Media of Communication:

A Comparative Study of Digital and Face-to-Face Interaction

Word Count: 3859

Introduction

The first spark of communication may have been as simple as a look, a shared glance before a hunt, or a gesture toward danger. Long before words, humans found ways to understand each other. However, how we communicate and the media through which we do so have evolved significantly. Starting with face-to-face (FTF), communication grew with each new technology and societal shift, from written language to telecommunication, and now the digital age. Given the pervasive role of digital technologies in modern interactions, this paper aims to understand the distinct benefits and limitations each medium of communication has on different aspects of human interaction and collaborative performance. Human interaction has come to rely on two primary media: face-to-face (FTF) communication or computer-mediated communication (CMC). With each medium offering specific benefits, this study does not declare a universally best medium, but instead, explores the specificities within each medium. To guide this exploration, the null hypothesis posits that there will be no statistically significant difference in collaborative performance, communication quality, or emotional experience between the FTF and CMC groups.

Literature Review

Scholars have examined the different dynamics and factors that stem from different interaction methods, often through two primary theoretical frameworks of understanding communication. The Media Richness Theory (MRT) (Daft & Lengel, 1986) evaluates media based on their ability to effectively convey complex information, emphasizing immediacy, nonverbal cues, and contextual understanding. On the other hand, the Media Naturalness Theory (MNT) (Kock, 2004) focuses on interactions being shaped by human evolutionary preferences, and thus, favors media that mimic FTF over those that don't.

A central aspect of measuring an interactive medium's value is communication quality, a dimension that both frameworks address with valuable perspectives. According to Shechtman and Horowitz (2003), computer-mediated communication (CMC) reduces interpersonal cues and leads to lower immediacy and diminished interaction quality. A conclusion that aligns with MRT, critiquing the inability of digital environments to fulfill the spectrum of communicative signals present in FTF. However, research by Walther and Parks (2002) disagrees, claiming that over time, users adapt effectively to the constraints of digital communication. Their "cues filtered in" perspective suggests that individuals employ compensatory strategies toward the lack of "richness" found in FTF when using CMC. This disagreement thus shows the evolving nature of CMC and suggests that the impact of a medium on communication quality may be directly related to how adapted the user is to the medium.

Furthermore, the work of Lindemann and Schünemann (2020) provides an additional layer to this discussion. Their phenomenological perspectives reframe CMC through concepts like "telepresence" and "social resonance space," arguing that those environments can still create a shared sense of connection and shared immediacy. They define "telepresence" as the feeling of being physically present despite spatial separation, and "social resonance space" as this shared emotional field that is constructed by both communicants in an interaction. Thus, they reconceptualize CMC not as deficient, but as differently embodied, challenging the assumption of digital interactions as inherently less authentic. Through the introduction of a phenomenological lens, Lindemann and Schünemann complicate the common binary view of digital media as simply "less than" FTF, thus pointing towards qualitative shifts in presence rather than reductions.

Building on the discussion of presence and immediacy, another key dimension shaped by the medium is emotional connection. Research by Nguyen et al. (2022) during the COVID-19 pandemic presents a set of strengths found in digital communication. It argues that high-presence digital media like video calls can sustain emotional bonds, including over long distances–a context where FTF becomes obsolete. Lindemann and Schünemann's phenomenological approach reinforces Nguyen's argument, illustrating how CMC creates "mediated immediacy," a co-constructed sense of presence that enables genuine emotional resonance despite the lack of physical proximity. However, the study conducted by Baym et al. (2004) disagrees, offering a more traditional perspective that FTF remains the strictly dominant medium when it comes to cultivating strong emotional ties, specifically when in deeply personal or high-stakes contexts. Such contrasts reflect not only the ongoing tensions in literature regarding the replicability of physical media in digital environments but also the consistent evolution of digital media.

Beyond emotional connection, engagement is also an important dimension where the media diverge. Atkin, Chen, and Popov (2022) argue that FTF interactions naturally foster engagement due to the sharing of a physical space, which leads to relevant spontaneous interactions and dynamic feedback. However, particularly in collaborative and task-oriented settings, digital environments are suggested to provide new forms of engagement that are not reliant on spatial proximity. Supporting this, Thoms and Eryilmaz (2014) found that online social networking platforms generate higher levels of engagement and interaction among students than traditional learning management systems, highlighting the strengths of well-integrated digital tools in cultivating meaningful participation and collaboration. Lindemann and Schünemann's phenomenological lens reinforces this potential through the idea of a "social resonance space" where individuals still engage meaningfully despite distance. By focusing on this embodied nature of interaction, it is revealed just how much digital tools can support active participation and a sense of shared purpose despite the lack of traditional markers of engagement.

Notably, much of the existing literature relies on observational or self-reported data, with very few studies employing experimental designs in the comparison of media. This methodological gap limits causal understanding of how communication quality, emotional connection, and engagement might vary across different settings–a gap this paper seeks to address through an experimental design.

Ultimately, the reviewed literature reveals that although different, each medium of communication–be it computer-mediated or face-to-face–can have its unique benefits and prevail in specific tasks. Accordingly, this paper does not aim to determine a universally superior medium, but instead investigates how each performs within a specific context: collaborative logic-based problem solving.

Methodology

Aiming to understand the role played by the medium of communication in determining how communication occurs in a simple collaborative task, I designed an experiment to measure the difference in communication and performance between Group A (control), which communicated in person (FTF), and Group B (experimental), where participants were placed in different rooms and communicated through the *Google Meet* platform (CMC). Participants ranged from 9th to 12th grade.

Both groups had the goal of completing a logic-based task, requiring effective communication and coordination between each member of the assigned pairs. The task remained the same for both groups, executed on a standardized Chromebook through a platform[1] developed for the experiment. The platform recorded time, moves, and score using the Google Sheets API (see Appendix A for the data schema and Appendix B for technical details on the development of the experiment platform). Right after finishing the task, the platform redirected participants to a post-experiment survey that asked five closed-ended questions using a 5-point Likert scale (responses ranged from 1 to 5).

Pre-Experiment Preparation and Pairing

Prior to the experiment, participants were instructed to complete a survey in which they had to identify the peers within the participant pool whom they knew, thus eliminating a previous relationship between the pairs as a variable. Using the results of the survey, participants were paired through a Python script, and finally, the pairs were manually reviewed to ensure no social dynamics would interfere with the results.

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[1] Here is a link to a demo of the platform: https://communication-experiment.vercel.app/room/99?role=StudentA&scenario=A

Right before beginning the task, each member of the pair went through a short onboarding phase. They were systematically introduced to the platform they would be using and all the ways they could and would be expected to interact with the computer. The introduction covered the interaction methods, including how to mark and unmark grid squares using the “M” key, rotate symbols with a mouse click, and drag and drop symbols to switch their positions. The experiment began only after both members of the pair had completed their individual practice rounds. This ensured that familiarity with the experiment’s mechanics and computers did not become a confounding variable in the experiment.

During the experiment, I was present for technical oversight. In Group A (FTF), I was physically present to ensure the FTF protocol was properly followed (no touching or looking into the other participant’s screen). As for Group B, I was present remotely, without a camera or microphone to avoid influencing behavior, in the *Google Meet* room, where, in the event of internet-related disruptions to the communication, the task and timer were paused until a stable connection was restored. No input was given regarding task-solving strategy or rule clarification beyond what was initially provided to all the participants.

Following the onboarding, students began the experimental task.

Task

The task consisted of organizing a 4x4 grid with 16 symbols according to a total of 6 rules–3 given to each participant. The rules were deliberately designed to create interdependence, requiring bilateral, back-and-forth communication between both parties for exchanging information about their grids and for interpreting the rules. This setup aimed to simulate a controlled collaborative problem-solving scenario, allowing for a meaningful comparison of how communication quality, understanding, and engagement manifest across FTF and CMC settings.

The symbols (Figure 1) used in the task were made by me using the *Krita* drawing software. I used basic shapes and lines during their creation to ensure they would not feel too alien to the participants, enabling them to describe each symbol easily verbally.

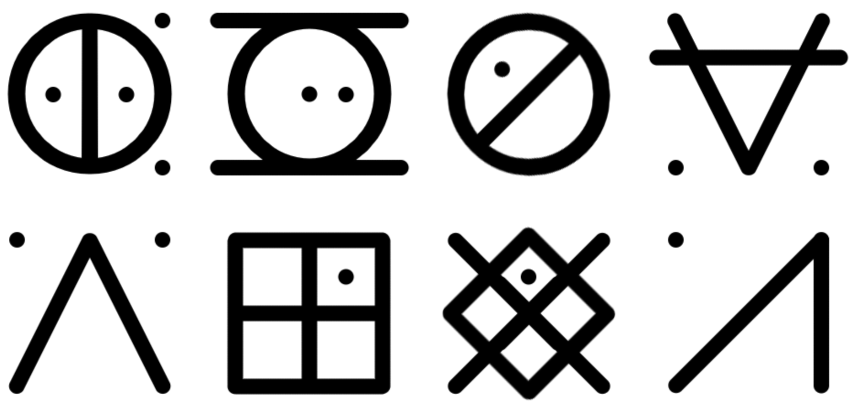


Figure 1 **- Symbols**

Relevant aspects about the symbols include the number of dots within the symbols and the categorization of either "round" or "sharp." Before beginning the experiment, during the onboarding stage, participants were introduced to the following reference image (Figure 2) to understand which symbols are considered "round" and "pointy" to avoid ambiguity.

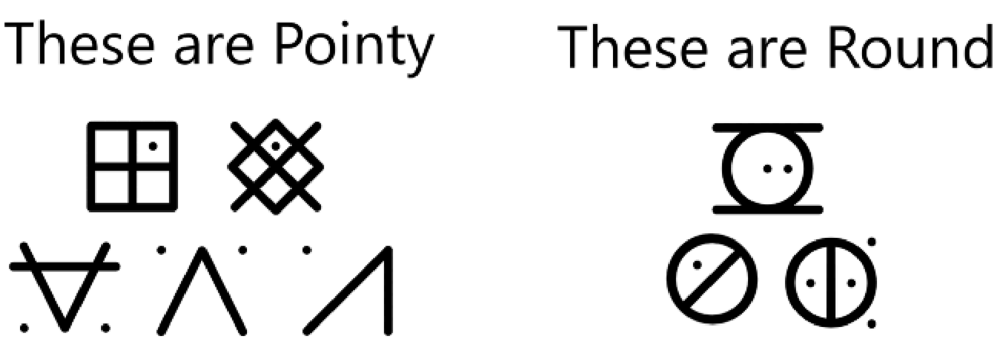


***Figure 2* - Reference Image**

In the task, each symbol of the grid could either be marked (Figure 3), rotated by 90° increments (Figure 4), or have its position swapped by dragging and dropping a symbol onto another slot (Figure 5).

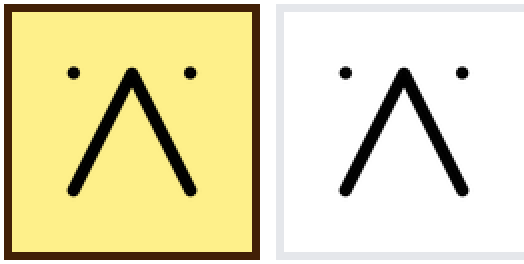


***Figure 3* - Marked / Unmarked**

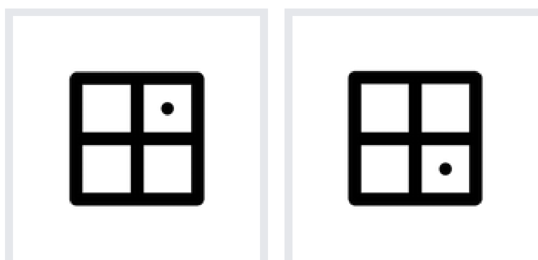


***Figure 4* - Rotation**

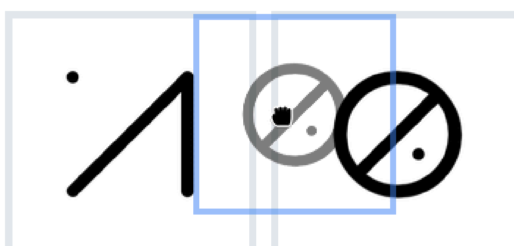


***Figure 5* - Dragging and Dropping**

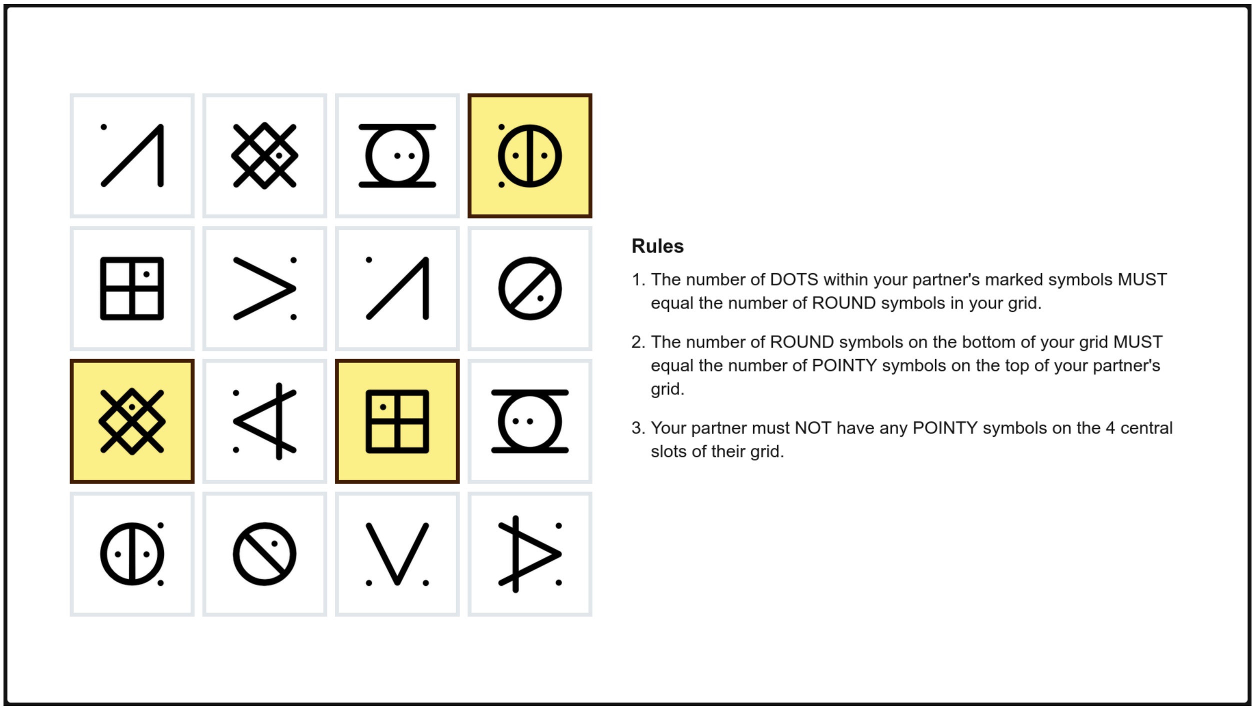


Figure 6 **- Task Screenshot**

Figure 6 showcases what the task looked like from the participant's perspective.

Rules

As mentioned earlier in the Task section, the Task was based on six rules–three given to each participant. Their design had the goal of intentional dependencies between both students' grid information–comparisons of marked positions, symbol orientation, relative positioning–to simulate the kind of bilateral reasoning required in real-world problem solving. There were two sets of rules; all pairs had the same sets, however, which member of the pairs got which set was completely randomized during pair assignment. The complete list of rules is presented below, named arbitrarily as Ruleset 1 and Ruleset 2. Participants did not have access to any category or name of their Ruleset, or to their partner's rules.

Ruleset 1

1. The number of DOTS within your partner's marked symbols MUST equal the number of ROUND symbols in your grid.
2. The number of ROUND symbols on the bottom of your grid MUST equal the number of POINTY symbols on the top of your partner's grid.
3. Your partner must NOT have any POINTY symbols in the 4 central slots of their grid.

Ruleset 2

1. The number of DOTS within the marked symbols of both players MUST be equal.
2. If you and your partner have equal symbols on equal positions, their rotations MUST be equal.
3. You and your partner must NOT mark symbols on the same positions.

Findings and Analysis

To examine whether the medium of communication affects collaborative task performance, three quantitative measures were analyzed: time, number of moves, and score. Respectively, these variables represent the amount of time taken to submit the task, the number of moves used by either player throughout the experiment, and the total number of rules respected on submission. After compiling the average from all participants in group A and group B, I found that the difference in all three variables for both media is statistically insignificant, as their error bounds overlap. This result can be observed in Figure 7.

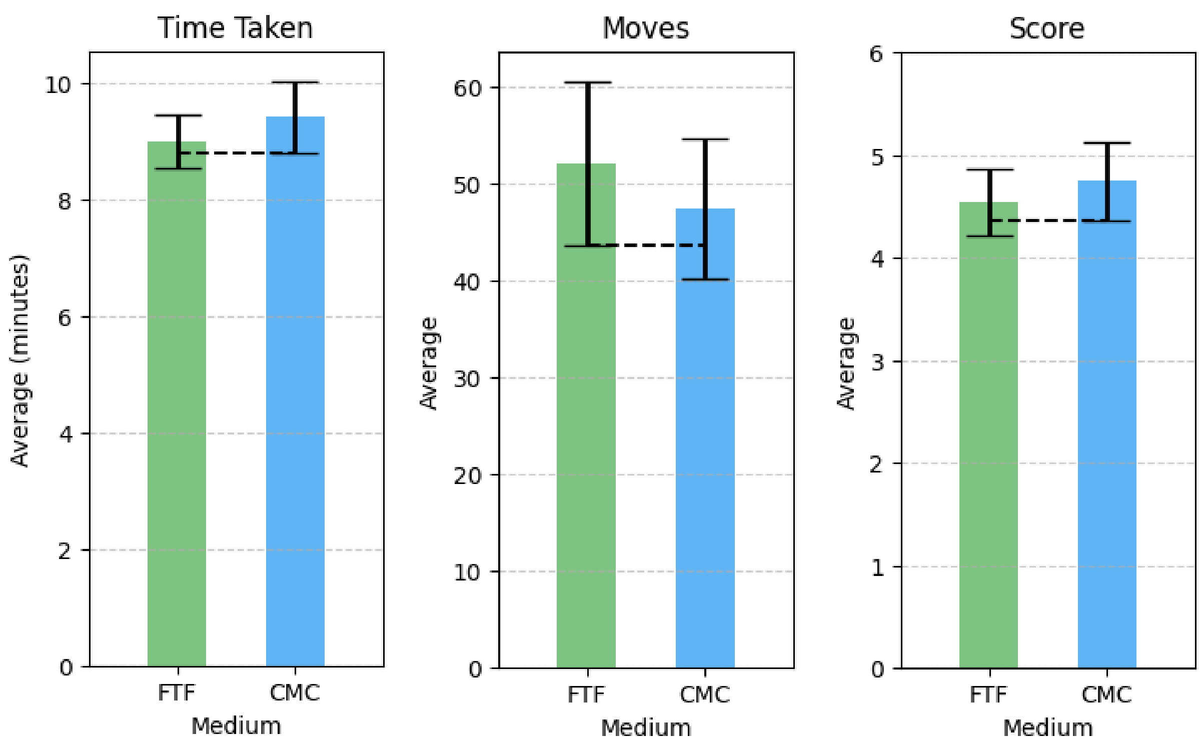
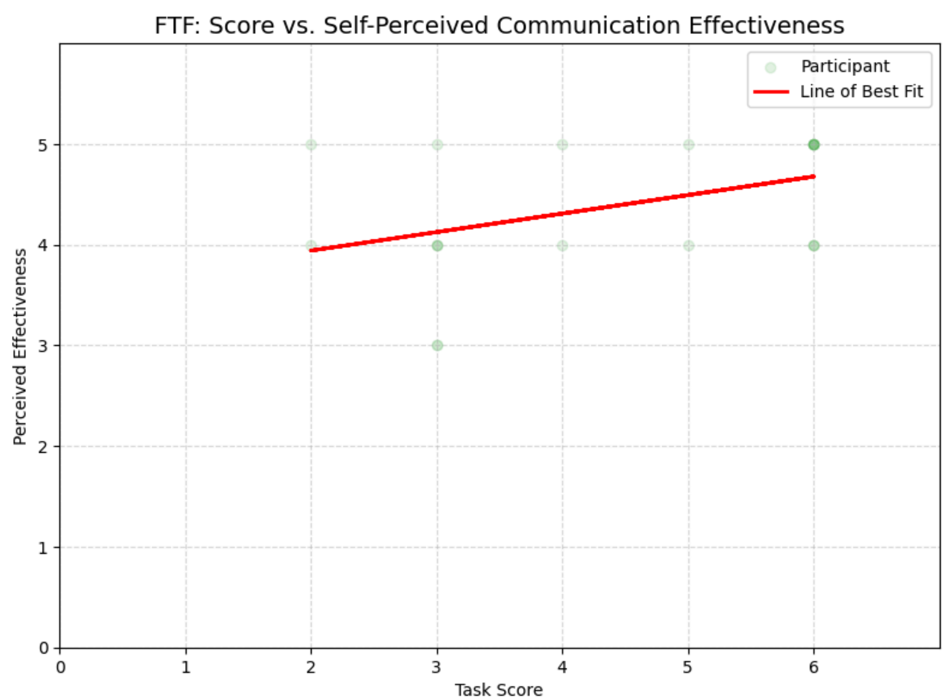


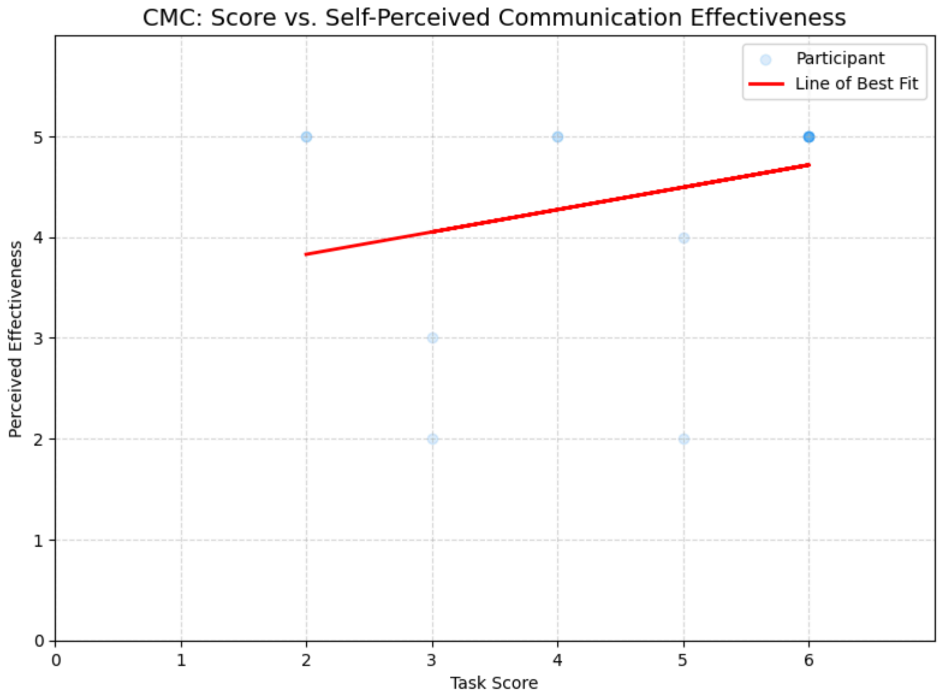
Figure 7 **- Time Taken x Moves x Task Score**

This result, thus, suggests that at least in terms of efficiency and accuracy, the medium did not play a significant role. These findings support the null hypothesis, which posited no statistically significant difference in collaborative performance between FTF and CMC. However, despite both media having similar outcomes, one must not discard the difference in the way the interactions themselves were experienced by participants.

Therefore, to assess the experiential dimension of the qualitative differences, I had a post-experiment survey conducted for the participants to give me a perspective into their subjective experiences regarding the task. The survey included questions regarding self-perceived effectiveness, engagement, enjoyment, frustration, and how understood they felt. Through the responses acquired, I was able to further understand and explore the differences across the FTF and CMC media, regardless of objective performance.



(a)



(b)

Figure 8 **- Task Score x (Self Perceived) Effectiveness**

As shown in Figure 8, both the FTF and CMC groups exhibited a moderately positive relationship between self-perceived communication effectiveness and actual task score. For the CMC group (Figure 8b), a Spearman correlation analysis showed a moderately positive result but with no statistical significance, $\rho(14) = .41$, $p = .118$ (Statistical significance was determined using a standard threshold of $p < .05$). As for the FTF group (Figure 8a), its Spearman correlation analysis had a nearly identical positive trend, though slightly closer to statistical significance $\rho(20) = .41$, $p = .059$. While neither result proves any strong correlation, the consistency of the positive trend across the media suggests the participants' self-evaluations to be somewhat aligned with their success. Moreover, one could also argue that embodied interaction may enhance the self-awareness of communicative effectiveness, given the stronger near-significant p-value found for the FTF group; this could possibly be explained by the minimization of nonverbal cues, however, further research is needed to be sure of such affirmations.

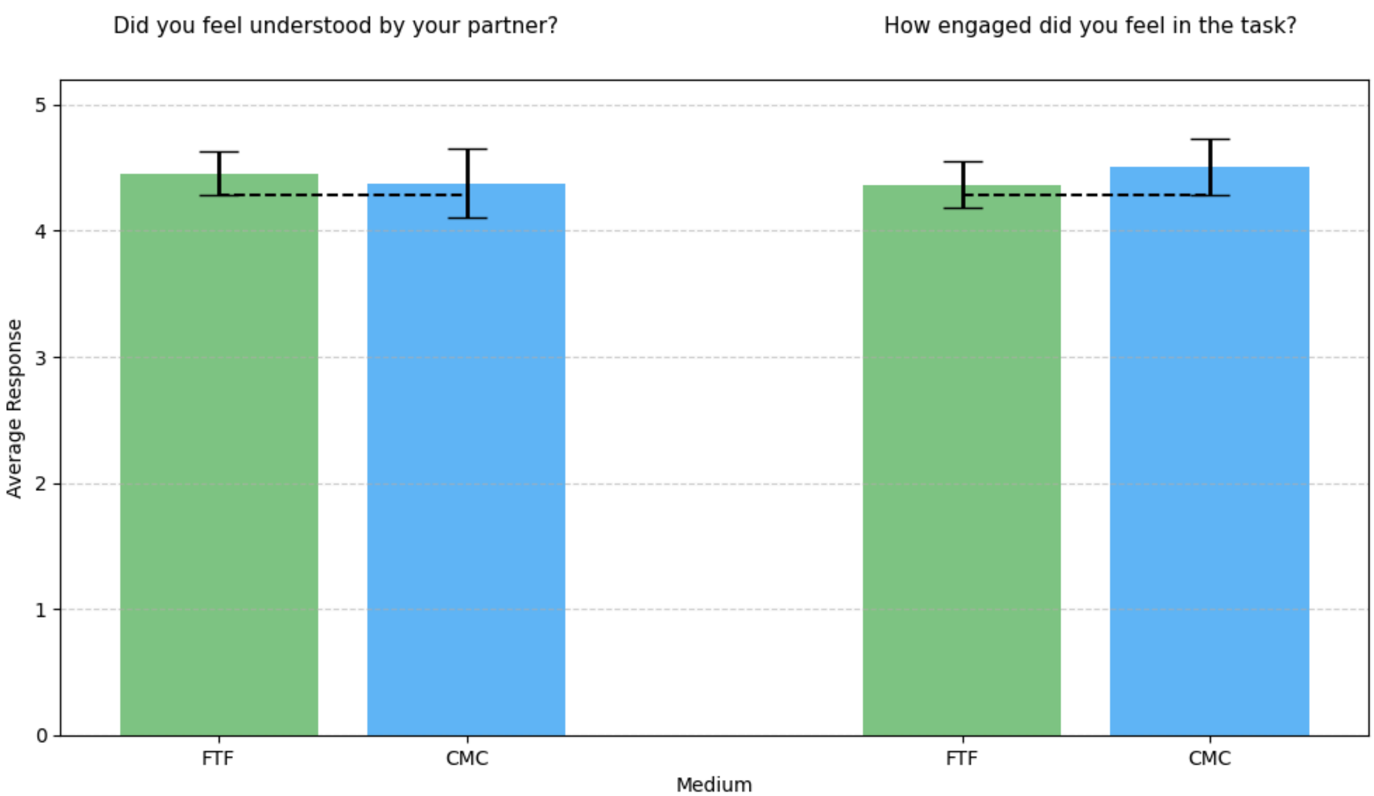


Figure 9 **- Understanding x Engagement**

As seen in Figure 9, there is no statistically significant difference between the levels of understanding and engagement of each medium. However, a key relationship was found through a Spearman correlation analysis. The FTF group showed no significant correlation $\rho(20) = .05$, $p = .844$, indicating that feeling understood did not matter for task engagement in FTF. Conversely, in the CMC group, a statistically significant positive correlation was found, $\rho(14) = .62$, $p = .010$, suggesting that to engage in a collaborative task in a digital medium, being understood played an important role. Thus, indicating a possible reliance on communicative clarity for the sustainment of active participation in digital communication, a medium-specific dependency that is less pronounced in FTF settings.

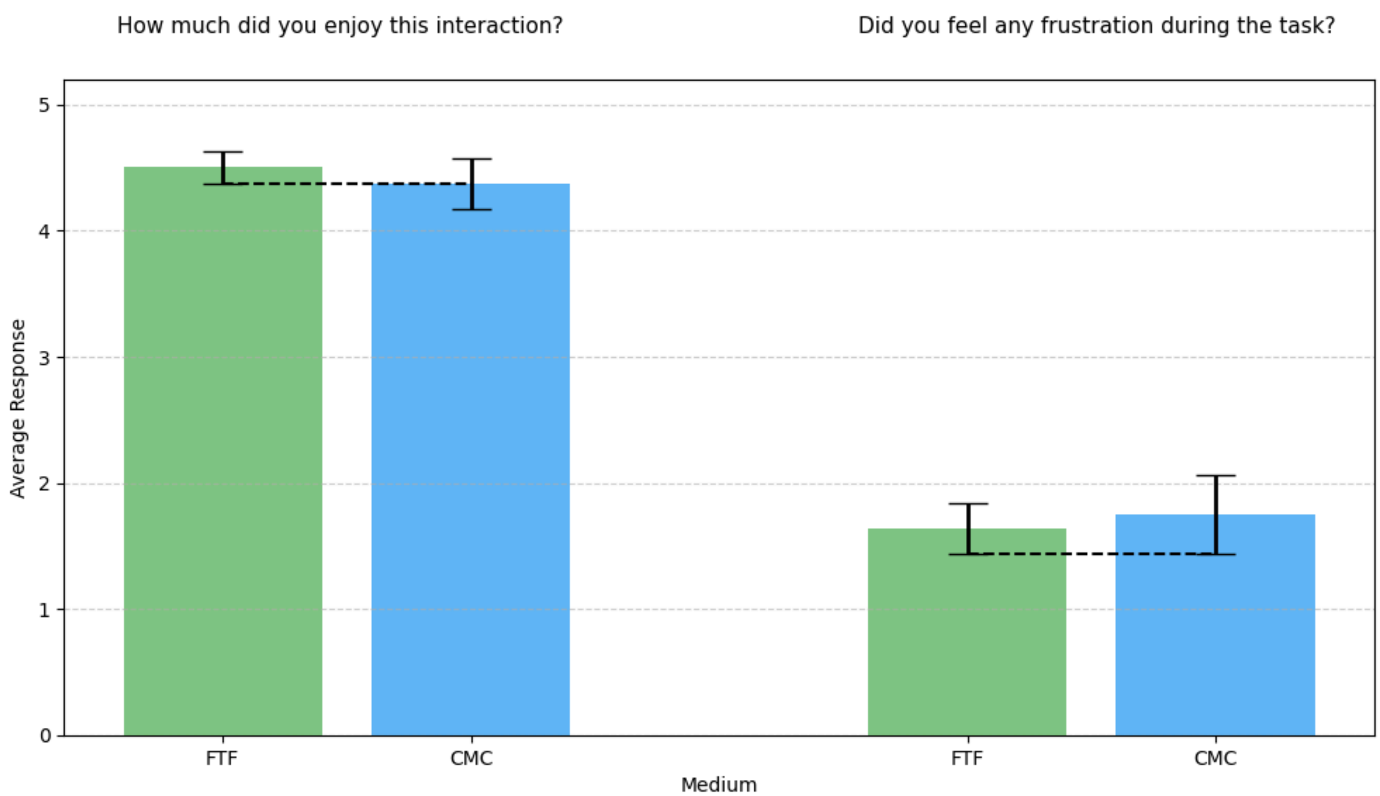


Figure 10 **- Enjoyment x Frustration**

Figure 10 presents the participants' average responses along each medium regarding their enjoyment and frustration during the task. Although the values are similar across the media, representing no statistically significant difference, the relationship between those variables in the media analyzed diverged meaningfully. Through a Spearman correlation analysis, the FTF group showed a statistically significant moderately negative correlation $\rho(20) = -.45$, $p = .034$, indicating that high levels of enjoyment were linked to low frustration. Thus, this suggests that, in an FTF context, positive affective experiences, like enjoying an interaction, are likely to buffer against negative ones, such as frustrations that might occur. In contrast, the CMC group had not only a weaker correlation, but a statistically insignificant one, $\rho(14) = -.23$, $p = .401$, therefore indicating a lower reliability of enjoyment as a predictor of lower frustration levels. One possible explanation for this phenomenon is the multiple different sources of frustration, such as delays and connectivity issues, that can independently generate frustration regardless of overall enjoyment. Henceforth, the disconnect between enjoyment and frustration of the CMC medium suggests that enjoyment alone is insufficient to overcome the background friction present in CMC settings. This finding aligns with the idea that FTF settings better support emotional regulation through nonverbal cues and co-presence, although further research is suggested to evaluate such causality.

Conclusion of Findings

Ultimately, the data suggests that one's success in collaboration is more closely related to each individual's soft skills than the medium in which the collaboration is executed, as the overall task performance saw no statistically significant difference between the media studied. However, what is suggested by the data is some differences regarding how participants experienced the interaction on different media. In particular, the CMC group had a statistically significant correlation between feeling understood and feeling engaged that was not found in the FTF group, suggesting communicative clarity as a more crucial factor for maintaining engagement in digital communication than it is in FTF. On the other hand, the FTF group with a stronger negative link between enjoyment points to a higher emotional buffering capacity of embodied interaction. These results, though not directly refuting the null hypothesis regarding performance, suggest that medium-specific emotional and communicative nuances do exist.

Overall, despite the outcome remaining consistent across media, the experience of communication varied. Thus, indicating the power of the medium in shaping how participants experience communication, a factor with long-term implications for engagement and relational dynamics. Further implications and limitations of this conclusion are to be discussed in the next section.

Discussion

This study found no statistically significant difference in task performance between participants using face-to-face and computer-mediated communication. However, the nature of the communication, perceived understanding, and emotional experience diverged significantly between the two media. Such divergences suggest that despite both media effectively allowing for collaboration in a controlled setting, the way they shape interaction differs; thus, the findings support, to some extent, both the Media Richness Theory (MRT) and the Media Naturalness Theory (MNT), though this agreement is nuanced.

According to MRT, richer media such as FTF are more effective for more complex messages due to the more immediate feedback and the additional nonverbal cues one might get from sharing a room with another. Such a theory is reflected within the data through the stronger, statistically significant inverse relationship found in the FTF group between enjoyment and frustration–participants who enjoyed the interaction had a tendency to have lower frustration levels. Thus, suggesting a higher degree of emotional buffering capabilities on the richer, FTF medium, as this phenomenon was not exhibited by the CMC group. This gap in emotional buffering of digital environments, therefore, supports MRT's concern about the limited nature of cues within the CMC medium hindering effective emotional communication.

On the other hand, MNT proposes that due to humans' evolutionary adaptation to the FTF medium, any deviance from it will inherently require additional cognitive load, regardless of how rich another medium might be. Due to the basis for this study being binary (only two media analyzed), it cannot fully confirm the MNT framework, as not enough media were taken into account. However, the results from this study do show a significantly easier communicative nature on the FTF medium, as one of the findings of this research suggests a reliance on feeling understood for the maintenance of engagement in CMC. Which in turn, implies the absence of embodied cues forces the users to rely more heavily on explicit verbal affirmation, such as asking if someone understood what they just said, reiterating, or structured turn-taking. This increased reliance on overt communicative strategies aligns with the added cognitive demands predicted by the MNT in a less naturalistic medium. Therefore, CMC's requirement of conscious compensation in the absence of certain non-verbal contextual cues points to not only the fragility of digital engagement, but also the adaptability of human communication when constrained by medium.

Ultimately, these findings portray the FTF medium as the more "robust" and the CMC medium as more "fragile" due to the lower emotional buffering observed in CMC in comparison to FTF, but also to the CMC group's reliance on feeling understood for the sustainment of engagement. Delving into the latter, despite not appearing to be relevant regarding task performance, as per the statistically similar task performances recorded by this research, this might be due to the task's short duration. Hence, such a trait of the CMC medium might have a significant impact on longer tasks, however, such a statement requires additional future research.

Regarding the limitations of this study, one of the most notable ones was the small and culturally homogeneous sample, composed of students from my school, with the only significant diversity being age. In this study, however, age might have played a bigger role than it seems, as per qualitative observation, younger participants were generally less dominant and confident within conversation, thus indicating lower levels of social and communicative skills in the younger age groups. A possible theory is that the pandemic might have affected such younger participants whilst they were in crucial stages of social development, however, further research is required to prove such theory.

Another limitation of this study was regarding the lack of depth in studying the emotional connection between participants, as it was not explicitly or quantitatively measured in any manner, only through the survey questions that shallowly explored the self-perception of some emotional variables. However, such variables were not analyzed over a period, and instead, just in an immediate post-experiment survey. Thus, this research completely fails to analyze the long-term development of emotional connection as a factor in communication, and thus, this research reflects mainly the effective and immediate aspects of communication in a controlled collaborative task resolution setting. Not accounting for how each medium changes the development of an emotional connection between the pairs analyzed.

Additionally, this study cannot be used to promote that efficient task-resolution can be achieved equally in CMC or FTF, as the study does not account for environmental vigilance. Therefore, the influence of perceived supervision or accountability in each medium is not studied within this paper. For instance, in remote environments (such as remote learning or home office), since participants are not necessarily observed, they might get more easily distracted and thus not be as effective as in the in-person, FTF medium. Thus, future research on the effects of supervision in both academic and professional contexts is suggested.

Despite the constraints, the findings of this research carry meaningful implications for education, remote work, and digital collaboration tool design. In professional or academic settings where CMC is unavoidable due to spatial constraints, being aware of the medium’s fragility may help teams prepare better by breaking down communication clearly and developing frameworks of feedback to ensure all participants remain engaged. For learning environments specifically, teachers should aim at designing activities and interactions that actively encourage student participation. As for the design of collaboration tools, I would suggest built-in communication prompts to facilitate asking for clarification and confirmation of understanding, shared note spaces, and more broadly, real-time collaboration spaces to ensure all participants are doing something, preventing the loss of engagement.

In terms of future research, as mentioned before, there is a need to explicitly measure how different media change the long-term development of emotional connections and how those different levels of intimacy might affect task performance. Furthermore, expanding the scope beyond logic-based tasks to include creative, narrative, or negotiation-based activities would allow researchers to determine how the effects of media might vary by task type.

Finally, further inquiry into personality types and communicative tendencies could prove immensely valuable. Observations of how the pairs worked together allowed me to perceive some traits that changed the structure of communication, such as dominance in speech, confidence, and strategy, thus hinting at success in a collaborative medium being more influenced by interpersonal compatibility between participants rather than the medium itself. Research exploring how different personality pairings or communication styles interact with different media could provide nuanced insights into the contextual rather than universal differences between each medium of collaboration.

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Appendix A

This appendix discusses the data acquisition process in detail. To ensure systematic data acquisition during the experiment, a custom web platform was developed using **Next.js** and hosted online. All experimental data—task actions and survey responses—were logged using **Google Sheets API v4**, allowing for real-time and persistent storage.

Each pair was anonymized via an assigned pair number. No personal data was kept after the initial assignment process (which required non-anonymity to ensure the pairs were properly separated), and the dataset contains no names, email addresses, or demographic identifiers.

Once an experiment was over, a **POST** request was sent to the API endpoint (**/api/checkSolution**), which handled:

- Authentication using a service account key (base64-encoded in an environment variable).
- Validation of the participant's role (**StudentA** or **StudentB**) and their corresponding row number on the spreadsheet.
- Serialization of the final grid state as a JSON string.
- Recording of:
  - **Time taken** (in seconds)
  - **Number of moves**
  - **Serialized solution grid**

Depending on the participant's role, the data was written to one of the following columns in the spreadsheet's "Data" sheet:

Column	**Field**
A	Pair ID
B	Timestamp
C	Time A (Student A)
D	Time B (Student B)
E	Moves A
F	Moves B
G	Grid Solution A (JSON)
H	Grid Solution B (JSON)

The Google Sheets batch update request used the **RAW** value input option to preserve data structure integrity. The full backend logic for this operation is documented in the project's **route.ts** file.

Pair Number	Time (ms)	MovesA	MovesB	Medium	Score
1	661153	10	4	FTF	5
2	736847	120	22	FTF	3
3	645816	41	22	FTF	2
4	556633	26	40	FTF	3
5	409294	8	22	FTF	6
6	633707	28	37	FTF	4
7	336352	2	6	FTF	6
8	396697	19	12	FTF	6
9	550074	21	23	FTF	6

10	400874	2	10	FTF	6
11	613879	73	25	FTF	3
12	575560	11	14	CMC	6
13	485485	6	29	CMC	6
14	791657	83	29	CMC	5
15	608514	10	21	CMC	4
16	364355	13	10	CMC	6
17	724009	32	17	CMC	3
18	663710	25	32	CMC	6
19	669216	27	6	CMC	2

Due to space efficiency, the solutions were separated from Table 2 and are to be shown in the following Table 3.

Pair Number	SolutionA	SolutionB
1	[{"symbol":1,"rotation":0,"marked":false},{"symbol":2,"rotation":180,"marked":false},{"symbol":7,"rotation":0,"marked":false},{"symbol":8,"rotation":180,"marked":true},{"symbol":3,"rotation":0,"marked":false},{"symbol":4,"rotation":90,"marked":false},{"symbol":1,"rotation":0,"marked":false},{"symbol":6,"rotation":180,"marked":false},{"symbol":2,"rotation":0,"marked":true},{"symbol":5,"rotation":90,"marked":false},{"symbol":3,"rotation":990,"marked":true},{"symbol":4,"rotation":180,"marked":false},{"symbol":8,"rotation":0,"marked":false},{"symbol":6,"rotation":90,"marked":false},{"symbol":7,"rotation":180,"marked":false},{"symbol":5,"rotation":270,"marked":false}]	[{"symbol":7,"rotation":0,"marked":false},{"symbol":3,"rotation":90,"marked":true},{"symbol":2,"rotation":180,"marked":true},{"symbol":5,"rotation":180,"marked":false},{"symbol":1,"rotation":90,"marked":false},{"symbol":8,"rotation":0,"marked":false},{"symbol":6,"rotation":180,"marked":true},{"symbol":4,"rotation":270,"marked":false},{"symbol":5,"rotation":0,"marked":false},{"symbol":6,"rotation":0,"marked":false},{"symbol":3,"rotation":270,"marked":false},{"symbol":8,"rotation":180,"marked":false},{"symbol":2,"rotation":90,"marked":true},{"symbol":4,"rotation":90,"marked":false},{"symbol":1,"rotation":180,"marked":false},{"symbol":7,"rotation":270,"marked":true}]
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	"symbol":5,"rotation":900,"marked":true},{"symbol":3,"rotation":990,"marked":true},{"symbol":7,"rotation":630,"marked":false},{"symbol":8,"rotation":270,"marked":true},{"symbol":6,"rotation":360,"marked":true},{"symbol":4,"rotation":720,"marked":true},{"symbol":5,"rotation":270,"marked":false}]	symbol":2,"rotation":360,"marked":true},{"symbol":3,"rotation":270,"marked":false},{"symbol":8,"rotation":270,"marked":false},{"symbol":6,"rotation":0,"marked":false},{"symbol":4,"rotation":360,"marked":false},{"symbol":1,"rotation":450,"marked":false},{"symbol":7,"rotation":270,"marked":true}]
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Upon task completion, participants were automatically redirected to a post-experiment Google Form. The form collected self-reported Likert-scale data (1–5) through the following five questions:

1. How effective were you and your partner at communicating? (Very ineffective – Very effective)
2. Did you feel understood by your partner? (Not at all – Completely)
3. How engaged did you feel in the task? (Not engaged at all – Fully engaged)
4. How much did you enjoy this interaction? (Not at all – A lot)

5. Did you feel any frustration during the task? (No, not at all – Yes, a lot)

Survey responses were timestamped and automatically appended to a separate Google Sheet via the default Forms-to-Sheets integration. No identifying information (name or email) was collected, only the pair number.

Appendix B

This appendix discusses the web development process in detail. After designing the task, I developed a web app using **Next.js** to execute it. The platform consisted of two main pages:

1. Onboarding
2. Task Interface

Each participant was assigned to a role (Student A or Student B) and received three unique rules depending on their role (Ruleset 1 or Ruleset 2).

Pairs were either physically co-located (FTF group) or separated and connected via *Google Meet* (CMC group). In both conditions, the task interface ran locally on individual Chromebooks. The system did not provide a P2P connection, and all coordination had to be accomplished verbally, respecting each group's communication constraints.

After reaching a mutually agreed-upon configuration and verbally stating so, I submitted their solutions through a special command.

The overall technical summary of the platform is:

- Frontend: Next.js, React
- Backend: API route written in TypeScript (see /api/checkSolution/route.ts)
- Data Logging: Google Sheets API (authenticated via service account)
- Deployment: Vercel (public demo here)
- A complete and public code repository on GitHub is found here