized during the project design and delivery process, in keeping with lean construction philosophy and principles.

engineering, and construction have recently undergone significant adjustments to adapt to new processes and demands in the industry. Because these professions should be working toward a shared objective of delivering a completed built structure, communication between architects, engineers, and construction managers is necessary (Gusmao Brissi et al., 2019). Several characteristics that are required for successful teamwork have been identified through a literature review. Many of these characteristics have been observed repeatedly. Table 1 summarizes the literature on elements essential for effective teamwork.

In reality, each team is unique and faces its own challenges. Not all perform as successfully as planned, and of course, teams can also fail. Researchers have observed a variety of factors that can lead to unsuccessful teamwork: *lack of clear purpose and goals, lack of effective leadership, lack of trust, poor communication,* and *unclear roles or insufficient skill*s (Parisi-Carew, n.d.; Maldonado, 2015; Eckfeldt, 2017). While the list of characteristics that lead to failed teamwork appears to primarily represent an antithesis of attributes that lead to success, there is one notable exception. For example, although trust was not explicitly mentioned by the authors cited in Table 1 as a critical factor for effective teamwork, *lack* of trust has been cited by others as one cause for *in*effective teamwork (Maldonado 2015; Parisi-Carew 2015; Wanamaker 2018).

Table 1: Key Attributes for effective teamwork

Author	EC	ATC	EL	RA	CUR	CSG	I
Azmy 2012	×		×		×		
Bannister et al. 2014	×	×		×		×	×
Fapohunda 2013			×	×		×	
Fisher et al. 1997						×	
Holland et al. 2000	×	×	×		×		
Katzenbach and Smith 1993		×				×	
Khoshtale and Mahdavi Adeli 2016					×		
Kline et al. 1996	×		×			×	
Mickan and Rodger 2000	×		×	×		×	
Setiawan and Erdogan 2018			×	×			
Sohmen 2013			×				
Svalestuen et al. 2015		×					
Szewc 2014	×		×				
Tarricone and Luca 2002	×	×		×		×	×
Yusuf 2012	×						

EC, *effective communication*; ATC, *appropriate team composition*; EL, *effective leadership*; RA, *responsibility and accountability*; CUR, *clear and understandable roles*; CSG, *clear and shared goals*; I, *interdependence*

Extant literature reveals that few studies had been conducted to identify a competition's full impact on the students participating in these competitions. Although some studies have been conducted regarding the importance of design competitions to the OAEC disciplines, most existing research does not identify the attributes that are critical for teams to win—or lose—a collaborative design competition. These elements are helpful to know because student design competitions can arguably serve as a proxy for stakeholder collaborations in the professional world. In addition, these attributes can help institutions identify the areas on which they should focus efforts in order to prime a more sophisticated future workforce by offering appropriate training in their curriculum. The

success or failure of a project in the "real world" is likely built on collaborative skills that are formed when OAEC professionals are still students at universities. The intent of this research is to analyze competitors' experiences immediately following participation in a university-level interdisciplinary design competition. The research will probe an interdisciplinary student competition as a case study to identify which teamwork skills are naturally in play and which skills need to be better transmitted to future collaborative stakeholders of the built environment.

METHODOLOGY

RESEARCH DESIGN

This case study assessed post-competition responses to an annual interdisciplinary design competition entitled the Harold L. Adams Interdisciplinary Charrette for Undergraduates (HA-ICU) held during the weekend of February 25-27 of 2022 in the College of Architecture at Texas A&M University. This college-wide design competition was designed and organized by five members of faculty and five student "ambassadors" (organizers) selected from the departments of architecture, construction science, landscape architecture and urban planning, and visualization, and the program of university studies. Competition participants were recruited by the student ambassadors from all five departments and programs. Although their professional skill sets were still in their infancy, first and second-year undergraduate students were recruited as competition team members as it has been observed by several faculty members that students from the OAEC disciplines appear to be most open to learning from other disciplines during their early years of study, before disciplinary silos become hardened. The competition challenged entrants to collaboratively submit a design based on a specified prompt. The teams were asked to:

- develop a sustainable space to enhance awareness of the impacts of each discipline in the practicing world;
- design a structure or shade cover that should consider relationships to the context, the volume of traffic throughout the area, and microclimatic factors;
- recommend unique solutions to enhance access between the buildings that house the College of Architecture's students, faculty, staff, centers, studios, and labs; and
- incorporate the College of Architecture's mission to address three environments: the natural, built, and virtual.

For this research, a literature review was used to identify key attributes for effective teamwork. Based on these findings, a survey was administered to the student competitors following the competition. To streamline the survey process, the questions for this research were included as part of a multi-year survey that was being conducted by a separate researcher regarding participant knowledge growth during the competition.

STUDENT RECRUITMENT

An organizational team of five interdisciplinary faculty—from the departments of architecture, construction science, landscape architecture and urban planning, and visualization, and the program of university studies—selected five student ambassadors from their respective departments. The selected ambassadors were hired as student workers to collaborate closely with the faculty committee for a month prior to the competition to organize the 5th annual HA-ICU 2022 competition. The student

ambassadors took on different responsibilities, including poster design, advertising, participant recruitment, design prompt development, t-shirt design for participants, meal ordering and delivery for the weekend of the competition, etc. The ambassadors met weekly with the faculty committee to ask for guidance to avoid potential problems.

The ambassadors designed a poster as well as announcement emails to recruit participants. To build excitement among first- and second-year students, the recruitment process was conducted both virtually (via email) and in-person (by making announcements in classes and through the posting of the posters). This multi-level recruitment strategy was adopted to increase the likelihood that email recipients would read the competition announcements.

DATA COLLECTION

To collect student reactions regarding their experiences of teamwork during the three-day competition, a survey was administered using Qualtrics–an online survey service. Online administration of the survey made the data collection and analysis more efficient compared to paper (i.e., the data collected thorough Qualtrics were later converted into Excel spreadsheet for data analysis). However, paper copies of the survey were also made available to students who did not have their laptops or cell phones available at the time of the survey or who preferred to respond by paper.

The competition took place from 5:00 pm Friday, February 25 until 2:00 pm on Sunday, February 27, 2022. To avoid potential respondent bias based on the receipt of a prize, this study was conducted via a survey administered to student participants following their presentations to the competition jury, but *before winners were announced*. To maximize the number of survey responses, participants were given approximately 30 minutes to complete the survey and were awarded with tickets upon completion which gave them access to enter the auditorium where the winners were to be announced.

STUDENT PARTICIPATION

Although the original goal was to recruit participation of 50 students (10 teams of 5 interdisciplinary students each), the competition hosted 43 students (7 fewer than expected) as some of the registered students cancelled their registration due to conflicting work schedules and other personal matters. Ultimately seven teams of 5 students each, and two teams of 4 students each participated in the weekend-long competition. Table 2 presents the detailed number of students registered from each department.

Table 2: Disciplinary composition of student teams, by number of students. Numbers varied according to student availability.

Team	A	CS	LA	V	US
1	2	2	1		1
2	2		1		1
3	2	1		1	1
4	2	1		1	1
5	2	1	1	1	
6	2	1	1		1
7	2		1	1	1
8	2	1		1	
9	2	1	1		

A, *architecture*; CS, *construction science*; LA, *landscape architecture & urban planning*; V, *visualization*; US, *university studies*

SURVEY QUESTIONS

The primary purpose of administering survey questions to competition participants was to identify patterns of need that could help guide universities about how to better prepare OAEC students for collaboration. The survey research was based on responses to five survey questions:

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1. Do you think you will win one of the top three prizes in this competition?

    _____ Probably Yes

    _____ Probably No

    Why did you select the response you did?

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2. For the following questions please rate how you think your team performed with respect to each attribute of teamwork. Mark on a scale of 0 to 7 where 0 is poor and 7 is excellent.

	Poor							Excellent
Effective Communication	⓪	①	②	③	④	⑤	⑥	⑦
Appropriate Team Composition and Skillsets	⓪	①	②	③	④	⑤	⑥	⑦
Effective Leadership	⓪	①	②	③	④	⑤	⑥	⑦
Responsibility and Accountability	⓪	①	②	③	④	⑤	⑥	⑦
Clear and Understandable Roles	⓪	①	②	③	④	⑤	⑥	⑦
Clear and Shared Goals	⓪	①	②	③	④	⑤	⑥	⑦
Interdependence	⓪	①	②	③	④	⑤	⑥	⑦
Trust	⓪	①	②	③	④	⑤	⑥	⑦
Other (Please Explain)	⓪	①	②	③	④	⑤	⑥	⑦
Other (Please Explain)	⓪	①	②	③	④	⑤	⑥	⑦
Other (Please Explain)	⓪	①	②	③	④	⑤	⑥	⑦

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3. If the organizers were to offer training in advance of the workshop on team collaboration, where do you think their focus should be? (Pick only 3)

Effective Communication	☐
Appropriate Team Composition and Skillsets	☐
Effective Leadership	☐
Responsibility and Accountability	☐
Clear and Understandable Roles	☐
Clear and Shared Goals	☐
Interdependence	☐
Trust	☐
Other (Please Explain)	

Why did you recommend what you did?

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4. What is your Team ID? (This information will **not** be used to identify you)

    ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ 7   ☐ 8   ☐ 9   ☐ 10

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5. Overall, was this a worthwhile experience?

    _____ Yes

    _____ Somewhat

    _____ No

RESULTS

SATISFACTION WITH COMPETITION AND PERFORMANCE WITH RESPECT TO EACH ATTRIBUTE OF TEAMWORK

This section describes results obtained from the post-event survey conducted immediately following the competition to determine if interdisciplinary student competitions are capable of imparting teamwork skills to future collaborative stakeholders of the built environment, and to identify areas where educators should prioritize efforts to better prepare students for enhanced teamwork performance. After the weekend-long competition, student competitors were asked to rate how they felt their team performed with respect to each attribute of teamwork identified in the literature review. Participants were also asked to identify which of the attributes they felt should be given to participants through a separate, dedicated training before the competition to enhance their performance on teams.

The fifth annual HA-ICU 2022 competition united a total of 43 students from the departments of architecture, construction science, landscape architecture and urban planning, and visualization, as well as the undergraduate studies program. The post-event survey was conducted on Sunday, February 27, 2022, and 42 participants participated in the survey (one participant could not attend the winner announcement session due to a family emergency). Results showed that a majority of participants (95.23%) found this competition worthwhile as a learning experience (Figure 1).
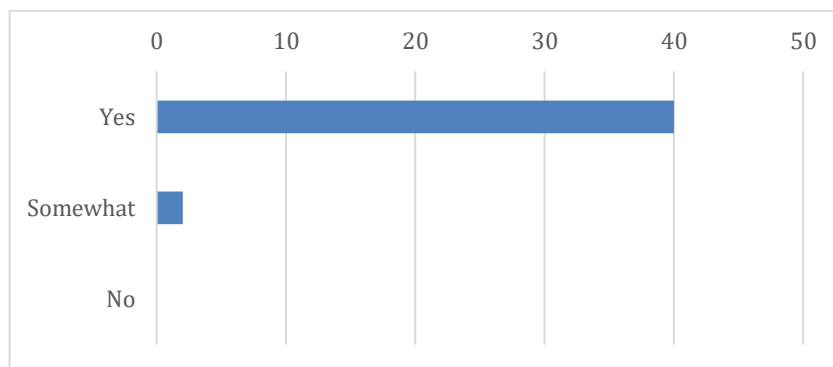

Figure 1: Participants' response to survey question "Overall, was this a worthwhile learning experience?" (Measurement is by number of respondents, n=42)

With respect to the listed attributes of teamwork (Question 2), participants indicated that *trust* (an average of 6.17 out of 7) and *interdependence* (an average of 6.17 out of 7) rated highest among all the teamwork attributes previously identified by the literature review and listed in the survey. However, respondent results also showed *appropriate team composition and skillsets* (an average of 5.90 out of 7) and *effective communication* (an average of 5.98 out of 7) were rated the lowest by the participants, revealing that these areas were more problematic for teams to overcome during the competition. Figure 2 summarizes responses to this question.

IDENTIFICATION OF ATTRIBUTE TRAINING NEEDED

Another core question that participants were asked in the post-event surveys was "If the organizers were to offer training in advance of the workshop on team collaboration where do you think their focus should be?" The attributes revealed by the literature were again listed for respondents, along with a follow-up question asking them to add any attribute

that they think may be critical but that was not listed in the survey (ie. "other" (please explain)).

Figure 2: Participants' response to the survey question: "Please rate how you think your team performed with respect to each attribute of teamwork."
(Likert scale is from 0 to 7, where 0 is lowest and 7 is highest)

Data collected for Figure 3 of the survey revealed that *appropriate team composition and skillsets* (52.38%), *clear and shared goals* (47.61%), *clear and understandable roles* (45.23%), and *effective communication* (45.23%) were identified by most participants as areas that needed training prior to the competition.
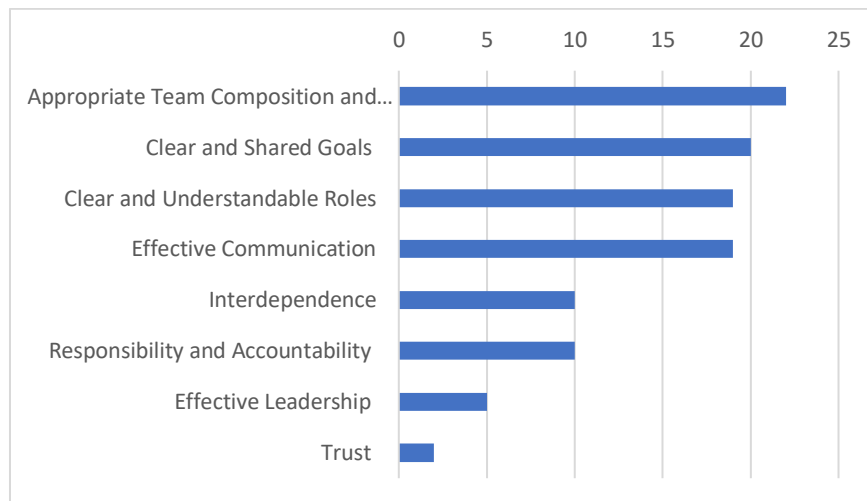

Figure 3: Participants' response to the survey question: "If the organizers were to offer training in advance of the workshop on team collaboration, where do you think their focus should be? (Pick only 3)"
(Measurement is by number of respondents, n=42).

As with Question 2, the participants were again invited to also suggest any other attribute they thought was important but not listed in the survey (e.g. "other" (please explain)). While two students recommended hosting pre-competition workshops on software and programs to better prepare competition participants, most respondents did not suggest any

additional attributes other than those listed, which suggests that the attributes listed were likely the most critical ones believed by participants to be necessary for effective team collaboration.

WINNING TEAMS VS. NON-WINNING TEAMS

Data analysis of participants' responses to question #2 revealed that all winning teams performed well regarding *clear and shared goals*. On the other hand, although the teams that were rated lowest by the panel of judges indicated that they struggled in having clear and shared goals and effective leadership, there is no evidence as to which factor was most critical for not winning the competition.

LIMITATIONS

There were some limitations to this study. Although this research is about teams, it explores the attributes of student teams in academia, which may differ from those of teams in firms/companies where an experienced individual is often placed in charge. Also, the argument that student design competitions can serve as a proxy for OAEC collaboration on actual projects needs evidence. There were two additional limitations, namely: there may be differences in the way the respondents interpreted the specific meaning of each of the teamwork attributes, and although follow-up interviews with the respondents could have shed additional light on how the results should be interpreted, a number of logistical issues prevented follow-up interviews from being included. Despite these limitations, the authors found the survey results of value and worth sharing.

CONCLUSIONS

In summary, results from this case study point to a recommendation that holding interdisciplinary competitions is worthwhile for OAEC undergraduates as a learning experience and can be helpful for them to appreciate the importance of the attributes that play a role in team success. It is interesting that team members in this competition felt a sense of *trust* and *interdependence* among their team members since these attributes can help team members feel comfortable about opening up, exposing vulnerabilities, and collectively overcoming existing problems. However, it must be acknowledged that both these characteristics–trust and interdependency–can also be adversely affected by a lack of necessary skillsets, which apparently challenged some participants of this case study competition. While the need to better equip students with more polished skillsets might suggest the competition should instead comprise upper-level student participants rather than first- and second- year undergraduate students, it is worth investigating to see if the vulnerability these more junior students felt may actually heighten their motivation to better equip themselves with the skills they need to become effective as professionals. A longitudinal study of the future performance of these students could offer some interesting insights.

Finally, and perhaps most importantly, results from the post-competition survey suggest that OAEC students appear to be calling for educators to not only teach disciplinary skills, but also how to develop clear and shared goals, to develop clear and understandable roles, and to communicate more effectively.

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