2.6

Teamwork

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While teamwork is considered one of the core transversal competencies expected from engineers and is widely implemented in engineering education, educators often have limited exposure to knowledge of team dynamics and processes, which can make it challenging for them to set up effective team-based learning. In this chapter, we discuss the knowledge, skills, and attitudes required for students to perform teamwork effectively. We dive into various team processes, such as action-oriented behaviours and emergent states that are built through interpersonal interactions during teamwork, which are crucial for functional and effective teams. Building on conceptual foundations, we provide educational examples on how to form and support student teams and how to provide training in conflict management. The chapter also lists our recommendations for setting up teamwork-based learning, forming teams, and managing teams, especially when teams experience problems. We share a concrete teamwork session lesson plan as an inspiration source for educators who struggle with incorporating a teamwork-themed workshop into their modules.

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1 Teamwork: a complex core engineering competency

Teamwork is a core engineering competency for adaptive, creative work, especially to solve interdisciplinary, complex issues beyond an individual's ability (Salas et al., 2008). Teamwork refers to the coordinated actions of two or more individuals — such as communication, decision making, and task coordination — to achieve a common goal (Driskell et al., 2018). Teamwork effectiveness refers to the degree to which team results satisfy the expected requirements or expectations (Essens et al., 2008) and usually includes attitude, behavioural processes, and performance (Wang et al., 2014). In this chapter, we use teamwork as an umbrella term and do not distinguish between related terminologies, such as groupwork, collaboration, and cooperation (for a reference to this distinction, see the references and further reading section).

1.1 Teamwork competencies — knowledge, skills, and attitude (KSAs)

Teamwork competencies are comprised of a series of interconnected knowledge, skills, and attitudes (KSAs) that enable effective coordination and collaboration (Nadal et al., 2015). Examples of teamwork-related KSAs are listed in Fig. 2.6.1. Skills, which are often intertwined with knowledge, involve the ability to enact the strategies and perform the tasks in practice. Attitudes such as openness, a sense of responsibility, willingness to adapt roles, and valuing diverse perspectives are essential for effective, high-performing engineering teams.

Figure 2.6.1: Teamwork-related knowledge, skills, and attitudes (Own Work by Éva Kalmár, 2026)

Team competency frameworks, in general, list what professionals should be competent to do. For example, the CDIO framework highlights that engineers should be able to 1) *work in teams*, which covers aspects like team formation, setting goals, planning the project and scheduling tasks, setting team norms, coordinating and managing team processes, making choices about team leadership and membership, handling conflicts, supporting individual and team creativity, motivating team members, and finally, assessing the process and the outcome through reflection; 2) *engage with stakeholders*, co-create with them; 3) *manage multi-perspective* and multi-, inter- and transdisciplinary *collaborations*; and finally 4) *establish* diverse connections and *networks* (Crawley et al., 2014). Other frameworks utilize different taxonomies to categorize teamwork-related KSAs, such as 1) conflict resolution; 2) collaborative problem solving; 3) communication; 4) goal setting and performance management; and 5) planning and task coordination (Stevens & Campion, 1999); or 1) identifying team membership and role; 2) establishing productive relationships; 3) meeting team objectives, and 4) resolving conflicts (Leslie, 2016). *Regardless of the framework that you decide to use, it is important that you select and adapt one*, as students will benefit from explicit support in understanding the aspects and competencies of teamwork.

1.2 Relation to other skills

Task-related, interpersonal, and reflective competencies have been shown to significantly influence individuals' capacity to foster team effectiveness and performance and enhance team dynamics (Jalali et al., 2022). Some of these are discussed in detail in other chapters of this handbook.

Interpersonal skills, such as open dialogue, empathy, active listening, information sharing, and participation, are foundational to effective teamwork (Jalali et al., 2024; Stevens & Campion, 1999). As conflict is a normal aspect of teamwork, helping our students understand how to sustain collaboration through the common teamwork setbacks can help them develop these skills more effectively. Therefore, conflict resolution and negotiation skills are essential to help student teams distinguish productive disagreement and constructive feedback from destructive conflict.

Furthermore, the ability to step back, think critically, and reflect on specific situations, and particularly on how students perform, is essential for learning and skill development (Isaac et al., 2024). The meta-cognitive perspective, *including individual and group reflections*, is crucial for developing self-awareness and team awareness. Reflection allows students to evaluate their contribution, understand team dynamics, and plan for future improvement, but more importantly, it can have a huge influence on how they perceive teamwork and their attitudes for the future.

2 Teamwork competencies need facilitation

Teamwork competencies are widely recognized as core transversal competencies in engineering education because of the inherently collaborative nature of engineering practice and due to accreditation requirements, industry expectations, and the growth of team-based and project-based learning (Borrego et al., 2013; Felder & Brent, 2024;

Prince & Felder, 2006; Trevelyan, 2019). *However, simply placing students in teams does not ensure that they will develop strong teamwork abilities* (de Prada et al., 2022). In other words, teamwork-related KSAs must be explicitly included as learning outcomes, and the modules must be intentionally designed to support the development of these KSAs through theoretical grounding and opportunities for practice, feedback, and reflection on students' experiences (Borrego et al., 2013).

We can learn a lot about facilitating team-based learning from student-reported teaming experiences. Their positive experiences with teamwork typically involve clear communication, the value of building personal relationships, and the sense of satisfaction derived from what they accomplished. Without intentional design, student teams frequently experience negative outcomes traditionally associated with teamwork, even developing an attitude against teamwork. Negative experiences often are associated with role ambiguity, interpersonal conflict, and uneven contributions (Wolfe et al., 2016), which could lead to dysfunctions in student teams (Wei & Han, 2025). Often, students do not interpret teamwork through contextual lenses or social structures (e.g., they do not reflect on their previous teamwork experiences, how they perceive the value of a task or the usefulness of the teamwork project), although these factors shape their attitudes and engagement in the team effort (Tucker & Abbasi, 2016; Wei & Han, 2025).

Designing engineering programmes that support teamwork is itself a complex challenge. Educators must understand what effective teams and healthy team dynamics look like and when to prevent conflict that becomes destructive while encouraging productive collaboration. This can be challenging when educators do not have the theoretical foundations. Conceptual frameworks on team effectiveness, particularly *input-process-outcome (IPO) models*, are useful to rely on. The IPO models highlight the intricate relationships between three crucial components: inputs, processes, and outcomes (Marks et al., 2001). Within educational settings, inputs refer to factors such as team composition, task complexity and structure, and other factors, such as the length of the project. Processes encompass how teamwork is performed, including team member interactions, communication, and task coordination. Finally, outcomes include the results of collaboration, such as the quality of deliverables (reports, presentations, artefacts), individual satisfaction with team membership, and the impact of teamwork on individual development.

A key strategy to develop strong team-based learning environments is to focus on the team processes over time, especially team emergent states — conditions such as team efficacy, collective confidence, shared mental models, and psychological safety, that arise through interaction and experience. Modules supporting the development of teamwork competency have to support the development of emergent states at the early stages of teamwork (Ilgen et al., 2005). These early interventions aim to promote discussions on students' understanding of the project, information seeking and sharing, feedback, and interpersonal communication, which lead to shared understanding, shared team mental models, and team goals (Marks et al., 2001). Team members' feelings, emotions, and attitudes are crucial in creating these

emergent states and have a relevant effect on whether students trust each other and believe that the team can reach its common goal together (Collins & Parker, 2010).

As a practical introduction, a simplified Tuckman and Jensen (1977) model on *team phases* (forming, storming, norming, performing, adjourning) can help students understand team development, while instructors normalise early struggles and intentionally support motivational and interpersonal dynamics, so teams move more effectively toward norming and performing.

To support student teams to become effective and well-functioning, educators need to invest in explicit instructions that equip students with the necessary tools and strategies, and they should create opportunities for reflection and feedback. In engineering education settings, while repeated opportunities for practice and feedback on the process of creating solutions are increasingly accepted, deliberate and explicit instruction related to teamwork processes, especially those that focus on emergent states, remains the exception (Borrego et al., 2013).

3 Forms of implementation

What criteria should guide team formation? How can we ensure that teams reach their full potential? In what ways can we support individuals in developing their capacities and acquiring teamwork competencies? How should challenges encountered during the teamwork process be addressed?

We believe that educators who are willing to set up team-based learning experiences need to be acquainted with teamwork theories and have a palette of possible methods to choose from to answer these pressing questions.

In the following sections, we present two case examples, recommendations and a template for a teamwork workshop that reflect and illustrate essential features and practices of effective teamwork, facilitating the development of teamwork skills. Our intention is not to provide ready-to-use solutions, but instead, sources of inspiration that can be modified to context-specific educational methods and materials.

Example 1. Forming effective teams: a case from TU Delft

It is common and beneficial for students to select their own teams because it can increase their commitment to solving a problem, resulting in more intrinsic motivation. However, such practice can result in a lack of within-team diversity, which has a huge effect on the team's transactive memory system — the knowledge represented by all team members (Kozlowski, 2018), affecting transdisciplinary learning (MacGregor, 1990), collaborative learning (Curşeu & Pluut, 2013) and the creativity of the teams. Setting up teams according to predefined diversity criteria is crucial for effective team learning. While homogenous teams tend to experience less team conflict, they also learn less, in general, because they do not challenge each other's worldviews, decisions and solutions. This also results in less creative outcomes.

In the Collaborative Science for Biomedical Breakthroughs (CSBB) interdisciplinary Nanobiology minor programme organised by TU Delft and Erasmus MC in the Netherlands, setting up teams is done by the minor coordinators based on students' topic preferences, gender, domain background, and team role preferences (Colgrove et al., 2025). This method of setting up teams gives students autonomy to maintain their interest-led, intrinsic motivation, while the coordinator ensures that all teams remain diverse and effective.

During the first weeks of the CSBB minor, students participate in sessions that facilitate individual and team reflection competencies, and they actively participate in various team formation exercises. First, they play biology-related board and card games to get to know each other and to create fun memories. Playing games can facilitate the creation of a team climate that supports playful experimentation and failure, instead of focusing on grades. When playing games, students can determine their own path (which gives them a high level of autonomy); they can engage with the game just for the sake of exploration, which stimulates experiential learning; they expose themselves to a series of surprises, which teaches tolerance of uncertainty; it fosters their imagination; and welcomes foolishness which boosts creativity (Gudiksen & Skovbjerg, 2020). By playing games during the team formation stage, students get to know each other outside of the challenge context.

A few days after playing games, students attend a workshop dedicated to mapping the teams' transactive memory system. In this workshop, each team member writes down on transparent plastic foil pieces their areas of knowledge, skills, methods used when approaching a problem, values, and finally, their emotions. Then, they discuss the various items by placing the transparent foils on top of each other, as shown in Fig. 2.6.2.

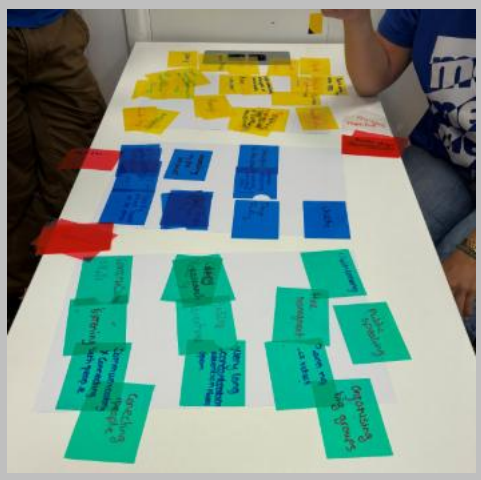

Figure 2.6.2: Demonstration of activity to map the team's transactive memory system at the CSBB minor (Own Work by Éva Kalmár, 2025)

Students are encouraged to discuss the potential meaning of the overlapping areas and the distance between various elements. As this workshop requires reflective

metacognitive thinking, it is advised to incorporate sessions on individual reflection and a lecture on various knowledge types before this session. This mapping activity can be used to analyse the various domain knowledge each member brings to the team, to articulate whether they miss certain knowledge, skills, or team roles, and the goals, needs, and characteristics (work styles, cultural differences) of individual team members. Finally, this activity can lead to the creation of the team's common values and norms and define the first draft of the team's ground rules.

Example 2. Facilitating experiential learning in cross-cultural teams to develop intercultural and teamwork competency together — a case from Purdue's global engineering module

We redesigned the required one-credit Global Engineering Orientation module at Purdue University, USA, for study-abroad students to better develop intercultural and teamwork competencies together. The earlier version focused mainly on individual learning and reflection about cultural theories, but the revised module added team-based intercultural activities and a 50-minute teamwork training session before team assignments. Because teams were primarily formed by study-abroad destination, the training emphasised practical teamwork processes that students could apply immediately.

The training session primarily focused on identifying roles in teams and conflict resolution. We first presented a variety of possible team roles based on the "Teamwork Foundations" video via LinkedIn Learning (Croft, 2020), which helped students to operationalize the teamwork input with tangible resources to enact. Then, we asked students to select two or three preferred roles based on their personal strengths and previous experiences, as well as two to three roles to avoid and other possible candidate roles. After individual selection, students shared their choices with the team. We then promptly introduced the concept of team conflict to students and emphasised that there existed constructive conflicts to improve the quality of teamwork and its product. Afterwards, we shared five styles of conflict management (Thomas & Kilmann, 1976) and videos on how to conduct crucial conversations to facilitate informative and productive communication (Effective Team Dynamics at GT, n. d.). With this setup, we then invited students to discuss with teammates how to negotiate individual team roles. This discussion allowed students to practice and reflect on conflict resolution and interpersonal communication, which are crucial for effective teamwork dynamics.

Cross-cultural reflections as a part of the module assignment, anchored in cultural differences, reinforced teamwork learning (Hofstede et al., 2010). Students first reflected individually on cultural barriers and created personal work plans, then collaborated on a team essay examining cultural similarities and differences and on a shared teamwork plan. Finally, they wrote an individual reflection on strategies that helped their cross-cultural team communicate and work effectively.

4 Recommendations for implementing and learning

In this section, we present several recommendations you can use to implement team-based pedagogy and develop teamwork competencies within your classroom environments. Our aim is to support setting up such team-based learning environments prior to the module starting, connecting the theoretical insights present in the previous chapters with hands-on advice. We also included how to handle dysfunctional teams during the process.

4.1 When developing teamwork-based education

Do not use teamwork just because this decreases the amount of feedback and grading time. Choosing team-based education has consequences for student learning, and if not done properly, it can cause more harm than good (Felder & Brent, 2024).

It is also critical not to assume that students naturally develop teamwork skills simply through group work. Consider making teamwork-related KSAs an explicit part of your learning outcomes, supported by thoughtful and targeted activities with clear instructions. The CDIO framework provides examples of *teamwork-related learning objectives* (Crawley et al., 2014). Highlighting the goal of these activities can help students who want to immerse themselves in the module content as soon as possible and spend some time on these activities. Be prepared that students might see these activities as irrelevant at the given time point for the project context and only appreciate them after the end of the module.

We suggest thoughtfully reflecting on specific frameworks of teamwork when designing instruction aimed at developing teamwork competencies. There are multiple frameworks available; just pick one that aligns with what you need and follow it. Finally, consider adopting a more systematic approach to teaching teamwork competencies. For example, we recommend the Trident Framework proposed by Isaac et al. (2024), which outlines three dimensions for teaching transversal skills: knowing, experiencing, and learning from experience.

4.2 Team formation

For the best team learning experience, teams of three to four are ideal, although teams of two to six students could also work fine, depending on the project context and complexity (Felder & Brent, 2024). Teams that are too large are more likely to face problems such as free riding, domination, and scheduling difficulties, while teams that are too small may lack enough diversity in skills and perspectives and can be more easily dominated by one member (Wankat & Oreovicz, 2015).

We recommend instructor-formed teams — especially when teamwork is a module learning objective — rather than relying on self-selection or random assignment. Digital tools like CATME (Purdue University, n.d.) can support team formation (the Team-maker survey takes lecturer's criteria into account when generating teams) and peer evaluation (the Peer Evaluation survey filled in by students can highlight team challenges), particularly in large classes. When forming teams, instructors should distribute students' abilities and experiences (e.g., language proficiency and

computer, technical, and hands-on skills), avoid isolating minority students in early-year modules (Felder & Brent, 2024), and ensure teams have a common time to meet outside class to reduce scheduling-related conflict.

To help you form teams, collect students' past teamwork experiences either by a brief pre-module survey or by asking them at the first team session. In addition, implement a team-building activity in class when the teams are announced, so students can get to know each other in a structured way to build psychologically safe environment (Ilgen et al., 2005). We advise playing (serious) board, card, or other types of games, potentially related to the topic or the case of the module, as mentioned in Chapter 2.1 (see Land, 2019). Also plan an activity when the teams create their team contract that includes their individual and team goals, roles and responsibilities, chosen ways of communicating with each other, and conflict resolution strategies.

In addition, suggest a social activity for the teams and highlight the importance of social-emotional interactions, besides task-oriented interactions. These activities are essential for the emergent states. Finally, explain the importance of developing teamwork competency and the importance of check-ins and accountability during the semester.

4.3 Team operation

During the module, design a session when students can learn and practice effective communication (active listening, collaboration, providing and obtaining information, and feedback). Also create a session when students can learn about various types of conflict resolution styles and provide them with possibilities to practice these (Magana et al., 2022).

Peer evaluation and feedback are well-established strategies for developing teamwork competencies in engineering education (Donia et al., 2018; Loughry et al., 2014.). We recommend web-based tools that let students evaluate peers and themselves using clear criteria tied to contributions and teamwork behaviours. Regular structured feedback and reflection improve students' confidence and skill in giving feedback, increase rating quality, and support teamwork learning (Donia et al., 2018; Loughry et al., 2014). As Felder and Brent (2024) note, peer evaluation should primarily promote cooperation, responsibility, and commitment — not just add another performance rating — so instructors should distinguish between items assessing task skills and those assessing interaction quality and teamwork commitment.

Beyond the formal peer evaluation, deliberately build in chances for students to reflect on their team process — what's working, what needs attention, and whether the original plan should change. This can be supported through assignments or in-class activities such as 1) creating and revising a team charter or code of cooperation; 2) writing individual reflections on collaboration; and 3) completing an individual contribution log that quantifies each member's contributions as percentages.

4.4 Team dysfunction tactics

Module design strategies suggest that forming balanced and evidence-based teams, conducting self- and peer evaluation, setting clear expectations, monitoring team dynamics, and cultivating a culture of psychological safety in teams are all effective means to circumvent team dysfunctions, such as social loafing or free riding, marginalisation, lack of team consensus, and lack of accountability. Besides those suggestions, the following approaches are helpful to avoid the frustrations caused by malfunctioning teams:

- In addition to a teamwork training workshop, require student teams to draft a team charter signed as the governing document to co-regulate the process.
- Provide opportunities for the teams to explicitly articulate everyone's contribution and set the expectation that individual scores could be reduced if not contributing enough, or at all.
- Reinforce periodic peer evaluation feedback as both a formative assessment for improvement and a summative assessment to adjust individuals' grades multiple times, especially in the early stage.

There are two main factors to consider: 1) if there is time for student teams to improve, and 2) if the situation is serious enough that it needs immediate, radical interventions. When time permits, we want to give all students a chance to improve, but there are a series of staged strategies that can be helpful to calibrate the team dynamics:

- Private instructor check-in with the whole team to solicit the team dynamics and contribution distribution and invite students to reflect on previous strategies and ways to balance workload.
- Lead a 'reset' meeting to revisit team charter and help establish a workable workload distribution, role clarification, and a concrete milestone, as rescope will be helpful. When necessary, provide tutoring and counsellor resources for additional support.
- If the team is given time and feedback to improve but this is not working, collect evidence and triangulate narratives across the entire team to inform judgement for grade differentiation. Provide a bonus for overloaded individuals and assess a penalty for free riders.
- As a last resort, remove the free rider from the team project pathway and set an alternative individual pathway if feasible.

Example 3. Example teaching material: an introduction to teamwork session for engineering modules

This example provides a complete resource that you can modify to your educational context at the beginning of a project or module. It draws on established findings from the teamwork literature, as well as our collective experiences teaching teamwork. You are encouraged to adapt the timing, examples, and activities to your own context. The language below is descriptive, directive, and rich in example phrases, allowing you to adapt. The recommended length of the session is 80

minutes, but it can be compressed to 60 or expanded to 120 minutes. Fig. 2.6.3 shows the overview of the lesson plan.

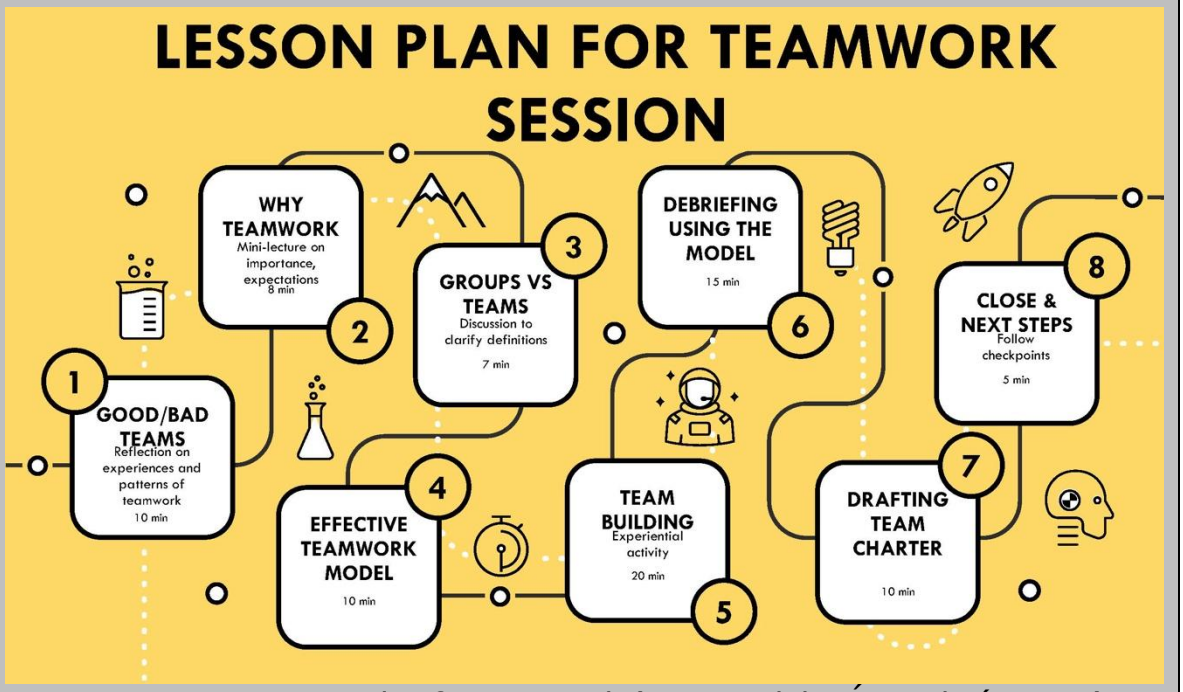

Figure 2.6.3: Lesson plan for teamwork (Own Work by Éva Kalmár, 2026)

Lesson plan for teamwork workshop

1. Opening reflection: "Good vs. bad team" (10 minutes)

Materials:

Slide "Think about your best/worst team", sticky notes, shared document, prompt cards.

Open by stressing that we expect teamwork but rarely teach it well. Use this moment to outline the semester project and expectations, then focus on students reflecting on prior team experiences, using their stories to avoid repeating past failures.

Student tasks:

- *Individually (1 minute): write an example that describes a positive team experience and a negative one. Alternative option: write three words or short phrases that describe a positive team experience and three that describe a negative one.*
- *Share with your neighbour or group (3 minutes): cluster common ideas — what patterns emerge?*
- *Whole class (5 minutes): invite volunteers to share one 'good' and one 'bad' pattern. Capture these visually on a whiteboard or slide.*

Have students identify recurring teamwork patterns so they can reinforce the positive ones and plan strategies to prevent negative ones. As themes like free

riding, psychological safety, and communication emerge, use them to launch a discussion about the behavioural side of teamwork and the importance of individual contributions.

2. Mini-lecture: why teamwork? (8 minutes)

Materials: *slides*

Key talking points:

- *Engineering work is increasingly interdisciplinary, and employers expect graduates who can collaborate effectively. Have students review job ads for their 'dream job' or provide industry examples and identify how teamwork is emphasised.*
- *High-performing teams generate synergy: the result is greater than individual contributions. Low-performing teams drain energy and time.*
- *Students rarely receive explicit training in team processes; we're making that training visible and assessable.*
- *This module will evaluate both your product and your process. Process evidence (charter, meeting notes, peer feedback) matters.*

Suggested slide visual: statistics on the time engineers spend collaborating, or a quote from industry partners emphasising teamwork.

3. Defining team vs. groups (7 minutes)

Materials: *definition slide; reflection on impact*

Have students work in their teams; ask them to establish characteristics of a team vs. characteristics of a group. Have them pick examples and share with the class. Have a discussion and agree as a class on what entails a team vs. a group.

You are in charge of summarising: groups coordinate logistics and split tasks; teams share a purpose with interdependent roles and collective accountability. Teaching this distinction matters because it shapes students' expectations, behaviours, and definitions of success — and helps them navigate many kinds of collectives beyond high-interdependence project teams.

4. The Effective Teamwork Model: definitions and mini-activities (10 minutes)

Materials: *model slide; handout summary*

We encourage instructors to select a teamwork model and present it. We have used the Effective Teamwork Model (Adams, 2002), but instructors can select the teamwork model of their preference. The important aspect here is to have a model that comes from the literature and has been implemented and validated in the past. Spend the time describing and presenting the model to the students.

Note: some instructors may present the model after the team-building activity; that may work too. We prefer introducing it beforehand, running the activity, then

debriefing by linking experiences back to the model — since students often omit key elements even when they know the framework.

Activity hook: "*as I describe each element, jot down one behaviour your team could adopt to make that element come alive."*

5. Experiential activity: the Marshmallow Challenge (20 minutes)

Include an early hands-on team-building activity so students meet their teams and start collaborating right away. Use a fun, low-stakes challenge (e.g., the Marshmallow Challenge — building the tallest free-standing structure from spaghetti, tape, and string, with a marshmallow on top) that encourages creativity and risk taking, then have teams analyse their process against the model.

Instructor notes: *run a countdown timer and circulate to observe behaviours (leadership, idea vetting, and conflict points).*

6. Debrief: connecting experience to the model (15 minutes)

Materials: *guiding questions on slide or handout*

The debrief is essential: it links the experience back to the teamwork model and makes students notice real team behaviours. In the Marshmallow Challenge, many students say it feels different when the activity is framed and analysed explicitly. A useful comparison is that kindergarteners often outperform engineering students (Furr,2011), likely because they have higher psychological safety in taking risk and prototype early with the marshmallow (the real constraint) in mind.

Guiding questions (display or read):

- *How did you start? Did you plan first, or jump into building? What were the consequences?*
- *Where did communication work well or break down? Any examples of active listening?*
- *Did roles emerge? Were they explicit? How did that help or hurt?*
- *Describe a moment of disagreement. How was it handled?*
- *Did everyone feel safe proposing ideas or pointing out problems? Why or why not?*
- *Another option is to have students fill out a short reflection on the activity.*

It is very important to map some of those moments to the teamwork model. Which element was strongest for a team? Which needs work? Have the students capture one improvement they will carry into the real project.

7. From concept to commitment: drafting the team charter (10 minutes)

Materials: *charter template; role cards*

Take the opportunity to have the students draft a team charter, contract, or similar. Explain that a charter is not busywork. It's their team's contract: how they will work, decide, communicate, and hold each other accountable. Explain that they will revisit it when things get messy. Emphasise that conflict is a normal part of life and we

should not avoid it; rather, we should have strategies in place to solve it productively. Here, instructors can bring the importance of individual preparation and contributions (Arthur et al., 2025).

8. Sustaining teamwork: follow-ups and assessment

Materials: *timeline slide; rubric excerpt*

Suggested checkpoints:

- *Process check 1 (Week 3): 5-minute anonymous form rating each model element; teams adjust charter accordingly.*
- *Midterm peer feedback (formative): short rubric-based feedback on contributions and communication. One example is to develop a survey where each team member will divide €100 among team members (including themselves) based on contributions. Analyse the data and report back to teams where issues arise.*
- *Reflection memos: individual one-page reflection tying a teamwork incident to module concepts (graded for insight, not positivity).*
- *Summative peer evaluation: Weighted component of final grade; rubric shared on day 1 (see Table 2.6.1 for an example).*

Table 2.6.1. Example of peer evaluation rubric

Dimension	*Meets expectations*	*Below*	*Exceeds*
Contribution quality	*Delivers tasks on time; work meets agreed standards; seeks feedback*	*Missed deadlines; superficial work*	*Proactively improves team output; mentors others*
Communication	*Shares info promptly; listens; responds respectfully*	*Silent or dominating; slow replies*	*Facilitates dialogue; models active listening*
Accountability	*Owns mistakes; follows through on commitments*	*Blames others; evasive*	*Holds self and others to high standard constructively*
Collaboration	*Participates in meetings; supports team decisions*	*Minimal engagement; undermines decisions*	*Builds cohesion; mediates conflicts effectively*

9. Closing script (5 minutes)

Close by reinforcing what the students just accomplished: they surfaced the behaviours that help teams succeed (and the habits that derail them), tested their collaboration under time pressure, and translated those lessons into concrete norms

in their team charter. Emphasise that a charter is a living agreement — not a one-and-done document — so they should revisit it at key moments (midpoint check-ins, in case of conflict, before major deadlines) and adjust as needed. The punchline: strong outcomes don't happen by accident; great products come from great processes, and their performance will reflect both.

4.5 Resources and further reading

In addition to the literature referenced in this chapter, we also suggest Aggrawal et al. (2024) and Jehn and Mannix (20001) on Teamwork conflict management and conflict resolution, Aguado et al. (2014) on the Teamwork Competency Test, Aubé et al. (2011) on skill acquisition and retention in individuals and teams, and Kozlowski et al, 2001, 2018), Mathieu et al. (2008), Oakley et al. (2004) and Ohland et al. (2012) on the effectiveness of teams. We also recommend Loughry and Tosi (2008) on performance monitoring, Rapp et al. (2021) on emergent states in teamwork and Reeves et al. (2018) and van der Vegt et al. (2001) on teamwork in professional practice.

5 Conclusion

Teamwork should be treated as a teachable engineering competency rather than an assumed byproduct of group work. Effective teamwork develops when educators intentionally design for it through explicit instruction, thoughtful team formation, structured opportunities for feedback and reflection, and timely support for conflict management and accountability. By focusing not only on task completion but also on team processes and emergent states over time, engineering programmes can better prepare students to collaborate effectively in diverse, complex, and interdisciplinary professional settings.

References

Adams, S. (2002). A conceptual model for the development and assessment of teamwork. In Proceedings of the 2002 American Society for Engineering Education Annual Conference. https://peer.asee.org/10049

Aggrawal, S., & Magana, A. J. (2024). Teamwork conflict management training and conflict resolution practice via large language models. Future Internet, 16(5), Article 177. https://doi.org/10.3390/fi16050177

Aguado, D., Rico, R., Sánchez-Manzanares, M., & Salas, E. (2014). Teamwork Competency Test (TWCT): A step forward on measuring teamwork competencies. Group Dynamics: Theory, Research, and Practice, 18(2), 101–121. https://doi.org/10.1037/a0036098

Arthur, W., Naber, A. M., Muñoz, G. J., Keiser, N. L., Atoba, O. A., Cho, I., & Bennett, W. (2025). A comparison of individual and team skill acquisition, retention (decay), and reacquisition using a synthetic task environment. Human Performance, 38(1), 43–60. https://doi.org/10.1080/08959285.2024.2436171

Aubé, C., & Rousseau, V. (2011). Interpersonal aggression and team effectiveness: The mediating role of team goal commitment. Journal of Occupational and Organizational Psychology, 84(3), 565–580. https://doi.org/10.1348/096317910X492568

Borrego, M., Karlin, J., McNair, L. D., & Beddoes, K. (2013). Team effectiveness theory from industrial and organizational psychology applied to engineering student project teams: A research review. Journal of Engineering Education, 102(4), 472–512. https://doi.org/10.1002/jee.20023

Carless, S. A., & De Paola, C. (2000). The measurement of cohesion in work teams. Small Group Research, 31(1), 71–88. https://doi.org/10.1177/104649640003100104

Colgrove, J., Geertsema, H., d' Hont, F., Kalmár, É., Maarschalkerweerd, J., Meijer, D. H., Slinger, J., Wackers, M., & Mira-Bontenbal, H. (2025). Co-creating durable skills education: A case study of the Collaborative Science for Biomedical Breakthroughs minor. European Journal of STEM Education, 10(1), Article 29. https://doi.org/10.20897/ejsteme/17466

Collins, C. G., & Parker, S. K. (2010). Team capability beliefs over time: Distinguishing between team potency, team outcome efficacy, and team process efficacy. Journal of occupational and organizational psychology, 83(4), 1003–1023.

Crawley, E. F., Malmqvist, J., Östlund, S., Brodeur, D. R., & Edström, K. (2014). The CDIO approach. In Rethinking Engineering Education: The CDIO Approach (2nd ed.) (pp. 11–45). Springer. https://doi.org/10.1007/978-3-319-05561-9

Croft, C. (2020). Teamwork Foundations [Video]. LinkedIn Learning. https://www.linkedin.com/learning/teamwork-foundations-2020/teamwork-is-the-core-21030268

Curşeu, P. L., & Pluut, H. (2013). Student groups as learning entities: The effect of group diversity and teamwork quality on groups' cognitive complexity. Studies in Higher Education, 38(1), 87–103. https://doi.org/10.1080/03075079.2011.565122

De Prada, E., Mareque, M., & Pino-Juste, M. (2022). Teamwork skills in higher education: is university training contributing to their mastery? Psicologia: Reflexao e critica, 35, Article 5. https://doi.org/10.1186/s41155-022-00207-1

Donia, M. B., O'Neill, T. A., & Brutus, S. (2018). The longitudinal effects of peer feedback in the development and transfer of student teamwork skills. Learning and Individual Differences, 61, 87–98. https://doi.org/10.1016/j.lindif.2017.11.012

Driskell, J. E., Salas, E., & Driskell, T. (2018). Foundations of teamwork and collaboration. American Psychologist, 73(4), Article 334. https://doi.org/10.1037/amp0000241

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. Administrative Science Quarterly, 44(2), 350–383. https://doi.org/10.2307/2666999

Essens, P. J., Vogelaar, A. L., Mylle, J. J., Blendell, C., Paris, C., Halpin, S. M., & Baranski, J. V. (2008). Team effectiveness in complex settings: A framework. In Team effectiveness in complex organizations (pp. 327–354). Routledge.

Effective Team Dynamics at GT. (n. d.). Crucial Conversations 1 [Video]. YouTube. https://www.youtube.com/watch?v=pCBBzveS10Q

Felder, R. M., & Brent, R. (2024). Teaching and learning STEM: A practical guide. John Wiley & Sons.

Furr, N (2011) Why Kindergartners Make Better Entrepreneurs than MBAs: And How to Fix It, Forbes https://www.forbes.com/sites/nathanfurr/2011/04/27/why-kindergartners-make-better-entrepreneurs-than-mbas-and-how-to-fix-it/

Gudiksen, S., & Skovbjerg, H. M. (2020). Framing play design. BIS Publishers.

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Cultures and organizations: Software of the mind (3rd ed.). McGraw-Hill.

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. Annual Reviews of Psychology, 56, 517-543. https://doi.org/10.1146/annurev.psych.56.091103.070250

Isaac, S., de Lima, J., Jalali, Y., Rossi, V., Schmid, S., Tormey, R., & Dehler Zufferey, J. (2024). How to develop engineering students' transversal skills. In S. Isaac & J. de Lima (Eds.), Teaching transversal skills for engineering students: A practical playbook of activities with tangibles. EPFL Press.
https://doi.org/10.5281/zenodo.13328581

Jalali, Y., Alberink, B., Dehler Zufferey, J., & Mondada, F. (2024). How to support students to develop skills for cultivating psychological safety in their teams. In S. Isaac & J. de Lima (Eds.), Teaching transversal skills for engineering students: A practical playbook of activities with tangibles. EPFL Press.
https://doi.org/10.5281/zenodo.13971766

Jalali, Y., Kovacs, H., Isaac, S., & Dehler Zufferey, J. (2022). Bringing visibility to transversal skills in engineering education: Towards an organizing framework. In Proceedings of SEFI 50th Annual Conference (pp. 1252–1259).
https://doi.org/10.5821/conference-9788412322262.1251

Jehn, K. A., & Mannix, E. A. (2001). The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. Academy of management journal, 44(2), 238–251. https://doi.org/10.5465/3069453

Kozlowski, S. W. (2018). Enhancing the effectiveness of work groups and teams: A reflection. Perspectives on Psychological Science, 13(2), 205-212.
https://doi.org/10.1177/1745691617697078

Kozlowski, S. W., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. Psychological Science in the Public Interest, 7(3), 77–124. https://doi.org/10.1111/j.1529-1006.2006.00030.x

Land, S. K. (2019). The importance of deliberate team building: A project-focused competence-based approach. IEEE Engineering Management Review, 47(2), 18–22. https://doi.org/10.1109/EMR.2019.2915600

Leslie, C. (2016). Engineering Competency Model. [Unpublished paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana].

Loughry, M. L., Ohland, M. W., & Woehr, D. J. (2014). Assessing teamwork skills for assurance of learning using CATME team tools. Journal of Marketing Education, 36(1), 5-19. https://doi.org/10.1177/0273475313499023

Loughry, M. L., & Tosi, H. L. (2008). Performance implications of peer monitoring. Organization Science, 19(6), 876–890. https://doi.org/10.1287/orsc.1080.0356

MacGregor, J. (1990). Collaborative learning: Shared inquiry as a process of reform. New Directions for Teaching and Learning, 42, 19–30. https://doi.org/10.1002/tl.37219904204

Magana, A. J., Karabiyik, T., Thomas, P., Jaiswal, A., Perera, V., & Dworkin, J. (2022). Teamwork facilitation and conflict resolution training in a HyFlex module during the COVID‐19 pandemic. Journal of Engineering Education, 111(2), 446–473. https://doi.org/10.1002/jee.20450

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. Academy of management review, 26(3), 356–376. https://doi.org/10.5465/amr.2001.4845785

Mathieu, J., Maynard, M. T., Rapp, T., & Gilson, L. (2008). Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future. Journal of management, 34(3), 410–476. https://doi.org/10.1177/0149206308316061

Nadal, C. T., Mañas, G. P., Bernadó, B. S., & Mora, C. A. (2015). Assessing teamwork competence. Psicothema, 27(4), 354–361.

Oakley, B., Felder, R. M., Brent, R., & Elhajj, I. (2004). Turning student groups into effective teams. Journal of Student Centered Learning, 2(1), 9–34.

Ohland, M. W., Loughry, M. L., Woehr, D. J., Bullard, L. G., Felder, R. M., Finelli, C. J., Layton, R. A., Pomeranz, H. R., & Schmucker, D. G. (2012). The comprehensive assessment of team member effectiveness: Development of a behaviorally anchored rating scale for self-and peer evaluation. Academy of Management Learning & Education, 11(4), 609–630. https://doi.org/10.5465/amle.2010.0177

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. Journal of Engineering Education, 95(2), 123–138. https://doi.org/10.1002/j.2168-9830.2006.tb00884.x

Purdue University. (n.d.). CATME [Web application]. https://www.catme.org

Rapp, T., Maynard, T., Domingo, M., & Klock, E. (2021). Team emergent states: What has emerged in the literature over 20 years. Small Group Research, 52(1), 68–102. https://doi.org/10.1177/1046496420956715

Reeves, S., Xyrichis, A., & Zwarenstein, M. (2018). Teamwork, collaboration, coordination, and networking: Why we need to distinguish between different types of interprofessional practice. Journal of Interprofessional Care, 32(1), 1–3. https://doi.org/10.1080/13561820.2017.1400150

Salas, E., Cooke, N. J., & Rosen, M. A. (2008). On teams, teamwork, and team performance: Discoveries and developments. Human factors, 50(3), 540–547. https://doi.org/10.1518/001872008X288457

Stevens, M. J., & Campion, M. A. (1999). Staffing work teams: Development and validation of a selection test for teamwork settings. Journal of management, 25(2), 207–228. https://doi.org/10.1016/S0149-2063(99)80010-5

Thomas, K. W., & Kilmann, R. H. (1976). Thomas-Kilmann conflict mode instrument. Group & Organization Studies, 1(2), 249–251. https://doi.org/10.1177/105960117600100214

Trevelyan, J. (2019). Transitioning to engineering practice. European Journal of Engineering Education, 44(6), 821–837. https://doi.org/10.1080/03043797.2019.1681631

Tucker, R., & Abbasi, N. (2016). Bad attitudes: why design students dislike teamwork Journal of Learning Design, 9(1), 1–20. https://doi.org/10.5204/jld.v9i1.227

Tuckman, B. W., & Jensen, M. A. (1977). Stages of small-group development revisited. Group and Organization Studies, 2(4), 419–427. https://doi.org/10.1177/105960117700200404

van der Vegt, G. S., Emans, B. J., & van de Vliert, E. (2001). Patterns of interdependence in work teams: A two-level investigation of the relations with job and team satisfaction. Personnel Psychology, 54(1), 51–69. https://doi.org/10.1111/j.1744-6570.2001.tb00085.x

Wang, D., Waldman, D. A., & Zhang, Z. (2014). A meta-analysis of shared leadership and team effectiveness. Journal of Applied Psychology, 99(2), 181–198. https://doi.org/10.1037/a0034531

Wankat, P. C., & Oreovicz, F. S. (2015). Teaching engineering. Purdue University Press.

Wei, S., & Han, Y. (2025). A call to foster psychological safety to facilitate inclusive and effective engineering student teams and learning. Engineering Education Review, 2(4), 172–181. https://doi.org/10.54844/eer.2024.0839

Wolfe, J., Powell, E. A., Schlisserman, S., & Kirshon, A. (2016, June). Teamwork in engineering undergraduate classes: What problems do students experience? In Proceedings of the 2016 ASEE Annual Conference & Exposition. https://doi.org/10.18260/p.26069

AI statement

During the preparation of this work, the authors used ChatGPT to verify grammar. After using this tool, the authors reviewed, edited, and made the content their own as needed. They take full responsibility for the content of the publication.

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