

ASSESSMENT OF GROUP WORK: The connection of group traits to group mediators

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ABSTRACT

In our modern world we are constantly asked to solve complex problems and adopt to changes, and little can be accomplished without a work group. Modern work groups are interdisciplinary teams of interdependent individuals who share responsibilities for results within their organization. However, today's professional trainings focus mostly on individual development. And often, training and coaching is only provided to top talents or those with performance struggles. Consequently, training resources do not necessarily focus on the entire workforce, and limited training options are available for actual teams to learn, improve collaboration and grow together.

This technical report puts the work team in the centre of work effectiveness in the public and private sector and provides an approach to better understand team success factors and tailored training leveraging those factors for a more successful team outcome.

We provide a derivation of the group assessment used in the product *Coach in a Box* and especially in *Coach in a BOX - Discovery*. We set the foundation with the theory of group work behind the model of connected team moderating traits and their team mediator. Second, we introduce how we measure these aspects in the team and how the training can be customized for each individual team. Finally, we provide empirical results of the model in practice, providing statistical evidence that the model is serving its purpose.

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1 INTRODUCTION

This technical report explains the theoretical background, validity, and reliability of Coach in the BOX – Discovery. Discovery enables a measurement of team effectiveness using 14 team traits moderating the respective team Mediators ‘Affect’, ‘Cognition’ and ‘Behaviour’ which ultimately determine every team’s output and success in their day-to-day routine. Discovery is taking a unique approach enabling a deeper understanding of your own team traits and effectiveness.

Modern teamwork effectiveness research is clear about how team effectiveness is determined using a refined work-input-output model and provides a more sophisticated definition of influencing factors called “Mediators” in-between. With Discovery, we provide a tool that measures these Mediators indirectly using our 14 Moderating Traits. The input and output parameters of teamwork have seen a lot of research over the years. Teamwork output is defined with generated quantity, quality, efficiency, or team viability and teamwork input is among others defined with motivation, knowledge, or capabilities the team possesses. Research also clearly connects positive and negative output feedback loops to the input parameters. In return, a measurement and understanding of Team Mediators is key for work teams as they influence how input parameters are generating output and act as positive or negative amplification of input and output characteristics of work teams.

In this technical report we also explain how our 14 Moderating Traits are derived and how we connect them to the team’s Mediators using the Connecting Factor Matrix (CFM).

2 Teamwork Efficacy, Interdependence and Moderating Traits

2.1 Work Group

A group or team is defined by Hemphill (Hemphill, 1949) as different in, comprised by McGrath (McGrath, 1964):

- Size Number of members
- The degree to which they are organized and operate in a formal manner.
- The degree to which they are stratified, that is, the extent to which group members are related to one another in a hierarchy.
- The degree to which they exercise or attempt to exercise control over the behavior of their members.
- The degree of participation which is permitted, expected, or demanded of members.
- The ease of access to membership in the group and ease with which a member can leave or be expelled from the group.
- The degree of stability of the group over time and the continuity of its membership over time
- The degree to which group members relate to one another intimately, on a personal basis and with respect to a wide range of activities and interests, rather than in a formal manner and only with respect to a narrowly defined set of activities.
- The degree to which the group is subdivided into smaller groups or cliques, and the extent to which such cliques are in conflict with one another.

2.2 IMIO Model and Team Success

To understand the theory of group interactions a look into McGrath's analysis of various published works on team setups and their activities is helpful. He postulated the idea of a basic input-group activity-outcome model which is today summarized as input-process-output model. Figure 1 (page 4) shows that he comprises the input parameter of the team in member characteristics, group structure and task and environmental characteristic. The group activity or process to achieve a goal, he split into three elements. Communication combines the task of combining resources and performing the task itself. Flow of influence describes the alignment process within the group such as decision making and goal setting. Finally, the flow of affects handles how the group treats one another and how they maintain a team bond. These three processes work simultaneously, even though they vary in importance depending on the task being fulfilled by the group. His studies also showed that the group activities itself have not only an impact on the outcomes, but the group input classes itself. (McGrath, 1964)

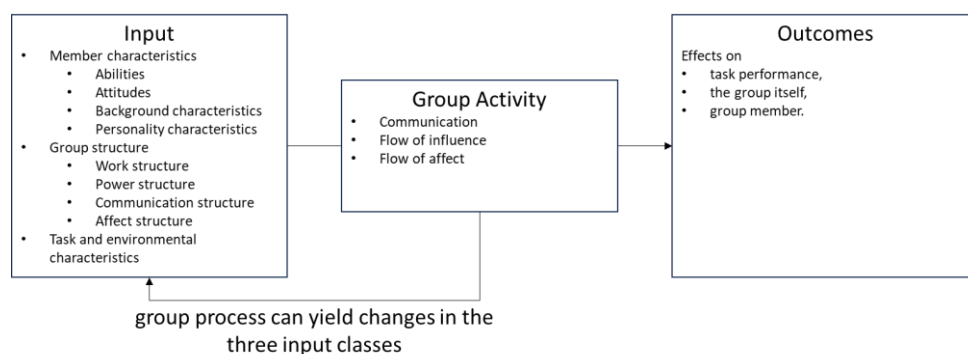


Figure 1: Input-group activity-outcome model (McGrath, 1964)

In this case the result of a process is considered a **Mediator** between the input and output side of the model. Basically, team input sizes have a fixed relationship with how they transform into outcomes of the team. Considering that the relationship can change of how processes derive inputs into outputs in group work, we extend the model from McGrath by **Moderators**. Brodeck describes these by using an example of making decisions in a team, Figure 2. Case A: Even though larger group sizes are intrinsically advantageous for the team's performance (superposition of member characteristics is larger), they can have negative impacts on communication. In larger groups each individual has less share of speech as for smaller groups, which in return allows less time to listen to everyone's input. As a result, the bigger performance potential of the larger group is not utilized well and can even have a negative impact on the outcome. Case B: is, however, a decision-making procedure established such as everyone gets the same share of speech in a meeting, then we can expect an overall positive impact on the outcome. The latter is called **Moderator** and is impacting given **Mediators** in a team's process. (Brodeck, 2007)

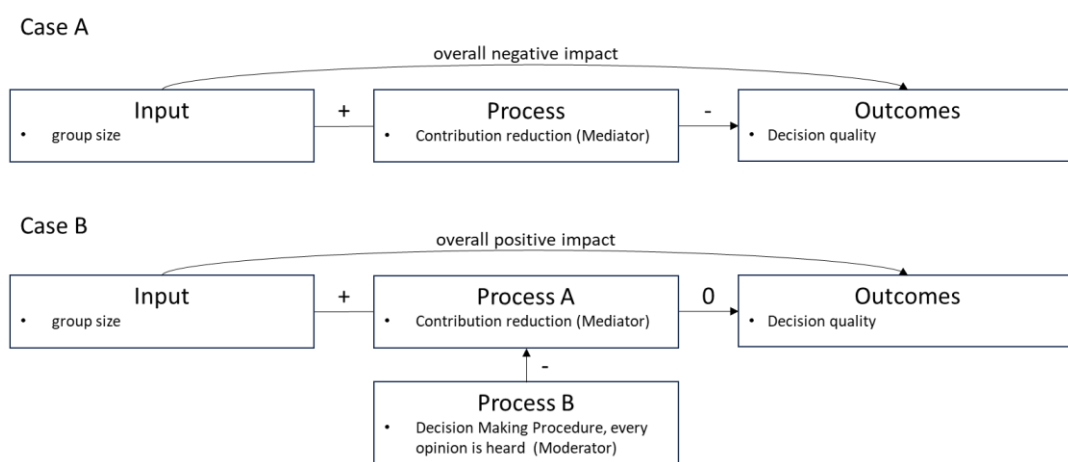


Figure 2: Impact of Moderators on the Input-Process-Output model. (Brodeck, 2007)

In summary, Mediators describe the relationship between the input and output side in the input-process-output (IPO) model in group work. Basically, the result of a process in which a group is transforming input sizes into a wished output or goal. Mediators can have a positive (e.g., coordination process) or negative (e.g., conflict management) outcome on the aimed goal. On the other hand, Moderators are influencing factors to Mediators, like communication tools or collaboration skills in a team. They can positively influence mediators and change the relationship between input and output of a team. (Brodeck, 2007)

Team success is not always directly impacted by the team's performance alone but by mediators in between. Often team members are not even able to influence all conditions relevant to the team's success. The level of autonomy is in reality often limited and in return the process towards a common goal cannot be controlled by the team in full. In Figure 3 Brodeck differentiates between three categories of Moderators: context conditions, group internal process (joined affect and foster), and dynamic development process (dynamic of performance and learning). Context conditions are resources, complexity, market influences and technologies. They can negatively impact the outcome of a team's effort, but under certain context conditions can even show advantage to other teams when applied e.g., a cohesive team can perform better under strong project pressure than other teams not being as good connected. Group internal process can cause process gains and losses. He lists motivation, coordination, and cognitive ability as potential effectors to influence the group's success. Finally dynamic of performance and learning understands the group as learning system. It differentiates between individual learning, social influenced learning, and collective learning as a group. All three can influence the team's success

(Brodeck, 2007). The dynamic of performance and learning is similar to McGrath result of processes having an impact of the capabilities or input of a team, just described as moderator.

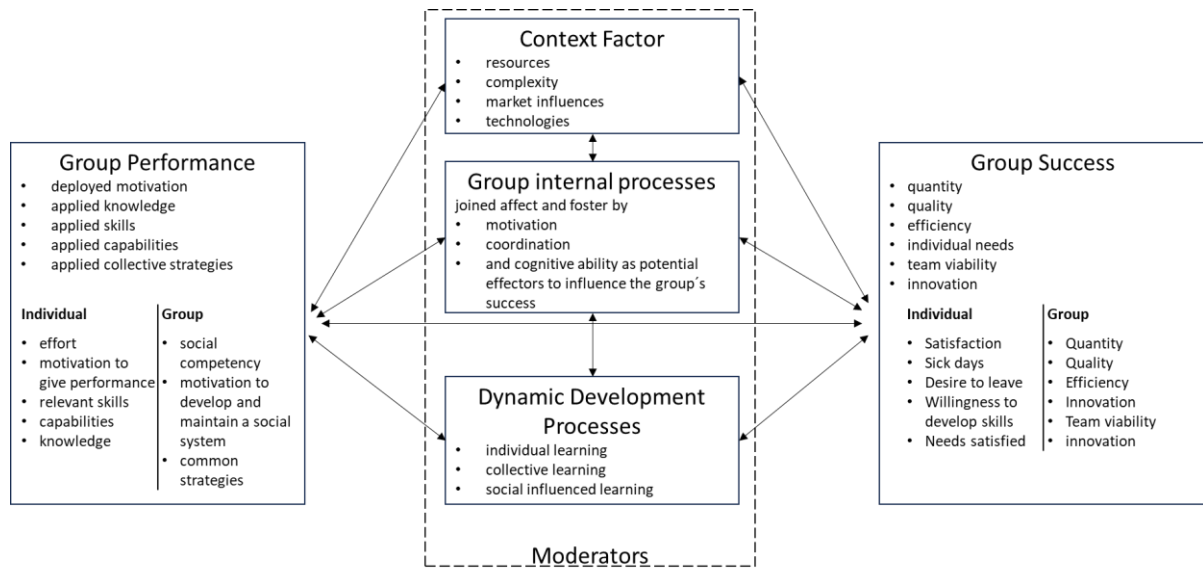


Figure 3: team success depends on three major moderator categories. They can influence the team performance positively or negatively towards a team goal (Brodbeck, 1996)

In an example of a project group aiming to develop a new car the difference and impact of Mediators and Moderators should be illustrated. These teams need to make constant decisions of how their design is serving the given specification. They often make attempts to solve an issue, get feedback, interpret results, and apply learnings to another attempt. Among other group inputs they need to apply their knowledge to interpret results properly and output the correct learning. The Mediator or process between this input and output is 'knowledge sharing'. How successful this process is, however, is then described by moderators impacting the mediator 'knowledge sharing'. For example, which coordination methods is the team applying (e.g., brainstorming). Often the difference of two project groups' success only comes to light when negative context factor moderators are applied in addition. For instance, when the deadline of an attempt is pulled in and the group needs to act quickly. Here the quality of the result (group success) might then differ.

Ilgen and colleagues found after reviewing multiple relevant studies concerning group work that the IPO model had great impact on how group work research was conducted, but also limited the understanding of group work to a linear relationship of input, process, and output. They describe this model as insufficient, naming three reasons. First, most mediating factors describing the relationship between input and output are in fact no processes, but emergent cognitive or affective states. Second, the IPO model implies a single linear cycle from input to output, but the output will influence the input. Third, the IPO model tends to suggest a linear progression of a single input times a process resulting in an output, but multiple interactions between input and process, and process and process happen at a time resulting in an aimed output. Therefore, they suggest a new IMOI model reflecting their findings. The term mediator is used instead of process as it also includes emerging states and the feedback of the output to the input is added as seen in Figure 4. Further they divide the IMIO model into three temporal stages and classified those based on their literature study in affective, behavioral, or cognitive aspects. The forming stage consists of trusting (affective mediators), planning (behavioral mediator), and structuring (cognitive mediators). The functioning stage contains bonding (affect), adapting (behavior), and learning (cognition). The finishing stage in which the work group ends its task for planned or unplanned reasons. They only found little work concerning this last stage and suggested more work on this final phase. (Ilgen, Hollenbeck, Johnson, & Jundt, 2005)

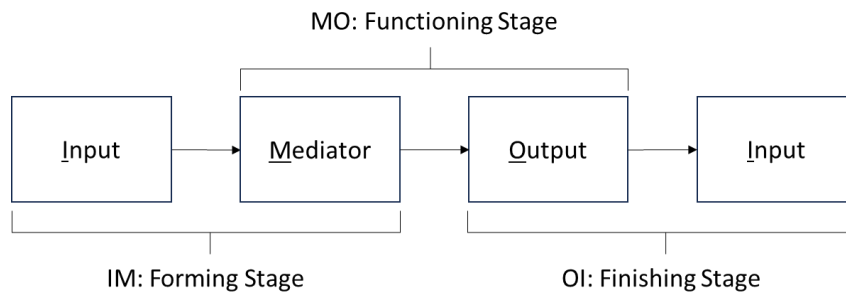


Figure 4: IMO framework with subdivided stages. (Ilgen, Hollenbeck, Johnson, & Jundt, 2005)

2.3 Work Team Effectiveness and Viability

Just considering the IPO model from McGrath (McGrath, 1964) the team effectiveness is only defined by processes or as later broadened by Ilgen and colleagues (Ilgen, Hollenbeck, Johnson, & Jundt, 2005), and Brodeck (Brodeck, 2007) by Mediators and Moderators. However, as Sundstrom states: “[...] team effectiveness is more a process than an end-state. [...]” (Sundstrom, De Meuse, & Futrell, 1990). With process they mean a continuously adopting task which does not have an end state. In their article they analyze multiple works concerning the influencing factors to work team effectiveness and they provide us with a dynamic model as shown in Figure 5.

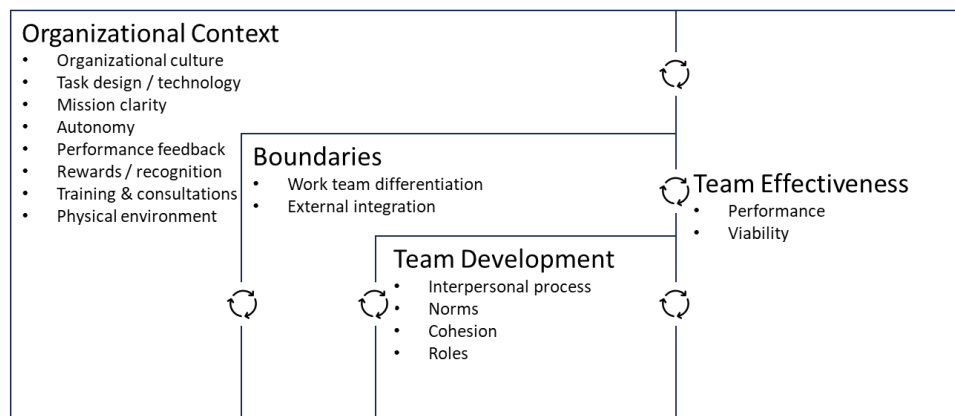


Figure 5: Dynamic work team effectiveness model (Sundstrom, De Meuse, & Futrell, 1990)

The model shows the dynamic interrelation of Team Effectiveness and three classes: Team Development, Boundaries and Organizational Context. They describe Team Effectiveness as more than performance, like output of quantity of a product, quality or delivered services, but also advance the term by team viability as term describing member satisfaction, their participant, and willingness to continue their work. Further they would add cohesion, intermember coordination, maturity of communication and their problem-solving skills. For them only looking at the actual performances doesn't provide a full perspective of the team's continuity in the future otherwise. Organizational Context is the first-class impacting Team Effectiveness, it describes the outer features of an organization around the work team providing resources, systems, or tools to the team. Boundaries on the other hand should not be perceived negatively, they describe differences of work groups to one another, barriers to access and transfer information, goods or people or serve as links between outer teams, peers, customers, etc. Boundaries provide the team context; without them the team has a to lose context and can get overwhelmed. Wise worse they would become isolated. Finally, Team Development reflects that teams learn and adopt to their boundaries and context. (Sundstrom, De Meuse, & Futrell, 1990)

2.4 Emergent Stages, the ABC and their Moderators

We introduced the IMOI model from Ilgen et al. (Ilgen, Hollenbeck, Johnson, & Jundt, 2005) in the previous chapter 2.2 IMIO Model and Team Success. Grossman et al. further detailed out the Mediators in the model by both the team processes and emergent states, see Figure 6. Basically, three major types of mediators are differentiated: affective, behavioral, and cognitive mediators. For each they focus on those three mechanisms which receive the most attention in the literature. First, affective mechanisms are described as reflection of team relationships such as shared motivational characteristics, team moods and emotions. Second, behavioral mechanisms outline what team members do, their activities and interactions focusing on task completion or as described before processes. Finally, cognitive mechanisms summarize what teams think or any cognitive activity within the team. In Table 1 a summary of the mechanism definition is conducted which is based on Grossmann et al.'s analysis of literature and their interpretation. (Grossman, Friedmann, & Kalra, 2017). Further it was refined with our own understanding of the applied work group experience.

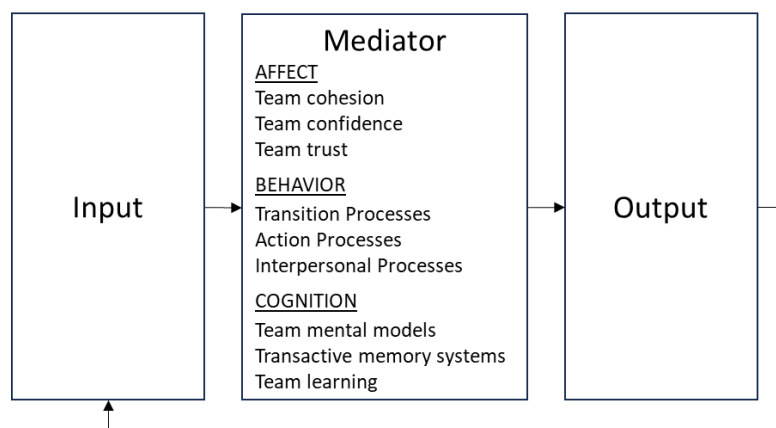


Figure 6: IMIO model and further defined mediators ABC. (Grossman, Friedmann, & Kalra, 2017)

Grossman et al. also facilitated the idea that the mentioned mediators and sub-mechanism are moderated by certain skills or traits a team possesses. Continuing this thought and combining it with Brodbeck's introduction of Moderators which can positively or negatively impact Mediators we continued the list to link these moderating traits to Grossman's Mediators. In Table 2 we list given examples mentioned by Grossmann for potential moderators connected to the ABC model and added additional once base on our applied work group experience. These moderating traits represent skills a team can have to impact the moderators within a team's task and are in return an influencing factor to the team's success and efficacy as the IMIO model suggests. We provide a team Moderating Trait definition in Table 3 which represents the maximum achievable skill level for each trait, but every team can also possess certain lower degrees of this maximum achievable definition. It is important to note that the shown Mediators in Figure 6 only address a portion of the factors defining team efficacy as we learned from Sundstrom et al. in chapter 2.3 Work Team Effectiveness and Viability, as the boundaries and organizational context is defined outside of the work group. However, the same model suggests that the work group's ability or their moderating traits can influence how they deal with those outside factors and make the team more performant and viable. Also, Brodbeck's model in Figure 3 notes that there are more Moderators which cannot be influenced by the team.

Table 1: Definition of team mediating sub-mechanisms following Grossman et al. analysis of various studies (Grossman, Friedmann, & Kalra, 2017) , and further defined by learnings in this article.

Team Mediator	Sub-mechanisms	Definition
Affect	Team Cohesion	Team cohesion, both social and task oriented, is a continuous process in which all team members have the desire to be and remain part of the team and achieve a common goal. The team enjoys working together. Favored by time, common interests, and common understanding of the team's goal and values. Conflicts negatively affect Team Cohesion.
	Team Confidence	Team Confidence is a running process which consists out of team efficacy (a shared belief that a particular task can be accomplished) and team potency (shared belief in the ability to meet future challenges). Describes, which tasks a team dares to achieve, how much energy it is willing to invest and how well it can deal with setbacks.
	Team Trust	Team Trust is an ongoing process which summarizes a generally positive attitude and positive expectations of the team members towards each other. Team members are willing to cooperate, to rely on one another and dare to admit mistakes. A shared leadership approach, empathy and common control mechanisms favor Team Trust.
Behavior	Interpersonal Process	Interpersonal Processes describe all personal relationships and conflicts among team members as well as their perception and assessment across members. Avoidance strategies and competitive thinking are negatively affecting interpersonal processes, but cooperative team goals strength them.
	Action Process	Action Processes are all processes dealing with the joint task completion and the achievement of common goals within the team. Further part of Action Processes is team coordination, back-up processes, communication, and status tracking.
	Transitional Process	Transitional Processes deal with planning for the future in the team. Strategy-forming processes are similarly part of it as well as working out a common mission and vision statement. Also, the implementation and support of the changes is part of it. Important for Transitional Processes are a strong Change Mindset, a critical reflection of the past and a good resource planning.
Cognition	Shared Mental Models SMM	Shared Mental Models are ongoing processes summarizing a common understanding of task sharing, skills, and roles. Also, the ability to predict how a team member will react or how they will solve a specific task. Same understanding about the importance of deadline, speed, and priority.
	Transactive Memory System TMS	Transactive Memory System summarizes continuous processes concerning the collective knowledge of the entire team. Means a clear understanding of who owns what knowledge, an established structure that makes it possible to access the existing knowledge and consensus on who is the expert in which area. Also, the accuracy to what extent the previous points are correct. TMS reduces the individual cognitive load or the urge to "need to know everything".
	Team Learning	Team Learning means all processes which deal with the exchange of knowledge, shared learning, and the ability to develop and improve as a team. Learning from experience and proper feedback handling is important for Team Learning. An important factor to deal successfully with dynamic work environments.

Table 2: The ABC model and connection to moderating traits. (Grossman, Friedmann, & Kalra, 2017). Extended by our applied group work experience in this article.

Team Mediator	Sub-mechanisms	Connected Moderating Traits
Affect	Team Cohesion	shared leadership, team self-confidence and charisma, team intimacy, tolerance and respect, accountability, empathy
	Team Confidence	Alignment, recognition, shared leadership, team self-confidence and charisma, accountability.
	Team Trust	Alignment, shared leadership, team intimacy, tolerance and respect, accountability.
Behavior	Interpersonal Process	Recognition, conflict management, team self-confidence and charisma, team intimacy, tolerance and respect, empathy.
	Action Process	Alignment, ability to adapt, analytic capacity, decision making, shared leadership
	Transitional Process	Ability to adapt, analytic capacity, decision making, learning, accountability.
Cognition	Shared Mental Models SMM	Alignment, shared leadership, team intimacy, accountability, empathy.
	Transactive Memory System TMS	Alignment, learning, team intimacy, tolerance and respect, empathy.
	Team Learning	Ability to adapt, innovative capacity, learning, team intimacy, empathy.

Table 3: Definition of Team Moderating Traits as used by Coach in a BOX – Discovery (Zedar Coaching Systems GmbH)

Moderating Traits	Definition
Alignment	Each team member is aware of all relevant information at any time. Entails task related information, long-term direction, vision & mission, goal setting and context changes. Has a strong communicative component and includes the quality of knowledge and information and the exchange systems used. Efficient alignment in terms of spent time and required effort.
Recognition	Recognize and celebrate successes of your own, of others and of the group. Draw positive energy from success as a team. Value the effort of the team or its individual members and establish and employ a system of recognition. Being able to contextualize successes and connect the individual contributions to the overall success of the team.
Ability to adapt	Fast adaptation to new situations without loss of efficiency, including new team member integration, organizational changes, back-up support (e.g. vacation, business trips), change of team context, change of role descriptions or new goal assignments. Further, it means the acceptance of change and to be able to react flexible and quickly to it.
Analytic Capacity	Ability to grasp and understand situations, problems, or tasks as a team of individuals. High-quality analysis and assessment of specific challenges or new tasks, drawing the right conclusions based on the evaluation. Fast and structured approach to exploring situations, including the relevant team members in the process to ensure a high comprehension level.
Decision Making	Make the right decisions based on a specific situation. Have the courage and confidence to make and employ a decision as a team. Ability to make shared decisions based on objective reasons and information. Do the right thing that serves the team or organizational goals and no other or hidden motives. Accepting decisions even after initial disagreement and having confidence in the decisions. Ensuring high quality outcomes by including the relevant people in the decision process.
Shared Leadership	Informal leadership capability of the team. The team is able to provide situational leadership as needed and team members can switch into leading roles based on capability and challenge. Team members are empowered to lead in specific situations or tasks and there is acceptance of and trust in their leadership. Shared Leadership is the opposite of micro-management by the team or management.
Innovative Capacity	Capacity, capability, and motivation to try new things, be open minded and question existing processes and situations. Allowing space for creative processes, techniques, and systems. Never be satisfied with the status quo, appetite for all things innovative. Have the courage to reinvent yourself as a team and dare to enter new terrain.
Conflict Management	Dealing with internal conflicts in a non-biased and fair way. Team capability to address conflicts directly and to resolve them together without loss of motivation or efficacy. Further, having a structured approach and methods that help to untwine complex situations in order to find and deal with conflicts. Ability to genuinely listen to one another and identify conflicts early, even in times of disagreement.
Learning	Means first, a collective learning refers to the exchange of experience in situations and creating a common understanding, analysis, and reflection of those as a team together. Then, the so-called social induced learning - when team members work with one another and learn traits and behavioral or cultural patterns on the go. Lastly, knowledge access - the ability to access the team's knowledge and information and a common sense to share these with the rest of the team.
Team Self-Confidence	A strong team self-esteem by a shared belief in the competence and potential of the team. The strengths to defend one's own abilities and expertise against external criticism or headwinds. Further, a team's willpower to accomplish new tasks successfully and trust in each others' capabilities. Openly communicating these believes to external stakeholders.
Team Intimacy	The team's ability to know, share and acknowledge each other's strengths & weaknesses, and personal traits. A common sense of sharing and recalling professional knowledge and skills across the team and a strong mutual trust in each other. Lastly, a clear understanding of personal boundaries, e.g., working hours and places, as a foundation for efficient collaboration.
Tolerance and Respect	The ability to interact unbiasedly and respectfully with one another. Everyone treats each other the way they want to be treated, even in case of differing opinions or disagreements. The admiration of other team members' knowledge, qualities, and achievements. Everyone in the team holds each other in high esteem and associates positive feelings with them.
Accountability	Mutual ability to rely on each other, follow the slogan: "Walk the talk"; Everyone in the team makes realistic promises and delivers accordingly (e.g., regarding time and quality of work). Capability, to communicate early and request support when one is not able to stick to their promises. Shared understanding of the connection between everyone's responsibilities and their contribution to the overall team goal.
Empathy	The ability to be genuinely curious about and aware of the emotions and feelings of others in the team. Capability to step into the other team members' shoes and consider situations from their perspective. Safe space in the team to share feelings and stories openly. Team members understand and accept their colleagues' emotions independent of bias or differences.

3 Model of Connected Team Moderating Traits and Team Mediator

3.1 Motivation and Model Derivation

The aim of this work is to provide a measurable, developable, and assessable model to measure work group effectiveness. Whereat, effectiveness is defined as performant and viable (Sundstrom, De Meuse, & Futrell, 1990) or also extended by the term group success (which we favor) meaning by quantity and quality of their output, efficiency, individual need satisfaction, team viability and innovation output (Brodbeck, 1996).

The previously described Moderating Traits are easily assessable in applied group work or daily routines of teams working together in the private sector or public government facilities and can give direct guidance to all different types of teams like interdisciplinary project teams, or disciplinary department organizations, etc. In the previous chapter we also explained the connection of those to the ABC Mediators which on the other hand connect to the level of team success. This opens the opportunity to measure ABC Mediators through Moderating Traits which are more easily measured in day-to-day teamwork and ultimately provides the chance to measure how successful a team can be. On the other hand, the ABC Mediators provide the foundation to define proper group training and tailor them to the teams strengths or weaknesses.

Following the literature analysis in chapter 2 Teamwork Efficacy, Interdependence and Moderating Traits we could not find a difference in importance of the ABC Mediators itself, in return we assume them as equally contributing to the team success. Also considering that we want to provide a model which is generally useful across various teams it makes sense to assume them equal. Thus, it is important to note that depending on the task a team is confronted with, one or the other Mediator is more dominantly used than others. Yet, the same logic can be applied to suggest that the Mediators are equally important as a team is never confronted with a single task which repeats. With that said, we extend the definition of a work group also by the fact that they continuously need to adopt and are confronted with new tasks, but also not neglecting recurring tasks a team can possess in addition.

Further, the Moderating Traits impact several Mediators at a time as shown in Table 2 and the same table suggest that they have a different degree of importance to the team as some impact the ABC Mediators more often than others. The other way around, the Mediators are impacted by multiple Moderating Traits which suggest that a superposition of them is defining a single ABC Mediator. This lays the foundation of the model we suggest, also summarized in Figure 7.

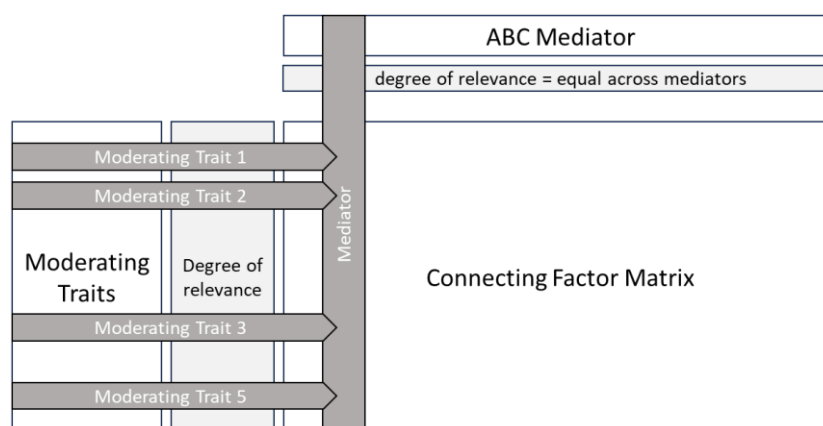


Figure 7: Model of Connected Team Moderating Traits and Team Mediator. Example given of how a single mediator is impacted by multiple moderating traits.

The single relationship of the moderating traits to the ABC mediators is defined by the Connecting Factor Matrix (CFM). To define the CFM properly a sharp definition of the ABC mediators and

Moderating Traits is important. this is already reflected in Table 1 and Table 3, after several adjustments using our applied group work experience. A two-step approach is required to define the CFM. First, a combination of independent rating and interviewing of experts and using the average of these results for a first definition of the CFM. Second, to analyze the Team Traits of a given team and conduct an interview with the members of how good they feel reflected by the ABC mediators using the CFM from the first step. Then the CFM can be fine-tuned to the feedback given from each team member.

3.2 Use case: Tailored Team Training

The CFM provides us with the ability to measure work group mediators indirectly using easier assessable group traits. With the aim to improve the group's common mediators we have a tool to customize trainings and training plans for teams. This approach is the foundation of the product *Coach in a BOX*. This connection is summarized in Figure 8 and shows that an expect positive feedback on the Moderating Traits is expected and in return on the ABC Mediators. The approach of how to assess the Moderating Traits is explained in the next chapter.

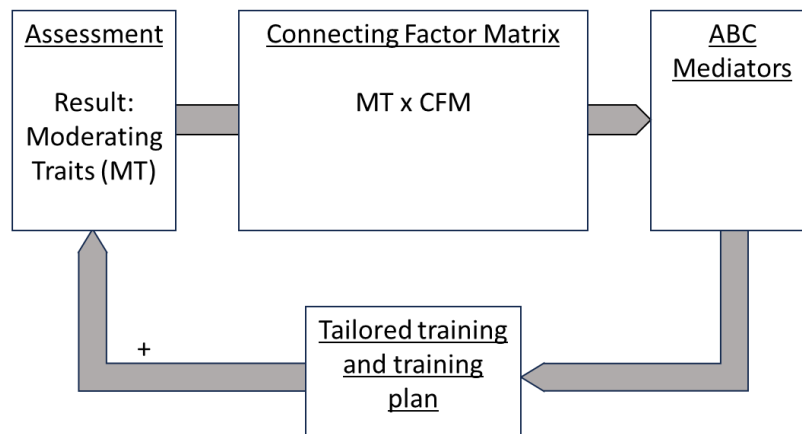


Figure 8: Tailored Team Training using the connecting factor matrix.

This concept also provides us with a method of validation. After s training is conducted a change in the assessment should be recognizes in the group's response. This rises the opportunity to conduct the assessment twice, before and after a training, and shows us how moderating traits are stimulated by the training.

4 Assessment of Team Moderating Traits

4.1 Constructing the Assessment

We want to measure the team's Moderating Traits directly from each individual member in the team. This provides us with two important insights into the group work. First, an average level of all opinions about the individual group trait and second, an understanding of how divided the group opinion is on certain group traits. The latter is important to select the right training plan because the team might not necessarily agree on the level of trait fulfillment.

In order to be able to have this discussion we need to measure the Moderating Traits a work group possesses. It is common practice in psychology, education, but also in work environments to use questionnaire assessments for this measurement. Accordingly, we make use of this tool and constructed 15 domains-based survey as shown in Table 4; one domain per moderating trait.

1929, Likert analyzed five attitude areas of political, ethical, and ideological interests among undergraduate students in nine US universities and colleges with somewhat above 2000 participants using with what he called "survey of opinions". He tested four types of questions. First, questions needed to be answered with Yes or No. Second, multiple choice questions. Third, proposition questions allowing to answer in a spectrum of five agreement or disagreement responses. Fourth, a repeat of the third type of question responses, but using abbreviated narratives about social conflicts. For the third and fourth type of question he used the following responses: strongly approve, approve, undecided, disapprove and strongly disapprove. As a result he found that the five-point statements yielded a normal distribution and concluded that "[...] attitudes are distributed fairly normally and to use this assumption as the basis for combining the different statements.[...]" . Further he found that the five-point statements resulted in high internal reliability across odd and even stated questions. Based on his results he provides us with a simple method in which each five-point statement gets a corresponding numeric value of 1, 2, 3, 4 and 5 in which the 5 represents the positive response to a statement which turns around between strongly approve and strongly disapprove depending on the type of question (odd or even). (Likert, 1932)

The *Coach in a BOX - Discovery* assessment is conducted based on a six-point Likert-like scale for attitudes suggested by Likert above and the provided guidance of how questions or statements need to be phrased (Likert, 1932):

- "[...] Permit a 'judgment of value' rather than a 'judgment of fact' [...]" .
- "[...] allow the subject to take sides as between two clearly opposed alternatives. [...]" .
- Draw issues with clearly conflicting groups of persons named or implied and allow the to affiliate the subject with one or with the other group. Basically, "[...] framing an ideal 'conflict issue' [...]" .
- Mix odd and even statements.

We conduct measurements on 14 different attitudes (Moderating Traits) and each set of statements needs to be consistent within. This is important for analyzing the results later correctly, only a set of items or statements is a true Likert scale. During the constructing of the survey, we extended the guideline from Likert by the given direction from Joshi et al. (Joshi, Kale, Chandel, & Pal, 2015):

1. "Whether the items are arranged in logical sequence?"
2. "Whether the items are closely interrelated but provide some independent information as well?"

3. "Whether there is some element of 'coherence/expectedness' between responses (whether next response can be predicted up to some extend based upon previous one)?"
4. "Whether each item measures a distinct element of the issue?"s

Likert scales are ordinal not linear scales, meaning the responses only determine the level of agreement or disagreement to a certain statement, but the distance between responses is not equal. As an example, the difference between 'strongly disagree' and 'disagree' might not be the same as between 'strongly agree' and 'agree'. Especially, if it comes to analyzing the results of the responses this is important to notice and to properly choose the correct analyzing method like parametric analysis (e.g. standard deviations) or none parametric techniques (e.g. frequencies of responses). (Sullivan & Artino, 2013)

To help the interviewee distinguishing between the different survey sections we use a software-based solution in which only a single section or set of questions per moderating trait is displayed at once and only if that section is filled out the interviewee can move to the next section. We avoid calling out the moderating traits in each section header as we want to avoid biased answers from the person filling out the assessment and concentrate only on the statements.

Table 4: Structure of the Moderating Trait Assessment. Shows numbers of statements by sections and how they split in odd and even statements.

No	Moderating Traits / Sections	odd	even	Questions
1	Alignment	2	8	10
2	Recognition	4	6	10
3	Ability to adapt	5	6	11
4	Analytic Competence	6	3	9
5	Decision Making	4	6	10
6	Shared Leadership	4	5	9
7	Innovative Capacity	4	5	9
8	Conflict Management	5	5	10
9	Learning	3	7	10
10	Team Self-Confidence and Charisma	3	6	9
11	Team Intimacy	4	7	11
12	Tolerance and Respect	4	6	10
13	Accountability	2	7	9
14	Empathy	3	6	9
	Total	53	83	136

The assessment is filled out by each individual team member separately and independently. We provide a web-based solution to access the assessment and only a single response per group member is possible. A version in German and a version in English is provided which is tested together as it reflects the actual use case best.

Each team member can fill out the survey in their own time and pace, but this implies the expectation of a certain time difference in the individual responses, which can impact the type of response. As an example, most of the team members are responding to the assessment on Day 0 and one is doing it on Day 2, but on Day 1 a communication exercise was held and now the response of this last team member is different and reflecting more the 'new' team perspective. This effect needs to be analyzed, but our proposed moderating traits are generic team skills which should not be sensitive to a few days difference in their assessment.

Finally, after the assessment is completed by everyone, they can request a report of their results.

In summary, the assessment is a 14-section base Likert scale assessing attitudes of the team called moderating traits. It is an aggregated scale meaning each section consists of a set of items the interviewee needs to respond to and only as a set provide inside into a single moderating trait. The response options for the interviewee are: 'Strongly Agree', 'Agree', 'Somewhat Agree', 'Somewhat Disagree', 'Disagree' and 'Strongly Disagree'.

4.2 Viability, Reliability and Analysis

In social, educational, or medical science it is not only about setting up an assessment but determining "[...] the extent to which a particular empirical indicator (or a set of empirical indicators) represents a given theoretical concept.", as stated by Carmines and Zeller. There are two different factors to make this determination. First, the reliability which describes the repeatability of an experiment but understood as two tests can never exactly repeat each other and a certain failure needs to be expected. Second, the validity represents the extent to which the measurement does what it should do. (Carmines & Zeller, 1979)

Validity

It is important to add that the validity of a test is always being assessed in context to its purpose for which it is created. There are three types of validity: content, criterion-related, and construct validity which we analyzed following Carmines and Zellers definition (Carmines & Zeller, 1979):

- Content validity looks at the completeness of the assessment. Basically, is the test representing the full domain of the criteria tested. In our case we test work group skill level. First, we can assume that we cover the full domain of work group skills following the theoretical derivation in section 2 and 3. Second, with our assessment we sample each skill with an aggregated survey and transfer it in a testable form. In return content validity can be assumed for our assessment.
- Criterion-related validity means how the test can be correlated to an external criterion. Our survey tests team traits, assesses the ABC mediators and predicts through them the effectiveness and success of a work group indirectly. 'Effectiveness' is one of our external criterions but is a rather individual and situational factor which will be assessed through team questionnaire after *Coach in a BOX – Discovery* was conducted by a team.
- Finally, construct validity means the level of relation between the measurement and the theoretically derived hypotheses concerning the purpose of the test. *In Coach in a BOX – Discovery* we argue that every team has their individual trait level and that a certain consistency should be visible within the individual team member's answers. In return the construct validity can be proven by comparing internal team result deviations to team-to-team deviations. Basically, expecting higher deviations from team-to-team.

Reliability and CFA

Carmines and Zeller explain different ways of assessing reliability of a test but conclude that the coefficient alpha should always be conducted for multiple-item tests. Especially, when only one type of test is conducted, and the alternative-form method is not practical. They propose Cronbach Alpha as "[...] encompassing both the Spearman-Brown prophecy formula as well as the Kuder-Richardson 20." (Carmines & Zeller, 1979). Cronbach alpha ρ_r (tau-equivalent) assesses the internal reliability of a scale, basically how good items assessing the same factor are correlated. Potentially a low Cronbach alpha value could mean that more than one factor is measured, but one should be careful with this assessment as also a high Cronbach alpha value and a high internal consistency still can mean that two similar factors are measured e.g., satisfaction and success. Nunnally postulated that for early-stage analysis a number of 0.5 to 0.6 is satisfiable and for applied research a level of 0.8. (Nunnally, 1967). Knowing that we expect multiple factors withing a group of statements in *Coach in a BOX – Discovery* we will assess the reliability by using McDonald's

Omega. Cronbach's alpha is assuming an equal factor loading which is likely not correct in our case.

To ensure our 14-section based survey is measuring only the factors it is supposed to measure, a Exploratory Factor Analysis (EFA) is required in addition to Cronbach alpha. Cho summarized relevant literature in the space of organizational research and also proposed a more structured approach to reliability. He suggests CFA (Confirmatory Factor Analysis) and SEM analysis in addition to the coefficient alpha. (Cho, 2016). We will pursue an EFA as it will show us if each item within one of the 14 factors is measuring their individual factor and provide additional evidence for construct validity. (Rodríguez-Santero, Torres-Gordillo, & Gil-Flores, 2020).

Analysis

Analyzing Likert scale or Likert-type scale surveys which are considered ordinal scales usually require non-parametric ways of analyzing the test, even though parametric based statistics are powerful and efficient to apply. Sullivan et al. concluded that when a relevant sample size, he speaks about 5-10 observations per group, and a normal or nearly normal distributed data set is given, a parametric analysis can be applied with Likert scales. (Sullivan & Artino, 2013) Further, Normann found that statistical methods like factor analysis, linear models, structural equation models are all based on the assumption of a normal distribution and interval-level data, but these parametric statistics can be used with Likert measurements also using small sample sizes and non-normal distributions as long as a single factor is measured by a sum of items. (Normann, 2010) Harpe even took a more detailed approach arguing that parametric statistics can be applied to Likert scale data as long as the following recommendations are considered (Harpe, 2015):

1. "Scales that have been developed to be used as a group must be analyzed as a group, and only as a group."
2. "Aggregated rating scales can be treated as continuous data."
3. "Individual rating items with numerical responses formats at least five categories in length may generally be treated as continuous data."
4. "Consider non-parametric or categorical data analysis approaches for individual rating items with numerical response formats containing for of fewer categories or for adjectival scales."
5. "Remember the benefits of statistical models."

In conclusion, we chose a parametrical approach to analyze our data based on how the assessment is constructed and proving that the internal reliability provides sufficient evidence that the aggregate items are measured consistently.

5 Testing *Coach in a BOX - Discovery*

5.1 Pre-Test

A pre-test was conducted to get a first impression of the applied assessment and potential correlations of items and factors (mediating traits). This pre-test was conducted with the English (n=4) and the German version (n=9) separately. Subsequent interviews were held with eight of the German interviewees to get more detailed feedback on the questionnaire. The pre-test was not meant to provide solid statistical backing but revealed first high-level structural issues which were clarified before the questionnaire was tested with a higher sampling rate. Also, important to note is that the English version was tested after the German and findings and improvements already went into the English version. In addition, the four people who responded to the English version were part of the same work group. The German participants span from nonprofit club, consulting, medical, educational, journalism, insurance, and media sales teams.

The pre-test revealed the need for rephrasing and wording corrections of the used statements in order to avoid confusion by the participants. Further, double negative statements were found and rephrased as they were the cause of lower reliability.

The interviews identified two major concerns which are connected. One, a discomfort answering the questionnaire truly to avoid revealing the participant's true belief on certain intense statements. Two, a leaning to an average answer response using the "undecided" middle ground always if a statement was found complicated or too sensitive. In the pre-test we still used a 5-type Likert response scale ('strongly disagree', 'disagree', 'undecided', 'agree', 'strongly agree') for the participants, but we changed that as a result of the pre-test to a 6-type-Likert-like scale to make the participants decide about a side answering a statement. The second learning and in response to the 'discomfort', some of the participants experienced, we decided to ensure an anonymous answering of the questionnaire and make the participants aware of this fact in the beginning. Further to explain the participants to which extent their own point of view will be reflected in the results later. With that we believe the participant can decide to answer the questionnaire in their own comfortable way, if they feel they cannot be really true about their answers.

At last, we got responses that some of the statements were perceived tangled and not grouped correctly. This is an indication for non-correlated items even spanning between different factors. We applied these learnings and rearranged the statements.

A reliability assessment was not conducted due to the low number of participants.

5.2 Single User Testing

Applying the changes from the pre-test, a single user test (n=200) of worldwide participants was conducted on *Coach in a BOX - Discovery*. The English (n=133) and German (n=67) questionnaire version were tested together. The participants for each assessment language were selected since they speak the corresponding language fluently but were not necessarily native speakers. This selection reflects a more realistic use case of *Discovery*. The analysis of the reliability is shown in Table 5 for all 14 moderating team traits. Despite "Shared Leadership" and "Innovative Capacity" all traits showed a solid and reliable McDonald's Omega and provide confidence in the setup of the statements and sections of the questionnaire.

Further, we asked the participants to provide feedback about the questionnaire. First, the participants were asked for their perception 'How difficult was it to fill out the assessment (statements, length, overall impression)?' and got 4 possible responses as shown in Figure 9. Second, we asked for general feedback about the assessment and got feedback as shown in Table 6.

Table 5: Reliability Analysis (n=200) McDonald's omega for all 14 moderating traits as part of the single user testing. Show the actual measurement results and the later corrected reliability based on learnings out of the test.

No	Moderating Traits / Factors	McDonald's ω	McDonald's ω
		actual	corrected
		n=200	n=200
1	Alignment	0.846	0.878
2	Recognition	0.903	0.900
3	Ability to adapt	0.780	0.788
4	Analytic Competence	0.838	0.838
5	Decision Making	0.820	0.856
6	Shared Leadership	0.625	n/a
7	Innovative Capacity	0.641	0.701
8	Conflict Management	0.846	0.846
9	Learning	0.879	0.862
10	Team Self-Confidence and Charisma	0.757	0.764
11	Team Intimacy	0.805	0.830
12	Tolerance and Respect	0.871	0.875
13	Accountability	0.795	0.821
14	Empathy	0.797	0.878

Table 6: Comments provided by participants as part of the Single User Tests, selected by requests for changes and clustered in categories. Number of people requesting this category.

Cluster Categories	#English	#German
Request for an 'undecided', 'NA' or middle option in the response answers	1	1
Concern about the length of the questionnaire / questions (concentration suffers), monotonous at times, similar questions	3	5
Change answer from "approve" to "agree"	4	-
Clear statement that leader is part of team	1	-

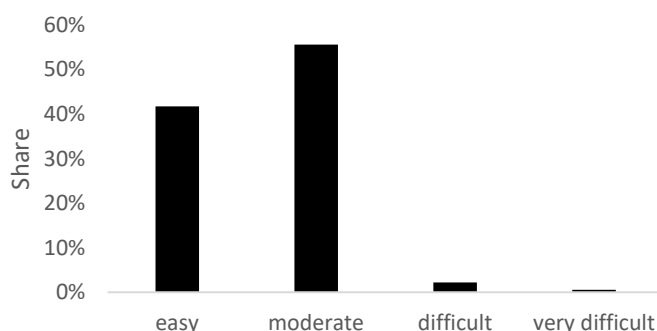


Figure 9: Difficulty Rating (single user test, n=182/200). Answering the question: "How difficult was it to fill out the assessment (statements, length, overall impression)?" Only these 4 responses were given.

Three changes are applied to *Coach in a BOX – Discovery* based on these results:

- (1) Reduction of the questionnaire length: Based on the concern about the length of the questionnaire we removed a selected number of statements in the questionnaire to balance the trade-off between user experience and reliability of the assessment. The statements were selected by not affecting the principles of the assessment and not impacting the overall reliability too much. The corrected values are shown in Table 5.
- (2) Improving the reliability of “Shared Leadership” and “Innovative Capacity”: like number (1) the two moderating traits were analyzed for possible statements which could be removed. In ‘Innovative Capacity’ the first statement (*On short notice, our team needs to deliver a result to respond to an internal or external customer request. We will strictly follow the existing rules and processes, even if it means we will not be able to finish in time.*) was removed as it lowered the reliability and did measure a different factor other than innovative capacity. For “Shared Leadership” a statement affecting the reliability negatively could be identified but could not be removed as it is crucial for this section’s validity. We decided to rephrase the (odd) statement from *“Our leadership provides exact instructions even on task level.”* to *“Our leadership or other team members are micro-managing the team”*. The original statement could be misunderstood as positive behavior of the leader which we did not intend. The new statement clearly asks the team for potential negative behavior of the leader or any other team member. Applying these adaptations, the corrected reliability values are shown in Table 5. However, more testing is required for “Shared Leadership” using the new statement.
- (3) Change the response label scale in the English questionnaire. The participants reported that they find the word “agree” a better fit compared to “approve” in the response scale which we adapted accordingly.

We also looked at the mean time the participants used to fill out the questionnaire and with 21.8 min we consider the assessment as reasonably long and still an adequate load on work teams in their day-to-day routines.

6 Conclusion and future research

Coach in a BOX – Discovery is based on a profound technical background and provides reasonably high internal reliability which makes us confident in the applied usage of the product by work teams. Even though further research needs to be conducted, like applying learnings from actual work teams, the internal consistency is making *Discovery* a reliable tool for work groups. It is providing key insights in the team’s structure, behavior and cognition and helps to reflect perspectives among team members.

Further research will be conducted working with work teams:

1. Conduct more reliability assessments considering the change in the moderating trait “Shared Leadership”.
2. Criterion-related validity: ask work teams to provide feedback on their perception about a change in effectiveness after *Coach in a BOX – Discovery* was conducted in the team.
3. Construct validity: analyze result deviations within teams vs. the team-to-team deviation.

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