



FACILITATING MULTIDISCIPLINARY COLLABORATION

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1. Introduction

Being able to collaborate with people from different disciplinary backgrounds becomes increasingly important (e.g., Nancarrow, Booth, Ariss, Smith, Enderby & Roots, 2013). The (future) challenges that are awaiting our students are very complex and require input from different fields of knowledge in order to be solved. It is therefore of pivotal importance that our students learn to collaborate with people from different disciplines. Universities offer the opportunity for future engineers to experience and experiment with interdisciplinary collaboration in a safe environment that fosters learning and development of students.

Although multidisciplinary collaboration can be very successful, there is abundant research that underlines the difficulties of working with people different from oneself. For example, conflicts are likely to emerge, distribution of tasks and responsibilities can be extremely hard, information sharing and learning might get hampered, and planning and coordination might fail. The question thus is how to facilitate interdisciplinary collaboration in the educational setting?

We expect tutors to play an important role in facilitating the collaborative processes in multidisciplinary teams. When students are uncertain how to behave, it is likely that they will heavily rely on the guidance of or on example set by the tutor. Tutors can help to formulate the potential value of interdisciplinary collaboration for the team, but they can also manage students' expectations by sharing own experiences. Furthermore, tutors can actively monitor manage teamwork processes. Therefore, we developed a tool, namely, a series of workshops and guidelines offering small interventions that tutors can employ when they observe their team is struggling at different points in the team's life cycle.

We developed and piloted our tool in the context of Engineering Design (4WBB0). The course 4WBB0 Engineering Design offered a perfect environment for this investigation. Engineering Design is a course in which all 2nd year TU/e students participate and in which they collaborate in multidisciplinary teams to design and create an autonomous active sports-aid for people with a physical or mental disability (4WBB0 course syllabus, 2018). The course lay out can be found in Figure 1. All student teams had a tutor and they met twice a week during the duration of the term (11 times in total).

Tuesday	Sept 4	Introductory Lecture
Friday	Sept 7	Group meeting 1
Tuesday	Sept 11	Group meeting 2
Friday	Sept 14	Group meeting 3
Tuesday	Sept 19	Group meeting 4
Friday	Sept 21	Non-compulsory Group meeting
Tuesday	Sept 25	Preliminary Design Fair Group meeting 5 (without tutor)
Friday	Sept 28	Group meeting 6
Tuesday	Oct 2	Group meeting 7 (includes Midterm evaluation)
Friday	Oct 5	Group meeting 8
Tuesday	Oct 9	Group meeting 9
Friday	Oct 12	Group meeting 10
Tuesday	Oct 16	Group meeting 11
Tuesday	Oct 23	Group meeting 12 (includes Final evaluation)
Friday	Oct 26	Project Closing Event

Figure 1. Lay out of the course 4WBB0.

The goal of this study was to design and pilot test our tool which consists of a series of workshops and small interventions that are aimed at helping tutors to facilitate multidisciplinary collaboration in the student teams. In the following sections, we describe the body of team research that laid the foundation for the design of our tool. We describe the different topics that were covered in the series of workshops and the accompanying workbooks we made for the

tutors. Because we were able to collect some empirical data, we also include some rudimentary analyses. We conclude with a discussion section, including a section on lessons learned and how to move forward from here.

2. Theoretical framework

Multidisciplinary teams are diverse teams. Diversity refers to differences between team members (Homan, 2018), and one salient category in which multidisciplinary team members differ from each other is their disciplinary background. Previous research on team diversity shows that type of diversity (surface level (for example, gender) or deep level (for example, expertise)) does not consistently predict consequences in cognitive, task-related, and affective outcomes (e.g., Van Dijk, Van Engen & Van Knippenberg, 2012). The research shows that all types of diversity can have beneficial as well as negative consequences and hence there is not a clear cut answer to question whether diversity is good or bad for a team.

Differences between team members can lead to negative processes and interactions within teams (Van Knippenberg, De Dreu, & Homan, 2004). In general, people have a preference to work with those that are similar to themselves. When people are asked to collaborate with others who are different from them, subgroup categorization may emerge (Tajfel & Turner, 1986). Subgroup categorization is based on perceived differences between the team members and leads to dividing people to ingroups (those similar to self) and outgroups (dissimilar to self). Subgroup categorization leads to increased conflict and decreased trust between these groups, which negatively affect information exchange and processes within the team and hence on a team's performance.

Diversity can also have a positive effect on the processes in and performance of teams. Compared to homogeneous teams, diverse teams have access to more diverse perspectives, ideas, and information (Phillips, Duguid, Thomas-Hunt, & Uparna, 2012). When teams are able to share, process, and integrate that information (i.e. engage in information elaboration), they can perform better than homogeneous teams (Mesmer-Magnus & DeChurch, 2009; Van Knippenberg et al., 2004).

The categorization and information elaboration processes are negatively correlated but don't cancel each other out. This means that at a certain point in time, one of these processes will become dominant in a team (Homan, 2018; Van Knippenberg et al., 2004). There are many contingent factors that may explain why diversity sometimes has positive and sometimes negative consequences (for an overview see Guillaume, Dawson, Otaye-Ebede, Woods & West, 2017). One of those contingent factors is leadership. Although empirical research on the moderating role of leadership is still rather scarce, it is expected that leadership will positively moderate team diversity effects on team processes and performance-related variables when it fosters identification with the team and when it facilitates multidisciplinary collaboration processes as well as the elaboration and integration of differences in expertise and perspectives. Although tutors are not in a formal leadership role, we expect students in the 4WBB0 course to be very dependent upon their tutor in order to make sense of the course, the course requirements, and to obtain guidance on how to conduct the project. Research has shown that when facing an uncertain situation, people are likely to seek out the interpretation of others (Volkema, Farquhar, & Bergmann, 1996). Meaning that tutors have a lot of influence in that respect and play a crucial role in facilitating multidisciplinary collaboration and team performance.

Another aspect that we considered in the design of our tool is the fact that teams are not static and that their behaviors change over time (Gully, 2000; Marks, Mathieu, & Zaccaro, 2001). At the start of a project, team members usually engage in getting to know each other, the task, and formulate ideas on how to approach the task, whereas at later on in the project members focus more on performing and on consolidating their work (Marks et al., 2001). We decided to pinpoint three points in time that seemed meaningful (Hackman, Wageman & Fisher, 2009) and matched the design of the 4WBB0 course:

1) The first workshop (& workbook) was given on September 5 and 6 just before tutors would have the first meeting with their teams.

2) The second workshop (& workbook) was given on September 26 and 27, directly after the Preliminary Design Fair (PDF) where their teams presented their initial design/prototype.

3) The third workshop (& workbook) was given on October 10 and 11, when the teams worked towards finalizing the project.

In the following section, we explain the content of our tool in more detail.

3. The design of our intervention tool

Because of the expected influence tutors have in their teams and because of their role description to facilitate the design process (4WBB0 tutor handleiding, 2018), we predominantly focused on relationship-oriented behaviors. Relationship-oriented tutors support, motivate and develop the students in their teams and the relationships within the teams. They encourage and facilitate good teamwork and collaboration, through fostering positive relationships and good communication.

Meta-analytic evidence underscores the importance of this type of behaviors for team effectiveness, team productivity, and team learning (Burke, Stagl, Klein, Goodwin, Salas, & Halpin, 2006).

3.1 Workshop 1 & Workbook 1

In the first phase of our tool, we focused on the role of tutors in ‘setting the stage’ within their teams. We explained that for many of their students, this first meeting might resemble a highly uncertain situation and that therefore, the teams will closely watch the tutor’s behavior. During the workshop, we did a self-disclosure exercise (see Appendices 1 and 2). Tutors were asked to think back to their own experience as a student in the 4WBB0 course (or a similar situation). We asked them to remember how they felt before the first meeting, why they felt that way, and remembering what was pleasant or unpleasant about their team experience. We then explained that tutors may want to consider to disclose (some) of their own past experiences with their teams. We explained that when tutors disclose some relevant information about themselves, such as their own past experience in a multidisciplinary team, they make a connection with their teams. Self-disclosure signals a willingness to be vulnerable to the other person by sharing personal information with them (Derlega, Metts, Petronio, & Margulis, 1993). Furthermore, the recipient is likely to reciprocate the behavior (Chaiken & Derlega, 1974) and thus we expect team members to themselves engage in disclosing some relevant personal information. Research also shows that self-disclosure is necessary for building psychological safety (Roberge & Van Dick, 2009). Psychological safety is a shared belief among team members, that no one will be punished, rejected or humiliated for speaking up with ideas, opinions, questions, concerns or mistakes (Edmondson, 1999, Edmondson, 2004). Given the importance of informational

elaboration for multidisciplinary teams to be effective, psychological safety is an important prerequisite.

Next we explained that tutors need to observe their teams closely. By observing the behaviors displayed in their teams, tutors can get a sense of how well their teams are doing. It also signals them when an intervention seems necessary. We distributed the workbook (see Appendix 2) at this point, and explained how they could engage in observing their teams and possibly, in intervening. In the workbook, tutors first read a description of the behaviors of a highly effective team for the first phase of the project (meetings 1-4)¹. On the following pages, we provided a grid where in the first column several deviations from the “ideal” are described. In the second column several small interventions are suggested that aim to improve the situation². In the third column we left some room for notes about the observed effectiveness or consequences of the interventions. We also underscored the rules of intervening, namely that tutors are only allowed to intervene when it was necessary, that they are not allowed to forcefully intervene and that they would only intervene with the aim to help their teams.

3.2 Workshop 2 & Workbook 2

In the second workshop, we decided to focus how tutors could help their teams to benefit the most from feedback and to help them move forward (see Appendix 3). The tutors attended this workshop just before the 5th meeting with their teams who received feedback on their idea/prototype from the PDF and whose members gave an evaluation of their work process in the second self-study assignment. Both types of feedback were discussed in their upcoming meetings. Feedback can have far-reaching consequences for future team interactions (Peterson &

Behfar, 2003) and intervention might be necessary (Hackman et al., 2009). We made a distinction between a positive and a negative response to either positive or negative feedback (see Table 1). We explained to the tutors that ideally all their teams react positively to positive feedback. That would resemble the effective team description that was included in workbook 1. Other teams may have developed a psychologically safe climate and are engaged and motivated but were a bit lost on where to go with the assignment. When getting negative performance feedback, these teams are likely to realize they need to step up their game. Thus tutors can expect some debates in those teams regarding the assignment (different sport, different handicap, etc.) and/or some discussion on how to improve their work processes, but they engage in these debates in a constructive manner and are able to solve them rather quickly. Either way, when teams react positively to feedback, tutors have a relatively easy job. It becomes more difficult when teams respond negatively to feedback.

Table 1. Possible team responses to types of feedback.

	Positive feedback	Negative feedback
Positive response	Yay! We're doing great, we just need to keep moving	Ouch! We need to step up/change something!
Negative response	We're safe, failure avoided	We can't do this, this will never work

During the workshop, the tutors participated in an exercise where they discussed in small groups a) how to assess whether a team responds negatively to negative feedback, and to think of two or three ways in which a tutor could intervene in this situation and b) how to assess whether a team

responds negatively to positive feedback, and to think of two or three ways in which a tutor could intervene in this situation. This was then plenary discussed. We warned tutors that a consequence of feedback teams may lose motivation and that conflicts might increase. These debates are fine as long as they are about the task itself (the content of the assignment), when they are constructive and resolved rather quickly. Some debates regarding the work processes might happen as well but ideally are relatively quickly resolved by making changes in the schedule, for example, or appointing new task to some members. Unfortunately, sometimes feedback can result in pointing fingers to certain members (if you only had done ..) and those conflicts are infectious and dangerous (for team success). We therefore shortly discussed the rules for constructive debates. We ended this part by giving a summary of tutor behaviors in helping teams to benefit from feedback (see Table 2).

Table 2. Tutor role in teams' responses to types of feedback.

	Positive feedback	Negative feedback
Positive response	Cheering, continue your support, strengthen positive vibe	Support their change, motivate, guide constructive discussions
Negative response	Motivate & inspire (warn)	Reformulate feedback, motivate, monitor & guide constructive discussions

Next, just as in the first workshop, we handed out the second workbook (Appendix 4) and we explained the observation and intervention grid for meetings 5 – 9.

3.3 Workshop 3 & Workbook 3

In the third workshop we focused on time pressure and integration (see Appendix 5). Because the deadline was looming at this point, we considered it appropriate to focus on how teams can react to the deadline. Teams who are collaborating well from the beginning probably do not get hindered by the deadline. In fact, these teams might benefit from the deadline because of an increased task focus (Waller, Zellmer-Bruhn, & Giambatista, 2002). However, that is not always the case and teams can experience stress because of the nearing deadline (Driskell, Salas, & Johnston, 1999; Karau & Kelly, 2003). During the workshop, the tutors engaged in an exercise in which they talked about how time pressure affects them (both moods and work behaviors), to think back how time pressure affected the teams they have been a part of in the past, and to remember strategies these past teams used to get the work done while experiencing time pressure. The idea behind this would be a ‘refreshed’ understanding of what the tutors’ teams might experience as well as to give them ideas on how to observe time pressure in their teams. We discussed this plenary and then explained that if they perceive their teams to suffer from time pressure, they might engage in temporal leadership behaviors (Mohammed & Nadkarni, 2011). Temporal leadership is the extent to which the tutor helps the team to schedule deadlines, prioritize and schedule (sub)tasks, helps to synchronize team member behaviors, and who monitors progress and progress communication. Research suggests that leaders that engage in these behaviors foster team members coming to agreement on the importance of meeting milestones, the appropriate pacing of subtasks, and time allocation (Mohammed & Alipour, 2014).

The second topic discussed in the workshop was integration. In consultation with Dr. Carla Oonk (WUR) we developed a rubric that represents different types and different phases of integration

(see Appendix 7). This rubric is based on the interdisciplinary learning rubric for individual students developed by Oonk (2016). The rubric intends to reflect the ability of teams to cross and integrate the boundaries between one's own perspective and expertise and others' expertise and perspectives, to make new connections, to learn from the "other" and to create new designs, products, or new practices with the other. We distinguish four different types of integration within teams, namely:

- a) Integration of tasks and responsibilities (focus on the work process)
- b) Integration of various intrateam perspectives, interests, and/ or expertise in the final product (focus on the content of the assignment)
- c) Integration of end user needs
- d) Integrative learning

We distinguish three levels of integration (level A, B, and C) whereby level C is indicative of integration. During the workshop, we explained the rubric to the tutors and then asked them to indicate one of their teams on the grid. Next, we asked them what they could do, to help teams move from an A or B level, to a B or C level. These ideas were shared during a plenary discussion.

Finally, we handed out the third workbook to the tutors and explained the observation and intervention grid to them (see Appendix 6).

4. Participants

Twenty-six tutors signed up to participate in this pilot. Two tutors failed to show during the first workshop and were therefore excluded from further participation and thus the final sample

consists of 24 tutors. Two tutors were substitutes, the rest all had 4 teams to tutor. Eighteen tutors (75%) had themselves been a student in this 4WBB0 course. Eleven tutors were male, 13 were female. Five of the 24 tutors (21.6 %) had tutored before in the 4WBB0 course and in total 9 tutors had been tutoring in different courses before (37.5%). All tutors received € 100,- for their participation.

5. Evaluation data

We concluded this study with an evaluation meeting of 45 minutes. We guided a discussion per time point, by asking the participants what they used, what worked (and what didn't) and we asked them to fill out an evaluation form (see Appendices 9 and 10).

The participating tutors are positive about the tool, and likely recommend future 4WBB0 tutors to participate: Mean score = 8.23 on a 10 point scale (1= very unlikely, 10 = very likely).

In Table 3 the responses are listed of the tutors who answered the question “How did this series of workshops & workbooks help you to better facilitate the collaboration processes in your tutor teams?” In general our interpretation is that the tutors felt the material was interesting and helpful for them.

Table 3. Responses to “How did this series of workshops and workbooks help you to better facilitate the collaboration processes in your teams?”

discussing together about the challenging we facing, and find the same problems... at the end having solutions
i did not know there is so much "science" behind it, it was very interesting to see and get suggestions what to observe, when and what to intervene
i gained more insight in group processes definitely. it was difficult for me to use the format of intervention provided by the workbooks, since implementing this costs a lot of time. however, some insights i definitely used, only i feel like i implemented these insights in my already existing patterns. Insights i gained: tell them own experiences to bond, positive/negative responses to feedback
it helped me realize there are many ways to help intervene with my teams
helped me to intervene more often during the meetings and gave me a guideline how to do so
it gave me ideas on how and when to intervene when my group here not performing optimally
i found it very useful to have some descriptions on how my team could behave and what to do about negative behavior/guide/trigger them in the right direction by intervention
it helped me to identify deviant behavior and to deal with them effectively
it gave a better, more realistic insight and expectation of my work
what to look out for and how to react on these situations
gave tools to give feedback to students how to spot dysfunctioning teams
it is a great guide for tutors that (might) have problems with their groups. these tips would be great if given to all tutors so that everyone can benefit from these in the time of need
the tools that were given and practiced were helpful and useable for me during the meetings
mostly interventions: very useful to know when and how to intervene. helpful to get an overview of things that can happen -> easier to recognize
especially the 'response to feedback and integration rubrics were very helpful to make you pay attention to aspects that could otherwise be overlooked
the workshop made me more aware of my role as a tutor and possible ways of intervening without harming the process. besides, that it made me realize how "normal" my groups behaviors were and that it could be improved
the most helpful was that i had tools to actively consider some relevant factors that might need extra attention. the provided interventions gave a guideline for possibly intervening
get insights in how to help as a tutor in certain situations. especially workshop 3
both of them were nice and useful guideline during the process. it was really nice/contribute to be able to look the process in a more critical way (especially during workshops when sonja asked us questions) and then think/discuss solutions if there was a problem
it was a clear and structured way of looking at the meetings. if i didn't know what to do, i could look at the workbook. the only downside was that is was difficult to use during the meetings (because reading while listening is a challenge). so i checked before/after the meetings what the possibilities are
helped me in understanding processes and peculiarities within teams + how to solve them
it mainly helped me to reflect on how i did as a tutor. it helped to critically look what actions to take and i became more aware of the importance of some actions + more aware of future actions that could help

5.1 Lessons learned

Even though the tutors were satisfied with the length of each workshop (45 mins), our own experience is that we think 45 mins are a bit too short. What we were not able to do well in this pilot was reflecting upon the observation and intervention grid of the previous time. There was simply no time to do that. We do think that integrating some time for such debriefing and reflection is important, because empirical findings underscore the importance of doing this for performance (Tannenbaum & Cerasoli, 2013). Furthermore, it gives the tutors an opportunity to learn from each other's experiences.

Another aspect that was indicated during the discussions at the evaluation meetings, was that tutors really appreciated the integration rubric. And in fact, had wished they were given this rubric earlier. We wholeheartedly agree on this because integration is fundamental to effective multidisciplinary collaboration.

Further, we learned that tutors found it sometimes hard to use the observation and intervention grid, because they hardly had time to use it in between their team meetings. That is something to keep in mind when the observation and intervention grid is implemented in a (different) course: it is important that tutors get some time after a meeting to evaluate and reflect upon that meeting.

6. Additional data and analyses

We handed out a few surveys, during the first workshop (T1), after the first workshop (T2), after the second workshop (T3), and after the third workshop (T4). We also received the team grades

for the Preliminary Design Fair (PDF), for the Closing event, and the report. In this section, we highlight the most interesting findings.

We developed a measure to capture the *self-efficacy* levels of tutors at the beginning (during the first workshop) and at the end of this pilot (after the third workshop). We submitted the scale items to two experts on team research, namely dr. Gevers and dr. Le Blanc (both TU/e), to assess its face validity. Both indicated that the developed items of the tutor self-efficacy scale matched the construct very well. The scale consist of 16 items (see Appendix 8). Example items are: “How much confidence do you have in your ability to help to address your teams’ needs?” and “How much confidence do you have in your ability to help help your teams in making decisions?”. The tutors answered the xx items on a 1 (none at all) to 5 (a great deal) point Likert scale. The scale was reliable with a Cronbach’s alpha of .76 at T1 and .79 at T4.

The mean level of self-efficacy at T1 was 3.68 and at T4 was 4.01. A paired sample *t*-test showed this increase was statistically significant $t = 3.78, p = .001$. Zooming in a bit deeper, we compared the scores on each item over time. Doing so, we learned that the increase in self-efficacy was significant for:

Item 2: helping to address their teams’ needs

Item 7: constructively intervening to increase collaboration in their teams

Item 11: assisting their teams in dealing with setbacks

Item 14: helping their team members to learn from each other

Item 15: motivating their teams to work collaboratively

Item 16: helping their team to continue to work collaboratively under time pressure

An increase in self-efficacy was to be expected, because participants grew in their role of tutor over time which will increase their confidence in their abilities. Because we did not have a control group to compare these scores of our participants with, we cannot conclude whether the tool contributed to this increase.

Diversity beliefs. We measured tutors diversity beliefs (T2) adjusting the scale of Kauff, Stegmann, Van Dick, Beierlein and Christ (2018). The scale consists of four items. An example item is “A team with a high degree of diversity is better able to tackle the 4WBB0 assignment”. Respondents indicated on a 4 point Likert scale whether they disagreed (1) somewhat disagreed (2), agreed (3), or agreed (4) with the statements. The Cronbach’s alpha of the measure was .80 which resembles a good reliability. The mean level of diversity beliefs was 3.20 ($sd = .57$) indicating that overall the tutors agreed that the diversity of the groups was useful for the assignment.

Diversity beliefs are a person’s attitude toward diversity and describe “the extent to which individuals perceive diversity to be beneficial for or detrimental to the group’s functioning” (Van Dick, van Knippenberg, Hägele, Guillaume, & Brodbeck, 2008, p. 1467). Knowing that tutors had a general positive outlook regarding the diversity in their teams is important. Research on leaders’ diversity beliefs suggests that those with strong diversity beliefs encourage interactions and the exchange of information between the diverse members of a team, and thus support the convergence of mental models. Moreover, they appreciate individual differences and treat members based on their membership in the overall team, which can help all members to feel connected to the team (Meeussen, Otten, & Phalet, 2014). Thus, tutors with strong diversity

beliefs can mitigate the negative process of categorization, and helps to build and maintain positive collaborations.

Use of self-disclosure. We asked tutors whether they had used self-disclosure in their teams (T2). Twenty-two tutors used some form of self-disclosure during the first meeting(s) with their students. Twelve tutors used some form in all 4 teams. Two tutors did not use any form of self-disclosure (intentionally) in their teams. The others briefly commented upon the perceived consequences of the self-disclosure and named things such as "...[students] were a little more comfortable during the first meeting" and "it gave them a certain reassurance". One tutor named a specific task aspect: "[...]more clarity of what to expect at the PDF" and two others addressed their own role specifically "The students were more willing to accept my point of view/feedback", "[...]it might be useful to listen to me", and "[...]students seemingly felt that I understood them".

Grades. We were able to compare the grades of the groups tutored by participants of this study and the other groups in this course. Although the means of the participating groups are all slightly higher than non-participating groups, *t*-tests indicated that these differences were not statistically significant (see Table 4).

We did observe, that in the participating groups, the correlation between the PDF and Closing event grades were more strongly correlated ($r = .361$, $p < .001$) than for the non-participating groups ($r = .138$, $p = .052$) (see also Table 5 on page 22). Further, because participating tutors

were asked about certain team behaviors at different points in time, we were able to correlate these behaviors to the different grades. We present these findings next.

Table 4. Comparison of team grades.

	Participants' teams (n = 88) Mean (standard deviation)	Other teams (n = 200) Mean (standard deviation)	T-value
PDF grade	M = 7.165 (.9338)	M = 7.048 (.8215)	1.07
Closing event grade	M = 7.381 (.9377)	M = 7.360 (.9473)	0.17
Report grade	M = 7.305 (.7219)	M = 7.192 (.6996)	1.25

At T2, we asked tutors whether they observed behaviors that are indicative for *psychological safety* (members openly discuss different viewpoints related to the assignment, members freely share information/ideas, members openly communicate about and find ways to improve their work/collaboration processes, and members show (verbal or non-verbal) signs of resistance/unwillingness to perform a task) in each of their teams. This resulted in 88 team observations (we excluded data provided by the two substitutes). A factor analysis showed that the last item needed to be removed in order to obtain a reliable measure (Cronbach's alpha was .78).

At T3 we asked tutors whether they observed *task and process conflicts* within their teams (did you observe task related debates/discussions in this team (discussing different views regarding the design or the report)?, did you observe debates/discussions in this team regarding *how* to get the work done (about planning, division of tasks etc.)?). We also asked about interpersonal

frictions, but a reliability analysis indicated to remove that item in order to obtain a reliable conflict measure. The Cronbach's alpha was .76. Furthermore, we used one item to assess whether tutors perceived their teams were able to solve their conflicts quickly.

At T4 we asked tutors for each of their teams whether the team experienced *time pressure*. We used the scale of Gevers, Van Eerde & Rutte (2001) which consists of 4 items. An example is: This team had too much work to do for the time available (1=disagree to 5 = agree). The scale had a high reliability, Cronbach's alpha was .92. We also asked whether tutors used *temporal leadership behaviors* in each of their teams, using the scale of Mohammed and Nadkarni (2011). An example item is "I helped this team to prioritize tasks and to allocate time to each". This scale was reliable, Cronbach's alpha was .81. We also used one item to ask how the teams *reacted towards the feedback* they received from the PDF (1 = negative response, 2 = positive response).

In Table 5 we present the correlations between these aforementioned variables and their grades.

Table 5. Team level correlations

	M	Sd	1	2	3	4	5	6	7	8
1. Psychological safety T2	3.90	.74								
2. Conflict T3	3.48	.85	.31**							
3. Resolution T3	3.93	.81	.44**	.17						
4. Time pressure T4	2.95	1.14	-.36**	-.13	-.25*					
5. Temporal leadership T4	3.14	.91	-.04	-.12	-.24*	.17				
6. Feedback response T4	1.88	.33	.23*	.14	.19	-.15	-.11			
7. PDF grade	7.17	.93	.22*	-.03	.22*	-.21	.04	.33**		
8. Closing event grade	7.38	.94	.28**	.17	.24*	-.45**	.11	-.03	.36**	
9. Report grade	7.31	.72	-.07	-.18	.09	-.20	-.12	.09	.07	.08

Note: N = 88 teams; * $p < .05$; ** $p < .001$

What can be seen from Table 5, is that psychological safety correlates significantly with all variables, except temporal leadership and the report grade. The positive correlations with the PDF and the Closing event grades are in line with the research on psychological safety, which found it to be predictive of learning within teams (Carmeli, Brueller, & Dutton, 2009; Edmondson & Lei, 2014). Furthermore, given the positive correlation with conflict resolution we believe psychological safety benefitted collaboration within the team. Also the negative correlation between psychological safety and time pressure is reassuring. This suggests that teams that were able to establish higher levels of psychological safety early on, experienced less time pressure later in the project. Those teams likely had early discussions regarding the content of the project and about how to organize the work in the team (task and process conflicts) and were also able to resolve them, which resulted in an agreed upon schedule and task division and coordination. Unfortunately, none of the measured variables were related to the Report grade.

7. Future research

In this pilot study we tried a few things, and overall the participating tutors reported to find the whole intervention useful. Most of them applied some interventions in their teams at different points in time. However, we were not able to demonstrate the effectiveness of the tool.

Regarding the grades we did not find significant differences between the teams that were guided by the tutors who participated in this pilot, compared to the other teams in this course. We were able to connect some core team processes to the PDF and Closing event grades of the participating tutors' teams. In the future, we would like to rigorously assess whether the developed tool indeed helps tutors to facilitate their multidisciplinary teams to collaborate more effectively, using a field experimental study design including a control group. Doing that, would

allow us to observe if there are indeed differences in emergent team phenomena (e.g. psychological safety) and processes (e.g. information elaboration, coordination) between the experimental and the control condition.

8. Integrating & upscaling the tool

In the future, we think the developed and validated tool can be relatively easily implemented in other courses that require students to collaborate in highly diverse, multi- or interdisciplinary teams. We think when tutors and teachers invest in facilitating the collaborative processes in multi- or interdisciplinary teams will benefit our engineering students. Learning to collaborate in a diverse team requires attention and encouragement from educators.

Integrating the developed tool in the DPO program requires more research, because of the timing aspect of the tool. Some parts can be easily integrated into existing programs of DPO, but we think a unique value of our tool is the timing aspect which is likely to vary between different courses. We discussed the possibilities with Femke Boesenkool (interim coordinator) and will continue these discussions when her successor is known.

We also informed the responsible lecturer of the 4WBB0 course (dr. R.H. De Lange) and also gave him the developed materials. Furthermore, he will also receive a copy of this report (as well as insight into the data). He is welcome to continue to use the developed materials and we happily offer our guidance when needed.

Notes

1. We based these descriptions on the ample research evidence of effective collaboration processes in high performing teams. See, for example, Cronin & Weingart (2007); Driskell, Salas, & Driskell (2018); Rispens (2014).

2. The suggested interventions are also based on the scientific literature. See for example, Hackman et al. (2009), Lacenerenza, Marlow, Tannenbaum, & Salas (2018).

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