

# Deciphering how to foster communication in interdisciplinary student teams through team building interventions

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## ABSTRACT,

*The evolving nature of higher educational institutes has given rise to holistic educational solutions with an emphasis on collaborative learning through interdisciplinary student teams. These teams comprise of specialists from various fields that collaborate and communicate to achieve a common goal. Interdisciplinarity helps significantly in complex problem solving as it elevates innovation and creativity. With the goal of tackling communication within an interdisciplinary student team, this paper addresses communication problems through identifying communication patterns. These can be tackled with team building interventions designed to foster communication. The interventions are grounded in the Behavioral Change Wheel Model that identifies interventions in accordance with the communication patterns. A qualitative investigation in the form of semi-structured with students of interdisciplinary student teams led to the identification of two interventions for effective communication. The study hence provides insight into designing team building interventions for effective communication along with recommendations for students, faculty, and organizations.*

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# 1. INTRODUCTION

The nature of education has been evolving over time with the recognition of holistic education. Many institutes create learning models that include collaborative learning tasks with an emphasis on interdisciplinary student teams. This is to increase innovation and creativity which is impeccably beneficial in complex problem solving (Leigh & Brown, 2021). Student interdisciplinary teams include specialists, in this case students from different knowledge areas, to collaborate and share their expert knowledge in order to accomplish a goal or project (Lungeanu et al., 2014). There is an increasing importance in understanding how to function within an interdisciplinary team where communication and collaboration are crucial for success. According to Lungeanu et al. (2014), interdisciplinary teams generated research publications of higher intellectual impact than singular researchers. This means that when the efforts of various disciplines are combined, the output is more fruitful in comparison to the output of just one discipline and hence is why student interdisciplinary teams consist of students from various studies. However, not all teams prove efficient. This paper will be tackling communication within student interdisciplinary teams and how to maintain or improve it.

## 1.1 Problem Statement

There are some aspects that need to be managed in order to ensure that a team is collaborating and communicating efficiently and effectively. Significant time is spent in forming the team as experts from various knowledge departments need to be identified (Steffes et al., 1996). In educational institutes, the professors usually randomly assign students according to a predetermined ratio to make sure that the teams are interdisciplinary as well as save time. This is also because it tends to mix students and these teams tend to increase their performance level and attitudes according to a study conducted by Felder and North Carolina State University (1996). The study also explains how the members then need to adjust to the team, the individual working styles, the forms of communication and establish a leader to ensure that tasks are completed according to their deadlines as each of them have their own learning styles. According to Bosch-Sijtsema (2007), this is vital to ensure that the team is aware of each other's expectations and ensure effort is put accordingly to avoid misunderstandings and conflict. When there is a group working on a task, there are bound to be some team members with lower motivations than others which can lead to less contribution or also free riding (John et al., 2023). This is a problem as collaboration and communication will not be present throughout the team leading to clashes like information not being passed on or tasks being incomplete which ultimately leads to unsatisfactory and poorly executed end project.

Efficient and effective communication seems to be a reoccurring theme in ensuring the effectiveness of an interdisciplinary team. Communication is the exchange of information (Miller, 2020). In order to accomplish a shared goal, all members need to understand the tasks and participate which includes sharing information with each other. If this is not executed, the team will not be able to achieve the goal, making communication a problem that needs to be addressed.

Often the case, the team members do not get to choose one another and are randomly assigned by the program professors in order to introduce innovativeness (Scott & Cross, 1995). This means that ensuring communication between them is crucial to secure a successful project/ goal. Teams are not permanent and are formed with a predetermined end date so student interdisciplinary teams often last for only the span of the project or course. This means that there is a relatively short time span to

build a synergy within the team. Another aspect to be considered is within which stage of Tuckman's team development model will the problem of communication be most efficient to be discussed (Bonebright, 2010). This is important because while the team progresses into the project or goal, so will the relationships and tasks which will ultimately affect their productivity.

In the study by Brown et al. (2023), successful interdisciplinary teams are characterized by their ability to produce and communicate results, with team building being one of the guiding principles interdisciplinary team success. Team building interventions help to encourage communication and collaboration which builds trust and avoids conflict therefore resulting in engaged team members (Scudamore, 2016). Team building entails finding the right fit of members with various expertise, ensuring effective communication as there are often discrepancies in lingo and building synergy to ensure all members have responsibilities and contribute to the end goal. In light of this, it becomes imperative to address team building. It is also important to address this at the right stage of the team development to avoid clashes and ensure communication leading to a successful project. There are vast amounts of research available on the importance of team building interventions themselves and lists of activities but not on which team building interventions for what kind of problems and where in the team development it should be addressed.

## 1.2 Research Question

This report will therefore be investigating conditions that need to be accounted for when structuring team building interventions to foster communication within the context of student interdisciplinary teams that last the span of one course. With the aim of investigating the problem, this research paper will focus on answering the following research question:

*"What are the communication patterns within interdisciplinary student teams that require team building interventions?"*

## 1.3 Contributions

Emphasis on interdisciplinarity has grown according to Goodman and Huckfeldt (2013) and is being incorporated within schools and universities giving rise to interdisciplinary student teams. It has been established that there is a lot of research on communication and interdisciplinary teams but less on tactics to be efficient in these teams. This paper hence aims to uniquely contribute to the gap that bridges the problems in communication among student interdisciplinary teams with team building interventions. This encompasses themes of interdisciplinarity, student teams, team building interventions and communication patterns. There is research into interdisciplinary teams especially in healthcare but less on student interdisciplinary teams and even less integrating communication. Research about barriers in communication in interdisciplinary teams and factors that foster communication form the base of this paper. Further investigation on communication in student interdisciplinary teams is conducted from which the utilization of the behavioral change wheel model (Michie et al., 2011) allows identification of intervention tactics. Integrating the behavior change wheel model also allows for a novel perspective. There is scarce research on this model and even less on the implementation of the model and so this paper adds to this field. This research will therefore function as a guideline to identifying interventions for student interdisciplinary teams to foster effective communication based on communication patterns.

Practically, this paper will especially aid faculties and professors that manage or want to introduce interdisciplinary student teams. This would decrease the likelihood of failed projects and

negative experiences that students would experience when interacting with their teams. Apart from educational personnel, students themselves can also benefit from this paper. They would learn to identify whether their interactions with their team consists of miscommunication and clashes and what they can do to positively enhance the communication.

## 2. LITERATURE REVIEW

### 2.1 The Power of Interdisciplinary Teams

In order to engage with this research question, it is first important to understand why students tend to work in interdisciplinary teams. This began when universities introduced project-based learning into their curriculums. Project based learning according to Kokotsaki et al. (2016), is when students collaborate to achieve a shared goal. Here, they are expected to act as experts from their study background and contribute to the project giving different perspectives. Hart (2019) explains how project-based learning is used to reap increased engagement within interdisciplinary teams and states that project-based learning is known to be effective for facilitating communication among other aspects. In concordance with Kaczmarczyk and Czop (2019), interdisciplinary teams allow for learning spaces through interacting with members of different knowledge backgrounds. In the context of student teams, this allows members to be an expert in their field while also learning from other studies in order to complete the task. Students are able to widen their knowledge and perspectives. In an effort to successfully do this, students will need to share knowledge from their field with one another which requires communication. Youngwerth and Twaddle (2011) explains how interdisciplinary teams often have organizational commitment which is that the team is formed with a project to accomplish and disbanded once completed. There is thus a willingness of members to complete the tasks to ensure a successful project. This also indicates that there is a notion of shared responsibilities for the outcomes as all members benefit from the final result (Avery et al., 2001). There are often formal requirements of participation of each team member within student teams which also enforces shared responsibilities. This therefore builds engagement and synergy within the team to make sure that collaboration and hence communication occurs to deliver the final goal but can also introduce the blame game if there is a mistake (Conzemius & O’Neill, 2001).

### 2.2 Communication Barriers in Interdisciplinary Student Teams

Communication within interdisciplinary teams is a complicated concept. On one hand, good communication can lead to efficient decision making and problem solving (Kuziemy et al., 2009). This also means that the outcomes of the projects would hence be successful with the different expert knowledges integrated. However, there can also be miscommunications and clashes. According to Whittington et al. (2020), this may occur due to the lack of integration of communication within the interdisciplinary teams. Each knowledge area has their own domain specific language so when different knowledge experts accumulate, there will be discrepancies in understanding. Within student teams, this is often the case as the program for each study is different and hence what abbreviations may mean to a business student for example may have a different meaning to a computer science student. It is hence vital to acknowledge this difference and build on clarity when communicating.

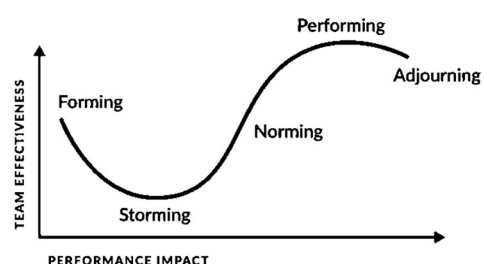
Liu et al. (2021) describes four key barriers that influence communication in interdisciplinary teams. This model can be generalized and adapted to the setting of student interdisciplinary teams which allows to understand communication and therefore structure team building interventions that foster communication.

The barriers are social norms, cognitive bias, hierarchy and relationships. Social norms are those “informal rules that govern behavior in groups and societies” (Bicchieri, 2023). Since the student teams are comprised of different knowledge experts, it is likely that the social norms differ too. Xu et al. (2022) found how students who do not have prior interdisciplinary experiences often struggle accommodating to project-based learning and the new learning styles in interdisciplinary courses. Korteling and Toet (2022) describes cognitive bias as consistent and widespread patterns in thinking that lead to errors and inaccuracies by distorting the interpretation of information. An example by Liu et al. (2021), is where young clinicians and surgeons were thought of incapable of interacting with. Hierarchy is “a system in which people are organized in levels according to their importance” (Hierarchy, 2024). When there seems to be tall hierarchies, it is found that it negatively impacts team performance and thus communication (Greer et al., 2018). Finally, relationships which is a connection between two variables, in this case, people (“APA Dictionary of Psychology,” 2018). It is often the case that those members that have worked together before, have already built communication channels and hence will tend to separate from the other team members (Liu et al., 2021). This may come across as teaming up and portraying that the others are not competent enough to do a certain task or role. These barriers will be used to identify design principles that fit the context of student interdisciplinary teams. However, barriers are not the only considerations in identifying interventions and understanding the different team development stages is equally important.

### 2.3 Team Development Stages

The team development stages by Tuckman include five stages (Bonebright, 2010). These delve into the realms for interpersonal relationships and task orientation. The first step is forming which is where the team is first introduced to one another, the organization and the tasks and goals. According to Clark (2021), members tend to try to find their fit by understanding the tasks required to achieve the goal and each other’s capabilities. This means that they don’t assert themselves to their full potential. The second is storming where clashes tend to occur with individuality persevering and the lack of unity (King & Lawley, 2022). Norming is the third phase where group cohesion is developed with roles and ways of working with each other identified and conflicts and clashes are avoided (Bonebright, 2010). The fourth stage is performing which is where the team reaches maturity and collaborates well together (Clark 2021). The last stage is adjourning which is the conclusion of the team as the goal is accomplished. The following Figure 1 represents the five stages in accordance with team effectiveness and task performance.

Figure 1: Tuckmans Team Development Model (Psych, 2023)



Communication is affected by interpersonal relationships and task orientation and hence identifying these stages in a team allows for the realization of the communication patterns

pertaining to the maturity into the team and availability of task information. It also helps defining when team building interventions to address certain communication problems need to be implemented.

## 2.4 Team Building Interventions

In order to foster communication, a team must have the ability to collaborate. There is a difference between these concepts of communication and collaboration, but they go hand in hand. According to Wells (2017), communication is the exchange of information while collaboration is working together to achieve a common goal. Without one, the other ceases to exist. This was important to clarify in order to discuss team building interventions. Team building interventions are activities that allow the team to engage in decision making and problem solving which builds relationships through shared experiences, clarify roles, and even helps to build goals (Morgan et al., 2021). These shared experiences can allow the team to trust each other based on research by Cheong et al. (2023). This is because humans crave a sense of belonging as one of the basic needs in Maslow's hierarchy of needs (McLeod, 2007). Team building is said to especially improve team process which communication comes under, but also depends on how they are understood (Klein et al., 2009). It is therefore important to specify that only actions that allow team members to have shared experiences while exchanging information and collaborating, are considered team building interventions for this research. Klein et al., (2009) also mentions a problem with team building interventions is that it is difficult to measure the effect of team building interventions especially because of the lack in agreement of the concept. This however can be tackled while focusing on a certain outcome and using theory to investigate it. Based on these studies, it is assumed that team building interventions foster effective communication.

Research by Lacerenza et al. (2018) revealed four components to team building which are goal setting, role clarification, interpersonal relationship management, and problem solving (known as GRIP hence after). These can be used solely or in combination of each other, and are aimed to foster team building. Goal setting includes formulating specific yet difficult to achieve goals. A format that can aid in formulating goals is the SMART goals method which according to Bovend'Eerd et al. (2009) allows for goal setting to be standardized and hence quicker. Role clarification involves developing boundaries of roles that limits the task a certain role is required or can accomplish. Kilpatrick et al. (2020) explains how role clarity generates trust and mutual respect as well as outputs which is beneficial in any team. Trust and teamwork skills are also apart of interpersonal relationships which, in order to have, requires communication. Podlowska (2017) defines interpersonal relationships as communication that occurs when people treat each other as individuals. This component also stresses the importance of the existence of the exchange of information among people. Lastly, problem solving which involves identifying and solving task related problems within a team (Mayselless et al., 2019). The point of this is that it is done collectively after the inability to solve the problem individually and hence requires communication.

## 2.5 The Behavior Change Wheel Model

The type of intervention in regard to the problem can be established using the Behavior Change Wheel Model (Michie et al., 2011). This is a theory that separated designing interventions into three steps that are (1) understand the behavior; (2) identify intervention options; (3) identify content and implementation options. The table below summarizes the content within each step.

**Table 1. Behavior change wheel steps**

	Understand the behavior	Identify intervention options	Identify content and implementation options
1	Define problem in behavioral terms	Use COM-B model	Identify behavior change techniques
2	Select a target behavior	Identify intervention functions	Identify mode of delivery
3	Specify the behavior targeted for change	Identify policy categories	
4	Identify what needs to change		

The first step, understanding behavior includes identifying and defining the goals of the intervention. This is done through gaining information about the current behavior, the target behavior, how to achieve the target and the target of the intervention itself. Next is using this information in the COM-B model that stands for capability, opportunity, motivation and behavior. Each component has two subcomponents which allows for information to be separated with higher precision. This enables for step two to progress which then identifies the functions of the intervention and the policy category. A matrix that demonstrates the association between the interventions and the com-b model is in Appendix 1. It allows for the intervention to be categorized to identify what knowledge areas it is targeting. Lastly, the intervention can be implemented and hence the behavior change techniques, and how to deliver them are discussed. This completes a standardized checklist in order to gather information and execute an intervention efficiently. For this paper, steps until identification of interventions will be discussed to build a guideline as implementation varies across different situations and environments.

By collectively using the barriers to communication, GRIP, the team development model and the behavior change wheel model, interventions to address communication patterns can be established. Lacerenza et al. (2018) and Lie et al. (2021) present overlapping components that help obtain information for the behavior change wheel model, which will be used to analyze results. The following section will elaborate on the investigation process.

## 3. METHODOLOGY

### 3.1 Research Design

The study utilized the qualitative research methodology which entails open ended question to gather deeper insights into those constructs that cannot be quantified easily (Tenny et al., 2022). This allows to investigate and explain phenomena such as experiences and behaviors which team building interventions are subjective about. This research type allows for identifying patterns and trends in data that enables the investigation of communication patterns to determine team building interventions for student interdisciplinary teams (Mwita, 2022).

Semi-structured interviews were conducted consisting of questions that take into account each step from the behavior change wheel model and keeping in mind the barriers in communication, GRIP and the team development stages while leaving room for information that might strike relevant to discuss. This allowed the discussion of whether communication problems exist within the groups, the reasons and what

interventions could aid in minimizing or solving them. A semi structured interview has a general guideline with room to ask follow-up questions on the spot, taking advantage of social cues leading to more in depth answers (Kakilla, 2021). As this research investigates communication patterns, the semi structured interview allows for suggestions from the interviewees that the researcher may not have targeted primarily in the questions.

### 3.2 Sampling

For the interviews, students who partake in an interdisciplinary team were selected. The level of analysis is the team and hence teams from minor courses at the University of Twente were identified. This also means that the students can be experts (to an extent) for their domain within a team since they are partaking in a minor course. The University of Twente was chosen as interdisciplinarity is important to them as part of their organizational strategy and hence comprises of various interdisciplinary projects (University of Twente, 2024). The research question was formulated to gather information on team building interventions that are implemented and effects a team as a whole and hence is the reasoning to the level of analysis. Purposive sampling was used to select participants as it is the selection of participants based on knowledge or experience about a situation and their ability to relay the information accurately and participate in the research (Palinkas et al., 2013). In the case of this research, it is vital that the participants are from different knowledge backgrounds and part of an interdisciplinary student team to provide information about the communication within the team and tactics that could enhance it. Students specifically were chosen as they would be able to provide the most accurate information given that they are the ones experiencing it and who the interventions would be targeted to. Eight participants in total were part of this study. Two members from each team were interviewed with a total of four teams. This is done to decrease the bias in experiences taking into account the different social factors that influence perception. This way, there will be a more accurate account of events and problems within the team. Participants included three students from computer science, one electrical engineer, one psychology, one creative technology and two international business. Each student was a part of an interdisciplinary project team for a duration of 7 to 8 weeks. This gave them enough time to be well acquainted within the teams and progress into the projects. If they were a newly formed team, the chance for the students to encounter communication problems would not have risen. Minor courses were chosen as they consist of students from different knowledge areas where students from the same course as the minor cannot partake in it. This ensures the criteria of interdisciplinarity. Prior to the interview, participants were first asked for consent to audio record as well as transcribe their responses.

### 3.3 Data Collection and Data Analysis

An interview guide (Appendix 2) was developed in order to maintain a list of vital information to collect during the interview. This was based on the steps of the behavior change wheel model explained in the literature review. Since it is based on existing literature, the interview can be considered valid as the content would be relevant to the research question and hence this investigation. However, validity can be hampered to an extent as the questions to the participants may not be worded in the exact same way given the nature of semi structured interviews which means that there is a risk of participants perceiving the same question differently. This issue can still be reduced with the use of follow up questions to ensure clarity in the questions. The data can be considered reliable as it is coming directly from students within interdisciplinary teams that are the target for the team building interventions which is what this paper aims to describe.

T0 accurately collect and analyze the data, the five steps of qualitative analysis were followed (Castleberry & Nolen, 2018). To compile the data, the recorded interviews were transcribed. This allows the researcher to make sense of the data. Transcription is done by the researcher themselves where the audio recording and transcription is stored on a personal drive. The second step is disassembling where the transcriptions are coded. ATLAS.ti software was used where the codes are done line by line. The codes themselves were created based on the literature review. Reassembling is when the codes are grouped to themes. Three themes are identified, namely, capabilities, motivation and opportunity which are according to the behavioral change wheel model. The quotations per code are also put into matrices to identify similar responses for patterns. During this step, the thematic analysis process for coding was utilized which included developing themes and groups these into categories based on the com-b model (Naeem et al., 2023). Interpretation occurs throughout the first three steps and involves what the data is actually suggesting in relation to each other. Lastly concluding which is what the response to the research question is.

## 4. RESULTS

The following section discusses the results obtained through interviews according to the behavioral change wheel model. The aim of conducting the interviews with students who are a part of an interdisciplinary team was to be able to investigate the problems, successes and possibilities for improvement in communication. The interview responses will facilitate the completion of the model in order to identify factors to target with interventions. The results will be discussed according to the three main components of the com-b model and their sub-components along with activities for interventions suggested by the participants themselves. When a participant is being quoted, the abbreviation "IP" which stands for interview participant, followed by the participant number will be used. The coding tree can be found in Appendix 3.

### 4.1 Communicational Capabilities in Interdisciplinary Student Teams

This component consists of the knowledge, skills and abilities in order to communicate effectively. Apart from skills, it is also important to discuss problems that arise when communicating in an interdisciplinary team. IP4 mentioned how those with different knowledge backgrounds will see a task in a "slightly different way than I will see it". Other participants also expressed how different courses had different styles of working (IP1, IP3, IP4, IP6, IP8). IP7 explained how "different cultural backgrounds or academic backgrounds even might have different goals or expectations". This suggests that clashes and miscommunications may arise because of different perspectives to the same problem. IP8 stresses on how this "matters because the pace of the work, it kind of depends on the harmony in the team" which indicates that interpersonal relationships are affected when there is a lack of understanding between a team.

Participants indicated different skills and abilities to communicate successfully, where some popular skills include being open-minded (IP2, IP4, IP8), a willingness to understand (IP2, IP6, IP7), and being able to articulate so everyone understands (IP3, IP4, IP5). IP7 mentioned how "respecting that they're from different backgrounds, so cultural awareness" is a necessary skill which allows the acknowledgment that "different cultures have different ways of doing things" (IP8) and "speak(ing) in a way that you know that the one you're speaking to understands" (IP5) allows to overcome the jargons (IP1, IP5) that arise when in an interdisciplinary team.

The development of these skills was also discussed where participants had not received specific training in communication but “it just came with experience” (IP2). These experiences included past group projects (IP2, IP5, IP6, IP8), a research project (IP7), organizing events and meetings in teams (IP5), courses in the past (IP3), game nights where they “got to speak to each other more casually” (IP1) and presentations (IP4). When working in a group for a project, they sometimes are “pre-formed and you just had to deal with the people that you didn't know” (IP2) which forces one to communicate in order to achieve the goal. “The more you have, the better you'll be at explaining” is what IP5 said about how experience in a group will allow the development of the skills required to communicate.

In order to effectively communicate, it is vital to interact with the team regularly (IP1, IP3, IP6, IP7, IP8). This encourages “clear understanding moments” (IP6) so that there is clarity. Prior to beginning tasks, one should “understand briefly what the whole works about” (IP2) which ensures goals, task and role clarity. This promotes transparency and explanations of each knowledge domain to ensure understanding. IP5 said “be honest and try to be serious” and if there are “problems that occur, I think we need to also let it know” (IP4) and “share our opinion” (IP8). These thoughts by the participants suggest that students are aware of how important it is to gain clarity of the goal, the different tasks and “what does the output of other fields of expertise mean for your part” (IP2) and the roles each one plays in the team.

## 4.2 Opportunities for Communication in Interdisciplinary Student Teams

This component consists of the external factors which determine whether communicating effectively is possible or not. Every participant described resources available that are easily accessible to be able to communicate effectively. In order to meet physically, participants often reserved rooms on campus (IP1, IP2, IP3, IP6, IP8). Offline meetings are preferred as one feels “more connected in that way... and you don't have that many distractions around” (IP8). You can also “really see if people are paying attention to what you're saying” (IP5) and “online feels too distant and I think maybe it will cause additional misunderstanding” (IP4). Acknowledging that it is sometimes important to see how one reacts to another and whether they truly understand especially in an interdisciplinary team is why face-to-face meetings are preferred. However, IP5 explained how they participate in physical communication for effective communication but they “preferably like over text messages and WhatsApp so that I can respond when I have the time”. This implies that using technology is convenient and preferred when there is no need of explanations and hence making sure others understand. Meeting physically in rooms was accessible but it would be “nice to have more than just 2 bookings a week” (IP1). This can be overcome by making “the others have to reserve it as well” (IP3) making meeting physically feasible. Participants tended to meet weekly (IP3, IP5, IP6, IP7) as a standard while some met twice a week (IP2, IP4) or even 3 times a week (IP8). The frequency of physical meetings depended on “whenever something big is coming up” (IP6) so “we plan an additional meeting if necessary” (IP5).

To contact each other online, WhatsApp (IP1, IP3, IP6, IP7), Discord (IP1, IP2, IP4), and emails (IP1, IP5, IP6) were popular. IP4 mentioned the use of slack and Trello to “keep track of our progress” (IP4). All participants highlighted the need to maintain deadlines and accountability with everyone being able to view the tasks assigned to each other. Within an interdisciplinary team, identifying the tasks allows the team members to assign the tasks to the members who possess the skills to accomplish them. In the case that the assigned person “believes someone else is better at

it... ask for their help” (IP8) for which the team members need to have the space to be able to seek help. These platforms were perceived as very accessible “Given you have good Internet which I assume everyone does” (IP1) since a lot of the resources to accomplish the course and tasks required internet.

Participants were also asked for an instance of when they felt encouraged or discouraged to communicate to identify patterns that made them want to express themselves. When team members were not afraid to share their opinions and discuss the tasks, it was perceived as being open and considerate which was encouraging (IP4, IP5, IP6, IP8). It was also important for “other team members to be enthusiastic to meet, to communicate” (IP7) as then one “feels like you should communicate especially when everyone is working towards a shared common goal, and everyone has different factors in which they can contribute” (IP1). The interdisciplinarity of the team is experienced to be difficult to celebrate if the members are not willing to share their unique perspectives. Even when the team is willing to express themselves, it is important that “people are open minded, and they tend to listen to you, and they expect you to listen to them” (IP2) for the opinions to actually be accounted for. A tactic that IP6 discussed was to “write everything down on a board without any comments on anything...and then afterwards everyone comments and talks on it” which promotes students to share their opinion without judgement and encourages discussing the best way forward and the ability to compromise to achieve that path.

When team members lack the same drive and consequently there is a mismatch in expectations, this can lead to discouragement (IP4, IP7). Even if the members are present but do not engage or are generally “hard to reach” (IP2), it possibly makes one feel like “whatever I told them they wouldn't do anyway” (IP5) and it “becomes more like a chore” (IP7) leading to a refrainment in communicating. This is important as sometimes “the outcome of the project depends on the person. That's why its discouraging” (IP2). When there are people who possess different domain knowledge, it is vital to not “shut down my opinions or shutdown other people's opinions” (IP1) so that every voice is heard, and multiple perspectives can be accounted for to make sure that the goal is accomplished efficiently.

## 4.3 Motivation to Communicate Within Interdisciplinary Student Teams

Motivation is the inner reasons that one has that influence decision making and behavior. The reasons for motivation differ amongst participants but ultimately it is for the success of the goal, in this case, their project (IP3, IP8). Participants also indicated that their careers (IP3, IP2) were motivation and “I want to grow as a professional” (IP2) indicating that it is expected to work in interdisciplinary teams in the future as well. These statements also indicate that the importance to build the skills to communicate while using the project as experience is known. IP1 wanted to “make sure everyone's on the same page so everyone understands” which is significant for an interdisciplinary team as jargons and perspectives can differ. Communicating effectively also allows the team to “work faster and more efficient and achieve goals even before the deadline” (IP4) which means that effective communication includes being quick without clashes and last-minute stress. IP6 details “if you get rid of the assumptions, you get rid of a lot of the resentment and anger that can build on the team” which stresses on everyone sharing their opinion and understanding each other. This is especially relevant when members have different background knowledge as in interdisciplinary environments.

Majority of participants indicated being able to communicate in general and with people from different backgrounds (IP1, IP2, IP4, IP5, IP6, IP7) while IP3 and IP5 suggested that it depends

on the situation. If someone is “not being honest with me or... are not clear enough” (IP3) or they were “not in the mood or see a bit of distance” (IP8) is when they would not communicate. This means that the participants believed in their abilities and tried to communicate because they were “interested in doing the good job” (IP4) and believe it was “okay to be corrected by others and to correct others” (IP2). It can be easier to communicate once relationships are built among team members as IP1 stated “if I get to know the person, it is very easy for me to express” and “get to know them a bit more... perceiving the situation”.

In order to delve deeper into the need to effectively communicate, participants were asked for advantages that effective communication will bring their group. IP2, IP3 and IP7 dictate how efficient communication leads to a successful project outcome. This is because there is an understanding of the tasks and roles (IP1, IP65, IP6) and there will be “no misunderstanding” (IP4). It is important to determine “what has everyone done, what is everyone going to do” (IP5) as it “makes the work flow smooth” (IP6) which ultimately leads to members being “happier in the group and actually wants to work on the project” (IP7). These portray some of the intrinsic and extrinsic motivation that one can have in an interdisciplinary group while making sure that they are understood and contribute efficiently.

Participants indicated that they constantly think of how they are communicating (IP1, IP3, IP6, IP7). This is to ensure that the team understands what is being said, especially the terminology (IP1) and if perceived the way it was intended (IP3). Participants also indicated how they reflect on the communication after the moment to review “what was the reason I did not agree with that opinion” (IP8) or “how we could communicate better” (IP4). IP2 believes that “a person shouldn't over think about it because it's going to drag them behind” which indicates that there is a balance between consciously thinking and reflecting how one communicates versus overthinking about it that will hamper the speed and hence disrupt the flow. This is important to establish as automatic motivation reveals whether there is no schedule or routine in terms of communication.

#### 4.4 Intervention Activities

To determine activities within interventions, participants were asked to suggest interventions. Competitive games were suggested by IP1, IP4, IP6, IP8 because “competitiveness might help cause if people from different streams, don't know each other, but compete in the same team to win some kind of like prize... it can facilitate, better team building and bonding among team members” (IP8). The games should be “fun and interesting so you don't feel like you're being forced to. You know, passively learn the skills” (IP6) which would motivate the students to communicate and build interpersonal relationships which “builds a more peacefully environment or atmosphere” (IP8). The faculty can provide an area and time with the facilities to bond and play these games (IP1, IP6, IP7). Whether to make it compulsory to attend had different opinions where IP7 believes “if it's compulsory, they have to come, they have no choice... the event would be so good that they would not regret coming and then they would take something from it positively” while “the more mandatory it becomes, the less people would go for it” (IP1). This indicates that the time within the team development, where such an activity is implemented, is important as “when it's new people, it's hard to convince them to these kind of activities... I believe an outside party should interfere and present the opportunity for this kind of building communication and team building” (IP8) which indicates that it should be implemented when the team is newly formed and external organizations like associations could organize them.

Apart from games for team bonding, IP4 suggested an assignment integrated within the course presented as a game so the team has to communicate to solve it and receive a prize. Such an “assignment would consist of different fields of expertise and these people will have to communicate with each other to put it into good use” (IP2). This is to embrace the interdisciplinarity of the group as well as build relationships and observe working styles to reach a harmonized way of moving forward in the project. Once the assignments are completed, faculty can advise students on “effective communication skills or abilities or what to do, what not to do while communicating” (IP3) which makes the activity a training. IP4 indicated “training in communication and presenting and trying to teach people how to listen to others” and IP5 offered “teaching what a good meeting looks like... people don't know a great structure to follow when having a meeting” which allows for the task clarity and keeping track of all the information.

#### 4.5 Behavioral Change Wheel Model

Having identified various communication patterns and suggestion of activities, they will be input into the behavioral change wheel model to arrive at the interventions required to tackle this specific combination of communication patterns. Table 2 demonstrates the first step of the model that includes identifying the target behavior to change. For this paper, miscommunication and clashes were mentioned and is a problem that arises frequently within interdisciplinary teams and so is the behavior chosen.

**Table 2. Specifying target behaviour (Michie et al., 2014)**

<b>Target behaviour</b>	Avoid miscommunication and clashes with effective communication
<b>Who needs to perform the behaviour?</b>	All student group members
<b>What do they need to do differently to achieve the desired change?</b>	Communicate effectively
<b>When do they need to do it?</b>	During the duration of their team
<b>Where do they need to do it?</b>	On every communication platform (WhatsApp, in person, Discord, Email)
<b>How often do they need to do it?</b>	At every interaction with a team member
<b>With whom do they need to do it?</b>	With their team members

Next is the behavioral analysis and diagnosis to arrive at the interventions themselves. This utilizes the com-b model and hence utilizes the patterns and responses obtained in the interviews as outlined before.

**Table 3: Behavioural analysis and diagnosis (Michie et al., 2014)**

	<b>COM-B components</b>	<b>What needs to happen for the target behaviour to occur?</b>	<b>Is there a need for change?</b>
<i>Capabilities</i>	<i>Physical capability</i>	Have the physical skills to communicate	No change needed as all students know English and have

			access to the instructions and so have these skills
	<b>Psychological capability</b>	Know the correct time and way to communicate	Change needed as some students may not know how to convey themselves and prefer easier alternative though inefficient
		Know how to create 'if-then' rules to prompt communication	Change needed as students do not necessarily know how to create and routinely apply if-then rules
<b>Opportunity</b>	<b>Physical opportunity</b>	Have communication platforms	No change needed as communication platforms are easily available via Emails, WhatsApp, Discord and in person
	<b>Social opportunity</b>	See each other and other teams communicate	No change needed as this can be seen in person and among other social settings
<b>Motivation</b>	<b>Reflective motivation</b>	Hold beliefs that communicating more frequently and effectively will reduce miscommunication and clashes	No change needed as it is believed that effective communication will reduce miscommunication and clashes
		Believing that consistent communication will result in better teamwork and results	No change needed as it is believed that typically weekly scheduled meetings are ideal for success

	<b>Automatic motivation</b>	Have established routines and habits for effective communication	Change needed to establish routine and habit formation
	<b>Behavioral diagnosis of the relevant COM-B components</b>	Psychological capability and automatic motivation need to change in order for the target behavior.	

Both tables will be discussed thoroughly in the discussion below along with the steps accompanying them.

## 5. DISCUSSION

The execution of interviews for this research has had the purpose of investigating the research question:

*“What are the communication patterns within interdisciplinary student teams that require team building interventions?”*

The data collected from the interviews were input into the behavioural change wheel model to arrive at interventions. The model itself allows for the identification of communication patterns which when analysed in combination with each other, lead to different interventions. Based on the results, table 2 and 3 will be discussed further.

### 5.1 Understanding the Behavioural Problem

As mentioned in table 1, this step involves defining the problem, selecting a behaviour, and specifying the target behaviour. This paper is investigating the multiple aspects and patterns in communication that arise within student interdisciplinary teams. It was determined through the interviews and the barriers to communication by Liu et al. (2021), that there are multiple problems that arise when working in an interdisciplinary student team and hence is noteworthy to explore. The problems that participants expressed included different perspectives, different ways of working, different paces in completing tasks and clashes and misunderstandings. These are in line with the social norms, interpersonal relationships, and cognitive bias within the barriers to communication. Within teams that exist for this short a time span, elaborate hierarchies do not emerge and hence remains flat that indicates that this may not be a barrier for this case. Miscommunication and clashes as a problem includes multiple patterns such as jargons, different perspectives, lack of goal or task clarity or even the unwillingness to want to understand or communicate. It is also easier to identify when occurring and to change this behaviour in comparison to other problems. This is hence a problem for interdisciplinary student teams that is worth finding interventions for.

Table 2 above summaries the specifications based on the particulars of avoiding miscommunication and clashes as a behaviour within communication in interdisciplinary student teams. Since the target is student interdisciplinary teams, students within these teams are the ones who need to perform this behaviour with each other. Teams are meant to accomplish a goal and are discontinued once successful and hence the tenure of this behaviour with one group is the duration of the project. Since the resources to communicate included in person, texting and video calls, these are the channels of communication on which students will have to demonstrate this behaviour.



## 5.2 Identifying Intervention Options

With the target behaviour identified, it is important to recognise what needs to change to achieve this behaviour. Based on the data collected in interviews, table 3 was documented. Within capabilities, there are physical capabilities and psychological capabilities. Participants indicated having both capabilities although they were aware that there was room to improve and the consequences of having ineffective communication. Since all participants had previous experiences with communicating, there is hence no change required with the availability of all the resources and information. However, participants did express difficulties in handling situations leading to discouragements as well as possibilities for training in articulation and information on the different ways to do things. Understanding the different perspectives allows members to reach a compromise on the best way for them to accomplish the goal. This suggests that additional aid can be granted to change psychological capabilities to communicate in an interdisciplinary team.

Opportunities as a component consists of physical and social opportunities. Physical opportunities are the resources available which participants explained are easily accessible. It would be beneficial to book a room at the library more than twice a week but this is overcome with other members also booking and finding more study spots. This means that physical opportunities do not need to change. Social opportunities include being able to have examples of communication within and outside the group. Regularly meeting for a minimum of once a week as well as in classes and the accessibility of the internet to communicate allows for social opportunities to be present resulting in no change required.

Lastly, reflective and automatic motivation. Reflective motivation is whether it is truly believed that effective communication will decrease miscommunication and clashes and that it is worth pursuing to achieve a more successful project. Participants were aware of the consequences of not communicating well and integrate their own tactics to try to communicate better. Since there is a baseline and always room to improve, there is no change required for this component. Although, there does not seem to be routines to communicate effectively, treating it as an afterthought. This indicates the need for change in automatic motivation.

All factors in the GRIP theory by Lacerenza et al. (2018) can be tackled based on the results of the interviews. Interpersonal relationships and role clarity however are the most important and especially relevant to interdisciplinary student teams. This is because it tends to be easier to communicate without judgement with people that have relationships between them in comparison to complete strangers. Getting to know them also helps realize the working styles that different members with various domain knowledges have and builds trust. The familiarity in the way to talk allows for the development of the best way to communicate and divide roles according to expertise and competencies.

With students being aware when in an interdisciplinary team, it is important to first realise the goals, physical capabilities, satisfaction levels and the ways of working so that a consensus can be reached. Talking about it in the open could overcome or at least positively influence social norms as a barrier to communication (Liu et al., 2021). Taking part in the activities would allow for relationships to form. Clarity for goals and capabilities would allow for role distribution and holding each other accountable since members have to rely on each other which would imply a flattened hierarchy. Lastly, cognitive bias would decrease if each member's part is equally important and each member is specialized in their own domain.

Hence, the components that require change were identified. It is the psychological capability which means that students require training or workshops according to Social Change UK (2019) and automatic motivation which would increase by making the students want to develop effective communication instead of not doing it. With reference to the matrix (Appendix 1), interventions that tackle psychological capability are education, training and enablement. Those that engage with automatic motivation include persuasion, incentivization, coercion, training, environmental restructuring, modelling, and enablement. The two interventions that would affect both components are training and enablement. The activities suggested by participants all address enablement or trainings and so can be implied that these interventions have a high likelihood of being successful for these student teams.

### 5.2.1 Training as an Intervention

Training is a vast concept and can take place in multiple ways. Principles that participants deem important are understanding, explaining, listening, clarity in terms of goal, task and role and meeting physically. Trainings that would encompass these would influence both automatic motivation and psychological capabilities. Accounting for these is also in line with the GRIP theory by Lacerenza et al. (2018). When discussing training with participants, it was always once teams are newly formed to be able to discover each other's working styles and get acquainted by building trust. This suggests that training would be efficient to be implemented during the forming stage of team development. The members would not need to assert themselves completely and allow each other's opinions in apprehension of offending anyone. The space to openly discuss all perspectives allows for listening and the acknowledgement of the difference in each members knowledge and capabilities helps the realization of the skills that each domain would contribute to the final goal. Trainings could also be introduced during the storming stage when clashes tend to occur the most frequent. This however can aggravate students and build resent if the willingness to communicate is lacking. Therefore, the best stage to introduce training or workshops are in the forming stage so students can practice the tactics and use the information for the rest of the project duration. Using activity ideas from participants, a feasible intervention activity could include a competitive game during the forming stage. The activity makes team members communicate to solve the tasks and achieve a top score or win. Once there is a winner, the organizer will explain the importance of the values in effective communication and the participants will become aware and more accepting of these after having practiced them. Experience was one of the ways that participants enhanced their communication skills and abilities and hence would be receptive to an activity as such as long as it is fun and there is a reward or other forms of extrinsic motivation such as free food and drinks.

### 5.2.2 Enablement as an Intervention

Apart from trainings or workshops, it is difficult to find the right activity that would equip students to communicate without making them feel forced or demotivated. Negative emotions are generally expressed when mandatorily having to attend sessions. Students who actively see the value in the trainings do not mind it being mandatory, but this is a small percentage compared to those who would feel the latter. Enablement activities are those that provide an opportunity to increase communication capabilities beyond training and education. Examples of enablement activities could include the faculty imposing the use of scrum meetings or Trello, both tactics suggested by a participant that has been efficient to track progress and clearly define roles and tasks. This would allow the students to experience the usefulness of the tools. It also allows for clarity with the designation of tasks and roles which means that

members must have goal clarity in order to delegate and track progress. Enablement activities mostly require faculty or organizations to introduce spaces, opportunities, or methods to communicate. If this is introduced mandatorily in the forming stage of team development, it would be an opportunity to communicate from the very start which makes the students agreeable of utilizing it since they would believe that it is part of the course and the way of working. If introduced in later stages, students would require extra effort to accommodate for this change and be less receptive to the opportunity. This is why enablement should be integrated within the course to reduce the perceived feeling of force and be introduced in the forming stage of team development.

### **5.3 Practical and Theoretical Implications**

By delving into this niche topic incorporating communication barriers, communication patterns, team building interventions, student teams and team development stages into the theme of interdisciplinarity, this research adds some theoretical and practical implications.

This paper's findings hold relevant implications for both, the education sector as well as theoretical frameworks in communication and team dynamics. By integrating the analysis of communication patterns within student interdisciplinary teams with team building interventions, this study associates communication challenges within educational settings, specifically, project-based learning and holistic education. These results not only deepen understanding of communication problems specific to interdisciplinary student teams but highlights the impact of integrating team building interventions in education.

This research also enriches the behavioral change wheel model with data on its implementation. It does this by incorporating real world data on how team building interventions can change behavior to enhance communication in an educational setting. Such validation of a model allows for a basis for future research and educational institutes to implement the interventions. Ultimately, this paper highlights the potential of using targeted trainings and enablements as interventions to enhance communication dynamics, foster collaboration and build interpersonal relationships while celebrating differences in an interdisciplinary educational setting.

Apart from the theoretical implications, this study has practical implications with the use of team building interventions designed to enhance communication in student interdisciplinary teams. Organizations can leverage this research into implementing interventions based on communication patterns within student interdisciplinary teams. Unlike the majority of interventions being training in literature, this paper provides examples of enablement interventions that also prove efficient.

When structuring a course that includes interdisciplinary teams, faculty can consider the impact of experiences in teams on communication abilities. Integrating interventions into the curriculum will allow the student with opportunities to develop these skills and abilities further and cultivate a positive team experience. The results also include a discussion of the right stage in team development to introduce interventions which allows faculty and organizations to maximize the effectiveness of the interventions and achieve a healthier working environment within the teams along with productivity.

### **5.4 Limitations and Future Research**

While this research advances the understanding of team building interventions for communication in the context of student interdisciplinary teams, it is essential to consider the limitations. Addressing these limitations in future research will build a more

comprehensive framework to designing team building interventions based on communication patterns. Despite the constraints, this research still adds value to the existing literature on team building interventions according to communication patterns in student interdisciplinary teams.

For this research, the participants were contacted based on convenience and availability. This resulted in a lower grade of diversity which is important for an interdisciplinary study. Future research could include a criterion about diversity in the purposive sampling criteria. There is also a chance of response bias as participants may have provided socially desirable responses or narrated events inaccurately. This study had international students and hence cultural backgrounds would not play a very important role, but the style of learning is according to the University of Twente and hence there are no vast difference in working style as compared to students from different universities that do not utilize a generic, standard learning model. Future research can use a larger sample size with students from a higher diversity of knowledge backgrounds from different educational institutes to delve deeper into the effect of different working styles on communication. The researchers could also use other research methodologies like direct observation of interventions themselves to identify the patterns, and what could work to enhance the desired behavior.

Since the interviews were semi-structured, some questions were worded differently to participants depending on the flow of information which could cause different interpretations of the same question. The interviews were manually transcribed which could include errors. The transcriptions were also manually coded which could mean that different codes could be used to say the same thing or information was uncoded and hence affects results.

The scope of this research was niche with a specific focus on miscommunication and clashes as the targeted behavior to change so that communication can be enhanced. Future research however could investigate the other problems mentioned, different combinations of communication patterns or the implementation and effectiveness of the interventions once identified using the behavioral change wheel model. This research contains context-specific findings. This means that if the study is repeated with different participants, the results will differ. This will be the case especially for implementing the interventions, but future research can build a generic implementation plan and enrich the behavioral change wheel model by building correlations between patterns and the implementation effectiveness.

### **5.5 Conclusion**

This research explored the question "What are the communication patterns within interdisciplinary student teams that require team building interventions?". A qualitative investigation in the form of semi-structured interviews was conducted. The responses were used in the behavioral change wheel model which allowed for identification of two interventions that are required to enhance effective communication along with principles deemed important to be included. Based on the findings, educational institutions are recommended to design interventions that consider these principles for student interdisciplinary teams. For future research, this paper can pose as the base and ideation stage while implementation of these interventions can be researched in terms of specificities, feasibility and efficiency. This can also be investigated with other study backgrounds or types of teams to investigate if the principles change.

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## 8. APPENDICES:

### 8.1 Appendix 1:

Matrix of links between COM-B and intervention function (Michie et al., 2014)

COM-B components	Intervention functions									
	Education	Persuasion	Incentivization	Coercion	Training	Restriction	Environmental restructuring	Modelling	Enablement	
Physical capability										
Psychological capability										
Physical opportunity										
Social opportunity										
Automatic motivation										
Reflective motivation										

### 8.2 Appendix 2:

Interview Guide

Components	Questions
General	What is your primary field of expertise?
General	What is your role in the team?
General	How long have you been a member of this interdisciplinary team?
Capabilities- physical	What does effective communication mean to you?
Motivation- reflective	What are your reasons and goals to communicate effectively?
Capabilities- psychological	What do you think you and your team should do to communicate effectively?
Opportunity- physical	What resources do you need to communicate with your team? How easily accessible are these?
Capabilities- physical	What kind of skills or abilities do you feel are necessary to perform effective communication?
Opportunity- social	What kind of activities would you suggest to develop these skills and abilities?
Motivation- reflective	Do you believe that you can communicate well and why?
Motivation- reflective	Do you also believe that you can communicate with different backgrounds and why?
Capabilities	What problems regarding communication arise when working in an interdisciplinary team?
Capabilities	How would you help your team members with these problems?
Capabilities- physical	Please describe any training or experiences that you have had that has benefited your communication.

Capabilities	How would you integrate these within your education here at the UT?
Motivation- automatic	Do you find yourself consciously thinking or reflecting your way of communicating?
Opportunity- physical	What ways of communicating with your group do you prefer and why?
Opportunity- physical	How often do you communicate with your team and which method do you use the most?
Opportunity- social	Can you describe any social situation with the group or class where you feel encouraged or discouraged to communicate?
Motivation- reflective	What advantages do you think consistent effective communication with the group will bring?
Motivation- reflective	Do you believe that effective communication will decrease miscommunication and clashes? Why?
	If you were to participate in an activity for communication building, what would it look like?

### 8.3 Appendix 3

Structured Qualitative results- code tree

**First Order Concepts      Second Order Themes      Aggregate Dimensions**

