Comparative Study Exploring Personality-Communication Correlation in Design Students and Its Impact on Offline/Online Collaborative Learning

Mohana Das*, The Hong Kong Polytechnic University, HKSAR
Newman Lau, The Hong Kong Polytechnic University, HKSAR
Wenjing Zhang, The Hong Kong Polytechnic University, HKSAR
Kelly Tang, The Hong Kong Polytechnic University, HKSAR
Dominic Leung, The Hong Kong Polytechnic University, HKSAR

Received: 04/30/2024*;* ***Accepted:*** 06/11/2024; ***Published:*** -

Abstract:
Background: Collaborative learning is a common teaching strategy in design education. This study analyzes the correlation between personality types, communication styles and the learning outcomes of design students in collaborative learning in online and offline mode of teaching. The traditional approach of face-to-face learning had to be quickly adjusted with hybrid or online mode of teaching and learning process due to the onset of the pandemic COVID-19 during the last 3 years.
Methods: By comparing the data collected from two academic years, the study compares the different correlations in conducting online and offline collaborative learning environments. Students' personality and communication style are analyzed through the Myers-Briggs Type Indicator (MBTI) and a four-type communication model.
Results: The findings indicate that students face different challenges in online and offline collaborative learning activities, and the correlation between personality types, personality styles and learning outcomes is different. In the offline environment, the personality traits of Thinking (T) and the personality temperament of intuitive-thinking (NT) are positively correlated with learning outcomes. Among the four communication styles, directors are positively correlated with learning outcomes. In an online environment, having the personality trait of extroversion (E) and the personality temperament of intuitive-feeling (NF) are positively connected with learning outcomes. Socializer is a communication style that is closely correlated to learning outcomes.
Conclusion: This study points out that when organizing online collaborative learning, students face challenges in building an intimate and comfortable group atmosphere, while offline learning requires more leadership-quality team members. The findings help educators understand student personalities, help teachers organize learning activities more effectively for better collaborative learning outcomes, and provide students with equal opportunities for learning success.

Keywords: *Project-Based Learning (PBL), Myers-Briggs Type Index (MBTI), Personality, Communication Style, Collaborative Learning, Design Students, COVID-19*

Introduction

Collaborative learning is an educational approach for multiple learners to participate in one learning task, in which group members rely on each other and share experiences, aiming to achieve the same learning goals through multiple activities such as group projects and group debates (Chiu 2008; Smith and MacGregor 1992). Collaborative learning is considered to be more conducive to the initiative and creativity of learners than independent learning, as in a collaborative learning environment, students do not passively accept knowledge, but create and share knowledge through the process of participating in discussions, obtaining information, communicating, and obtaining feedback (Brindley et

al. 2009). It is a learning method that helps to deepen the grasp and use of knowledge and realize critical thinking (Nelson 1994). Therefore, collaborative learning is considered to be effective for non-basic learning and helps improve the learning environment in higher education (Kyndt et al. 2013; Sumtsova et al. 2018). In a collaborative learning environment, students or students and teachers work together through interdependent learning activities. Knowledge is co-created and shared by students, not acquired from teachers and course materials, and owned by a particular individual. Learners are not passive knowledge recipients, which demonstrates the transformation of the educational approach from teacher-centered to student-centered (Laal and Laal 2012).

For educators, just asking students to complete a common task together does not necessarily promote the collaboration and participation of all students, which faces the biggest challenge of group conflict (Thompson and Ku 2006). In addition to allowing students to acquire knowledge, promoting the formation of collaborative spirit and interpersonal relationships is also one of the purposes of collaborative learning, although this ability is not always formed naturally (Kreijns, Kirschner and Jochems 2003; Näykki et al. 2014). Educators are required to give students the right to freely manage their roles in the team and encourage the development of teamwork skills, as well as to provide timely learning support (Dillenbourg 2002; Naismith, Lee and Pilkington 2011). Particularly focusing on design education, the features of the design studio setting have a big impact on group learning and that makes it crucial for a comprehensive understanding of the topic within the context of design education. According to a recent study by Rosa and Ferreira (2023), students studying design respond differently to distant learning settings, especially for specialized courses that count toward a degree. Notably, especially for Project or Drawing classes that are usually taught in design studios, students tend to appreciate in-person environments. This result emphasizes the need to consider the function of the design studio in cooperative learning in the discipline of design education. The design studio inherently encompasses numerous benefits of collaborative learning, including active participation, the co-creation of knowledge, and the cultivation of interpersonal skills. For learners, there may be individual differences in their attitudes towards participating in collaborative learning activities. Both personality and communication style have been identified as important factors that may influence the collaborative ability training process (Jang and Park 2016; De Vries et al. 2009). This is because effective collaboration often requires social interaction, and social skills are an important consideration for the success of collaborative learning (Borg et al. 2021). The mode in which an individual socially interacts is an important part of personality traits, and the style of communication is a direct reflection of the form of social interaction. Studies have shown that learners with different personality traits and communication styles have different tendencies to relate to the environment even when faced with the same learning environment (Cho et al. 2007; Moller and Soles 2001). It is important for educators and

learners to understand whether learning strategies are effective and how individual differences affect learning. Understanding students' individual differences and providing appropriate guidance facilitates effective collaborative learning.

New potential for collaborative learning has emerged as a result of the advancement of digital technologies. The online environment allows learners not only to rely on personal knowledge acquisition but also to acquire knowledge from different sources provided by the online environment, thereby having more opportunities to share information and interact with other learners and educators (Barak et al. 2009). In today's society, web-based tools such as e-mail, forums, and online meeting platforms provide timeliness and convenience for communication and work (Koch 2010). The COVID-19 pandemic has further forced higher education institutions to consider different education models in the online environment, especially how to ensure the effectiveness of student collaborative learning in the online environment (Adedoyin and Soykan 2023). Therefore, this study compares the learning outcomes of students of different personality types and communication styles in face-to-face and online learning environments, aiming to guide educators to organize effective collaborative learning strategies/models and achieve better learning outcomes.

Background

Collaborative learning

The theoretical framework of collaborative learning is based on the constructivist theory proposed by Piaget and Cook (1952), Bruner (1985), and Vygotsky (1978). Under this theoretical background, social interaction is considered to be the driving force of personal cognitive development, so this learning perspective emphasizes the importance of collaboration in learning activities. Learners can achieve full cognitive development through social contact, and they can even grasp topics that they cannot understand on their own by cooperating with others, changing the knowledge received through teamwork into their own unique experience (Vygotsky 1978).

The model of collaborative learning in higher education has been further developed. Higher education is considered a social practice, and this process needs to be set in a more realistic environment of human activities, and collaborative learning can encourage learners to participate in depth through the process of social interaction (Guyotte et al. 2014; Leathwood 2005). Collaborative learning provides learners with opportunities to negotiate, conduct critical discussions, and propose informed solutions. This process is conducive to helping learners internalize their ideas. For students participating in collaborative learning, especially when working with other people with rich knowledge and advantages, they will show a higher level of intelligence than before (Gokhale 1995). Research on college

students also pointed out that group work can have a positive impact on undergraduates' learning motivation (Hiltz and Benbunan-Fich 1997) and learning satisfaction (Al-Rahmi and Zeki 2017).

The concept of collaborative learning is widely applied in the field of design education. Design educators typically give students a design topic and then allow them to work individually or in groups to explore, research, and complete the project. Nowadays, design issues are becoming more and more complex, which means that it is difficult for a single participant to master all the skills required for the design task. Therefore, the ability to collaborate has become one of the important skills required by designers in their daily work (Ostergaard and Summers 2009). In recent years, some researchers have also proposed that design is a process of social interaction, and that design concepts are generated through interactive dialogue. As a team member, designers also need to have the ability to promote cross-boundary and cross-professional integration of knowledge (Kleinsmann et al. 2012; McDonnell 2022). For design educators, it is necessary to consider cultivating design students' ability to share and integrate relevant knowledge and carry out effective communication and cooperation. Design education encompasses the cultivation of individual creativity and personal expression, which can be shaped by the educational setting (Cennamo and Brandt 2012). Certain design courses may include direct, physical interactions that are most effectively supported in a face-to-face environment. However, online education formats can effectively teach conceptual or theory-based parts of design education. Design courses frequently necessitate adaptability to handle project deadlines, iterations, and unforeseen obstacles. To accommodate the iterative nature of design and facilitate both individual and group exploration, it is important to make sure that both face-to-face and online learning options are flexible. Research on the collaborative learning of design students is thus necessary.

Digital transformation is one of the important trends in the development of higher education institutions in recent years (Abad-Segura et al. 2020). Studies have shown that collaboration through online support is beneficial to help collaboration, enhance group cooperation, and promote the development of social skills (Apple et al. 2011; Koch 2010). At the same time, other studies highlight that, compared with face-to-face collaboration activities, online collaboration may reduce overall social interaction and reduce the need for social skills, thus helping some learners obtain better learning outcomes (Lomas, Burke and Page 2008). These studies indicate that online collaborative learning can promote students' learning and participation, but it is necessary to further explore the relationship between online and offline collaborative learning and the learning outcomes of different learners, and how individual differences (such as personality) affect the effectiveness of collaborative learning.

Personality and Myers-Briggs Type Indicator Test (MBTI)

Personality differences are closely related to learning outcomes because personality traits reflect the characteristics of an individual's thoughts, feelings, and behaviors (Eysenck and Eysenck 1978). Individuals with different personalities will show different preferences in communicating, sharing information, and solving problems (Heaven et al. 2005). In the process of collaborative learning, the interaction between participants is the key to this learning process, which means that the different personalities of learners will have a collective impact on the results of collaborative learning.

The concept of personality style has been widely accepted by educators (Conti and Kolody 1999). The establishment of this concept is based on Jung's theory (Jung 1971) of personality and is widely applied after the development of the Myers-Briggs Type Index (MBTI) psychometric tool based on Jung's theory. The core concept of MBTI is that the seemingly random behaviors of individuals are orderly and consistent because the difference is derived from personal perception and judgment, which emphasizes the judgment of individual preferences (Myers, McCaulley and Most 1985). Based on the MBTI theory, an individual's behavior is based on the following four preferences, which represent focus and source of motivation (Extrovert versus Introvert), the method of acquiring information (Sensing versus Intuitive), the method of making decisions (Thinking versus Feeling), and how to engage with the rest of the world (Judging versus Perceiving) (Table 1). According to the different combinations of these four preferences, a total of sixteen personality types have been produced.

Table 1: Four Personality Traits of MBTI

E (extrovert)	**Direction of attention** (source of energy): *Es pay attention and energy are invested in the outside world; Is pay attention to inner feelings and thoughts.*	**I** (introvert)
S (sensing)	**Cognitive style** (how to gather information): *Ss pay attention to tangible facts and information, Ns focus on the meaning, relationship and conclusion.*	**N** (intuitive)
T (thinking)	**Judgment** (how to make a decision): *Ts prefer an objective, impersonal analysis of the issue; Fs start from own values and pay attention to the emotional experience of others.*	**F** (feeling)
J (judging)	**Lifestyle** (how to deal with the outside world) *Js make decisions decisively, prefer a planned, organized world; Ps consider multiple possibilities and prefer a flexible, open life.*	**P** (perceiving)

Based on the MBTI model, Keirsey (1998) found that these 16 personality types can be further divided into four temperament types, including artisan, guardian, idealist and rational, each temperament type contains four types of MBTI (Table 2). Keirsey (1998) pointed out that artisans are empiricists, and their temperament is related to sensing-perceiving (SP); guardians are traditionalists, and their temperament is related to sensing-judging (SJ); idealist temperament is related to intuitive-feeling (NF) preference; rational temperament is associated with intuitive-thinking (NT) preference. Keirsey's (1998) division is based on two dimensions: concrete versus abstract and cooperative versus utilitarian. He argues that these two dimensions describe the way a person interacts and communicates with others and the way a person achieves goals.

Table 2: Four Temperaments Based on MBTI

		Cooperative			
	ISTJ	ISFJ	INFP	ENFJ	
	ESTJ	ESFJ	ENFP	INFJ	
	Guardian (SJ)		**Idealist (NF)**		
	stable and reliable cooperators who tend to cooperate on the side of the rules and are the stabilizers in the team.		unifier or empowerment person who tends to talk about abstract imaginative concepts or ideas.		
Concrete	**Artisan (SP)**		**Rational (NT)**		***Abstract***
	confident, adventurous activator who focus on specific and unique things about themselves.		clarifiers who seek clarity and understand the through distinctions and dualities with confidence.		
	ISTP	ISFP	ENTP	INTJ	
	ESTP	ESFP	INTP	ENTJ	
	Utilitarian				

Since the establishment of MBTI, it has been used to analyze the relationship between personality types and learning outcomes and has been proven to be an effective research tool by many researchers (Whitworth 2008; Kroeger, Thuesen and Rutledge 2009). Di

Tiberio (1996) summarized the reasons as different learning environments have different effects on the display of the strengths and weaknesses of different personality types, making the MBTI able to be widely used in the evaluation of student characteristics, learning styles, interaction with teachers, etc. For example, the study of M. Ayoubi and Ustwani (2014) pointed out that Sensing is the main factor affecting students' academic performance, while the study of Puji and Razaq (2016) pointed out that students' preference for Judging determines their learning style. The study by Kim and Han (2014) further pointed out that extroversion, sensing, feeling, and judgment (ESFJ) are the main personality dimensions that affect students' learning styles. Some researchers further pointed out that different disciplines will attract specific types of MBTI, so it is necessary to explore the development of more targeted teaching methods based on the characteristics of different majors (Briggs, Copeland and Haynes 2007). Durling's (1996) study on design students pointed out that more than a quarter of the 71 students who participated belonged to the same personality type: Extraversion, Intuition, Thinking, and Perception (ENTP). In addition, students have a higher preference for intuition and perception, reaching 79% and 69%, respectively. Numerous studies have demonstrated that learners of different personality types tend to use different learning methods and perform differently in final learning outcomes (Zhang et al. 2022). Applying the analysis of students' personalities to understand learners, and teaching students in accordance with their aptitude are the reasons that can truly tap students' potential and achieve better learning results overall (Busato et al. 2000). Design students have unique personalities. This research study will analyze the characteristics of design students from two academic years, to determine how their personality characteristics affect their learning outcomes.

Communication styles

Communication style is defined as the language characteristics of an individual during the communication process, reflecting the individual's mode of receiving information and responding. For learners, the way they communicate greatly affects the way they judge, choose, and view the information they receive (Pânişoară et al. 2015), therefore, communication style has been proven to have a strong relationship with student learning outcomes (Manca and Ranieri 2013). For example, Cho et al. (2007) found that students with a high willingness to communicate on collaborative social networks are more likely to get high grades.

Communication scholars have made many efforts in the study of personal communication styles and have proposed a variety of research tools. In higher education, collaborative learning is expected to enhance student autonomy through group work, and promote students' comprehensive ability to explore in teams, critically discuss, propose, and implement solutions to achieve good learning outcomes. The analysis of communication

styles should not only pay attention to the cooperative behavior of students but also pay attention to the purpose behind the communication behavior. Alessandra and Hunsaker (1993) developed the analysis tool which divided four different communication styles into the two dimensions of observable behavior and motivation. Observable behavior refers to whether an individual can influence others through their expressions, which includes modes called directness and indirectness. People who communicate more directly are usually assertive, controlling, and even aggressive. People who tend to adopt an indirect communication style are relatively quiet and reserved, and they prefer to be the listeners, but expressing their personal views is often difficult for them. The dimension of behavioral motivation refers to the goal of an individual in the process of communication, and there are two tendencies called support and control. Supporters prioritize the feelings of others and their relationships with others, so they are more flexible and eager to build comfortable relationships along the way. Controllers are more concerned with the event itself; they are task-oriented; their purpose is to complete the established plans and goals. Based on these two dimensions, Alessandra and Hunsaker (1993) proposes four communication styles: relator, socializer, thinker, and director (Table 3).

Table 3: Four Temperaments Based on MBTI

	Supporting (Relationship-oriented)		
	Relator They are easygoing, attentive to the feelings of others, and eager to form close relationships to gain a sense of security and belonging.	**Socializer** They tend to interact with others directly and quickly, enjoy being with people, and enjoy participating in the fast-paced work of a team. They tend to fall into fantasies.	
Indirect (Slow-paced)	**Thinker** They tend to solve problems slowly and carefully, analytically and logically, and need to analyze all the data before deciding. They prefer to work alone.	**Director** They are aggressive and competitive and prefer a fast-paced work environment. They tend to be good managers because they can manage themselves and others well and get results.	***Direct (Fast-paced)***
	Controlling (Task-oriented)		

Method and Data Collection

Participants

The study covers design students from two academic years: the 2019-2020 academic year and the 2020-2021 academic year. The participants are Hong Kong Polytechnic University graduate students enrolled in the Master of Design (Design Practices) programme, with a total of 39 students participating, 18 in the 2019-2020 academic year and 21 in the 2020-2021 academic year. These students come from different undergraduate backgrounds, including interaction design, industrial design, jewelry design, engineering, etc. This means that group projects are based on interdisciplinary cooperation, and this diversity is conducive to the analysis of collaborative learning results. All the courses involved are conducted in groups of three. The composition of the group is freely chosen by the students, and the grouping is different each time.

Research Setting

The study collected students' personality types and grade point average (GPA) as the main analysis materials. The student's MBTI type and communication style were collected through online questionnaires at the beginning of the two academic years. Students were required to complete the questionnaires online and report the results to the teaching assistant. The MBTI questionnaire contains a total of 93 questions, all of which are seven-scale mandatory rating questions. The communication questionnaire was developed based on Alessandra and Husnaker's (1993) four-type model, including 12 mandatory rating questions.

The research covers a comparison of two different courses, "Design Experience" and "Value Strategies for China", over the course of two academic years. The two courses have different design themes, but adopt a similar teaching mode, that is, the teacher first introduces the design background, and then the students form a team and choose the topic independently, and after an in-depth analysis, they are required to propose complete design strategies and plans from the designer's perspective by the end of the semester. Both courses also encompass multiple partner companies to improve the learning process and enable the teachers in guiding students through their projects, allowing students to tailor their coursework while still satisfying society's demands. Students are needed to work with various firms and suggest plans for future development. The topic is drawn from the business type of cooperative enterprises, and students are asked to work with various companies and propose models for further development. During this process, the three group members need to work closely together to achieve a common goal. The main difference between the two academic years is that in the second year, due to the Covid-19

pandemic, the teaching mode has been changed to online, and student collaboration is mainly achieved through online means.

When evaluating learning outcomes, GPA is used as a measurement tool. The calculation of GPA is based on the continuous record of student performance throughout the project. Teachers have reviewed the performance of students at different stages and performed a comprehensive calculation through the participation and performance of classroom activities, the display of results at different stages and the final presentation. In order to conduct a horizontal comparison between different disciplines, the study introduced the concept of "ranking" to conduct standardized evaluation of different disciplines. GPA ranking refers to the proportion of individual or group achievement rankings relative to all students. Table 4 gives an example of the GPA ranking obtained from the second year's Design Experience course:

Table 4: Example of Converting GPA Score to GPA Ranking in the Subject Value Strategies for China in 2020-2021 Academic Year

Group	GPA score	Ranking	GPA ranking (%) = no. of people or groups with equal or higher GPA scores / total no. of people or groups
G1	4	1	100
G2	3.7	2	85.7
G3	3.3	3	71.4
G4	3.3	3	71.4
G5	3.3	3	71.4
G6	3	4	28.6
G7	3	4	28.6

Student Profile Distributions

The MBTI results of the students are shown in Figure 1. Among the students in the 2019-2020 academic year, ENFP is the highest proportion of personality type, accounting for 22%

(4 students). From the perspective of personality traits, students with Feeling type (F) accounted for the absolute majority, reaching 94.4% (17 students). Among the students in the 2020-2021 academic year, ENFJ accounted for the highest proportion, at 23.8% (5 students). In terms of personality traits, design students showed an obvious tendency towards the Feeling type (F) and Intuitive (N) type, both reaching 76% (16 students). Generally speaking, design majors require students to use creative thinking and use their imagination to create unique works. The higher proportion of students with the Intuition (N) trait is reasonable because compared with Ss, Ns tend to use abstract thinking. Rather than digging deep into a problem, Ns is more willing to explore different possibilities and propose multiple solutions divergently. When it comes to making decisions, design students who lean toward Feeling (F), prioritize the values involved and the feelings of others over logic and reasoning.

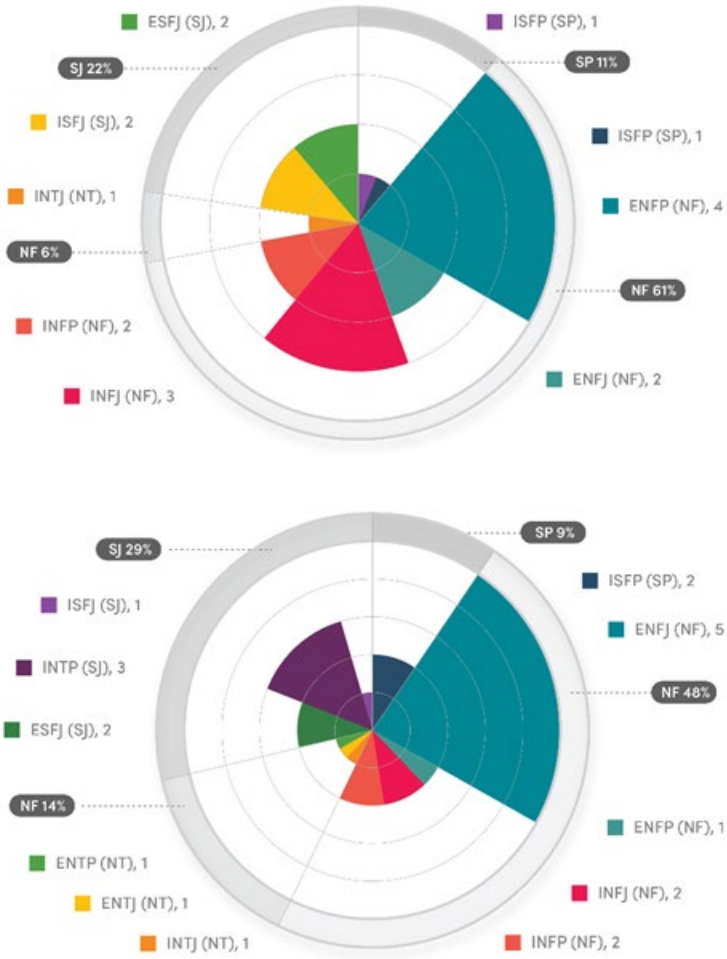


Figure 1: Distribution of MBTI Personality Types of Students at 2019-2020 (above) and 2020-2021 (below)

Further dividing the personality of all students according to their personality temperament, among the students in the 2019-2020 academic year, the proportion of NT is the lowest, with only 1 student. NF accounted for the vast majority, reaching 61.1% (11 students). NF also has the highest proportion among students in the 2020-2021 academic year, accounting for 47.6% (10 students). Among them, there are only three NTs and two SPs (Figure 2). In terms of communication styles, although the specific numbers are different, the proportion of relators is the highest in both academic years, and the number of directors is always the least.

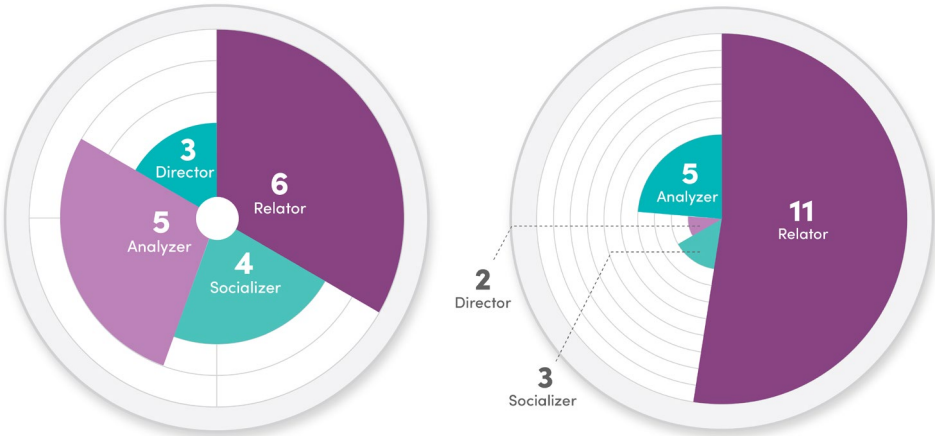


Figure 2: Distribution of Communication Styles of Students at 2019-2020 (left) and 2020-2021 (right)

Discussion of the Results

After collecting questionnaire results, GPA scores, and GPA rankings, Spearman correlation coefficient (r) was used to test the correlation between MBTI, communication styles, and GPA rankings. The research findings were validated and supported by using non-parametric Spearman correlation on account of the smaller sample size and considering that the research data requires no additional assumptions to confirm the normal distribution analysis as a statistical analysis. By comparing the differences in the statistical significance between two academic years, the relationship between the independent variables (personality and communication style) and the dependent variable (GPA ranking) under different collaborative learning environments is described. The value of the coefficient (r) varies between -1 and 1. The closer the result is to 1, the more significant the positive correlation is, the closer to -1, the more obvious the negative correlation, and the closer to 0, the lower the correlation.

Correlation Between Personality and Learning Outcome

The distribution of the personality type in each of the groups and the project success of the

two academic years are illustrated in Figure 3. The 'more successful groups' had a GPA ranking of 66.7% and above and the 'less successful groups' had a ranking of 33.3% and under.

Figure 3: Distribution of Personality Types in Each Group of Students at 2019-20 (above) and 2020-21 (below)

The relationship between various personality types according to the overall learning outcomes ranking of students has been illustrated in Figure 4.

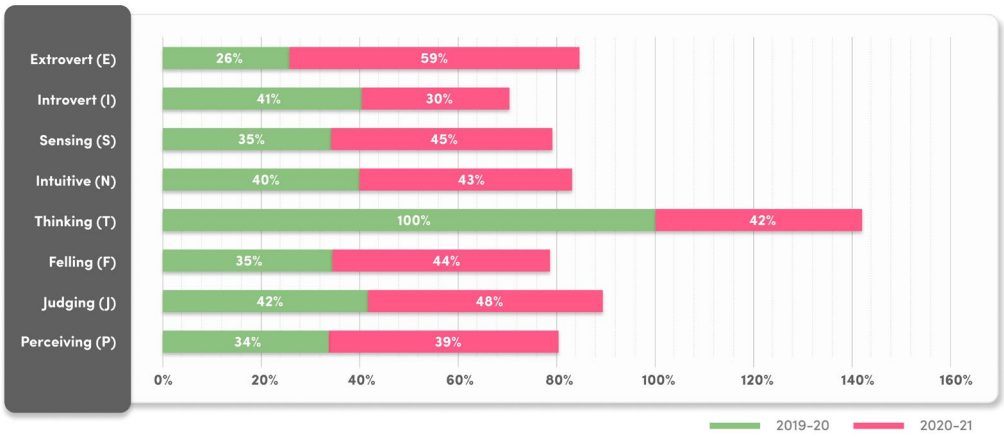


Figure 4: Relationship Between Various Personality Types and Learning Outcomes of Students

The results in Table 5 indicate that among the four groups of personality traits, the proportion of Ns and Ss has almost no correlation with learning outcomes. But the effects of the other three groups of personality traits changed. In the offline environment, the proportions of Ts and Fs have the closest relationship with the learning outcomes (r = 0.64). When the proportion of Ts in the group is higher, the learning outcomes are better. In Js and Ps, a higher proportion of members with the J trait also had a positive effect (r = 0.25). However, when the students' group collaboration adopts the online teaching mode, the high proportion of T has a negative correlation with the learning outcome (r = -0.16). The personality traits that produced the greatest positive correlation are E and I, and learning outcomes are better when the proportion of E increased (r = 0.71).

Table 5: Spearman Correlation Between Personality Traits and Learning Outcomes

Personality Traits	E/I	N/S	T/F	J/P
r (2019-2020)	-0.21	0.17	0.64	0.25
r (2020-2021)	0.71	-0.1	-0.16	0.26

T and F determine how decisions are made, whether individuals tend to make decisions based on rational judgment or the impact on the interests of others. When students conduct offline face-to-face discussions and learning, T, who follows logic, is good at comprehensively evaluating a variety of ideas and choosing the most appropriate solution (r = 0.64). This trait is beneficial to the collaborative learning efficiency of creative design students who are good at divergent thinking. But when learning online, the level of familiarity among students is relatively lower than offline (r = -0.16), due to which it is stressed that, a more harmonic and pleasant group environment must be established from

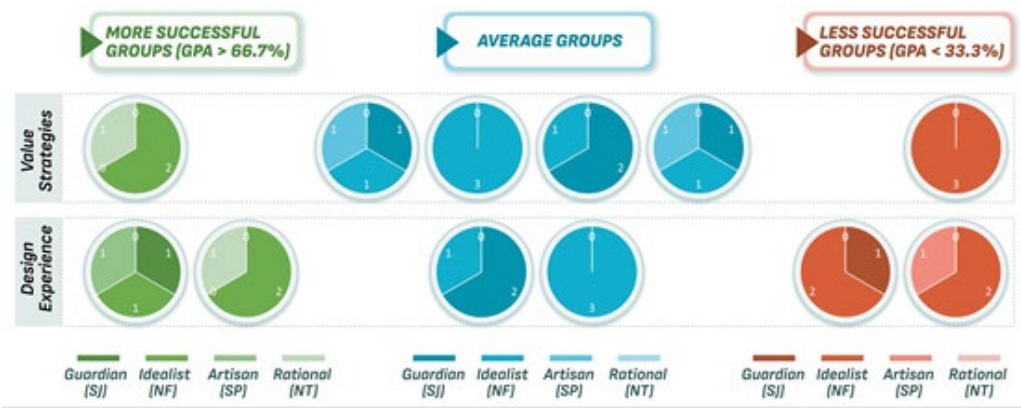
the start of the course by the design educators and team. Fs who tends to prioritize personal feelings and subjective values can more fully consider everyone's feelings after making a decision, which can help create a better team atmosphere.

When comparing the proportions of Es and Is, Es gained more motivation in interacting with others. In the process of online cooperation, it is more difficult to form an effective interaction with others than in a face-to-face environment. When there are more Es in the group who are willing to share, they will take the initiative to pay attention to the people and things in the outside world, and members tend to get to know each other quickly. Having more Es makes the group more active and creates more communication between other students and teachers. However, in a face-to-face environment, the interaction between everyone is more direct and convenient, which correspondingly reduces the influence of this characteristic of E ($r = -0.21$).

Kroger, Thuesen and Rutledge (2009) pointed out that the ratio of J and P is a key factor affecting team success. Although the correlation coefficients are different, the proportions of J and P are generally related to learning outcomes. The statistics present that a higher proportion of J is more beneficial to the success of the team. Compared with Ps, Js are better at planning their life in an orderly manner. In group work, it is often the person who controls the progress and makes the plan for the group, which is often the weakness of design students. As a result, groups with more Js are often better able to advance projects as planned and collaborate more effectively.

Correlation Between Personality Temperaments and Learning Outcome

The distribution of the personality temperament in each of the groups and the project success of the two academic years are shown in Figure 5.



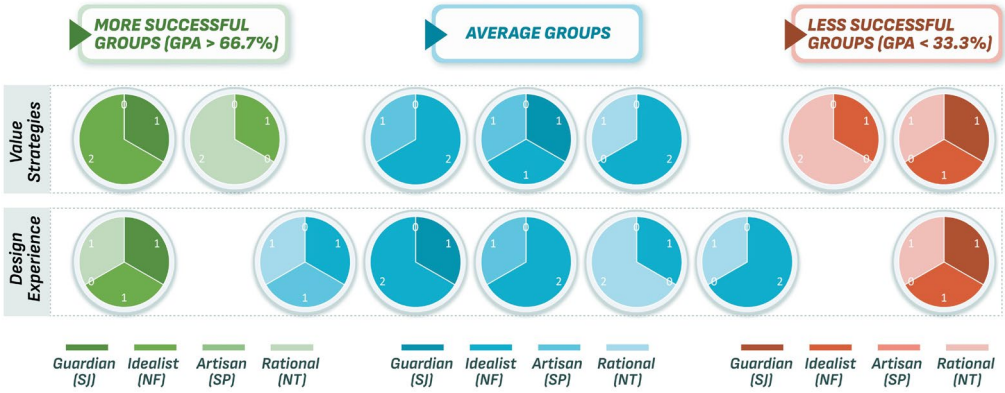


Figure 5: Distribution of Personality Temperaments in Each Group of Students at 2019-2020 (above) and 2020-2021 (below)

The relationship between various types of personality temperament according to the overall learning outcomes ranking of students has been illustrated in Figure 6.

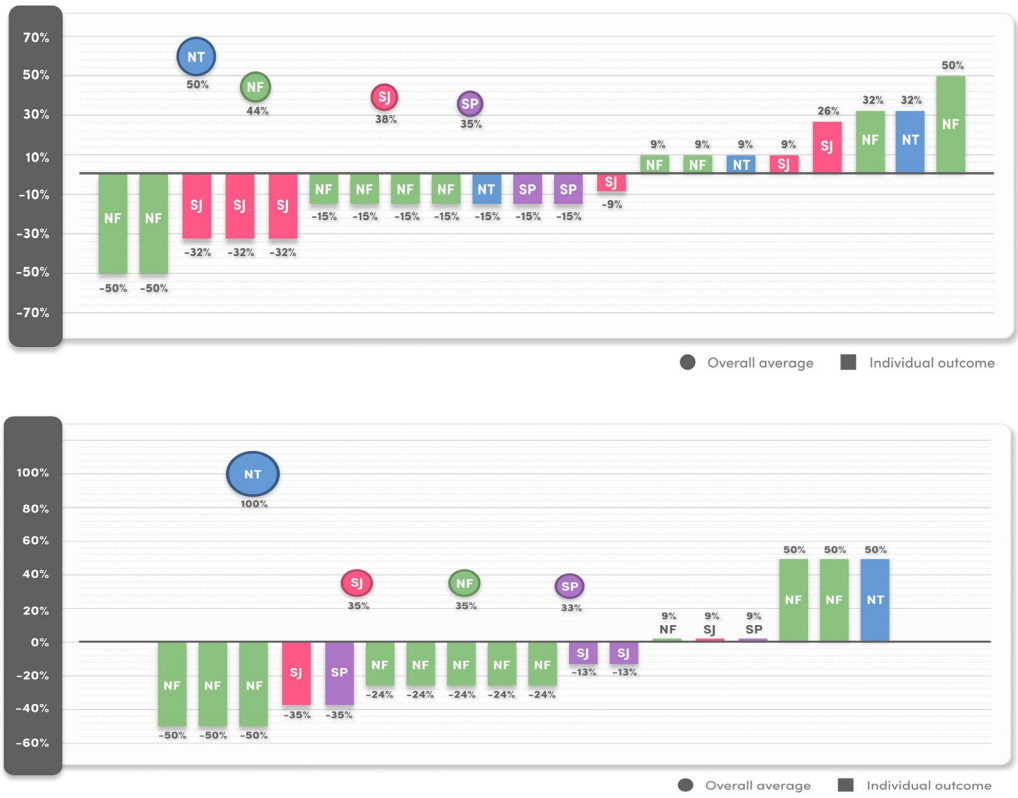


Figure 6: Relationship of Personality Temperaments and Learning Outcomes of Students at 2019-2020 (above) and 2020-2021 (below)

The correlation between different personality temperaments and learning outcomes has been explained in Table 6. The results indicate that the proportion of NT is positively correlated with learning outcomes despite a low proportion of all students through two academic years (r = 0.5; r = 0.3). The proportion of SPs nearly does not correlate with group learning outcomes although SPs account for the highest proportion. When face-to-face teaching was changed to online courses, the correlation between the proportion of NFs and learning outcomes was positively enhanced (r = 0.35), but the proportion of SJs and learning outcomes turned into a significant negative correlation (r = 0.43).

Table 6: Spearman Correlation Between Personality Temperaments and Learning Outcomes

Personality Temperaments	**SJ**	**SP**	**NF**	**NT**
r (2019-2020)	-0.07	-0.27	0.01	0.5
r (2020-2021)	-0.43	0.12	0.35	0.3

Although the Rational (NT) has the smallest proportion among design students, they do have attributes that are critical to the learning outcomes of collaborative learning. NTs have excellent logical thinking and rational analysis ability; they are tenacious and can dig deep into a topic. Under the leadership of NTs, the team can conduct an in-depth analysis of the topic and proceed step by step according to the project plan. In particular, Idealist (NF) and Guardian (SJ) account for a higher proportion among design students, and their advantage is that they have a higher degree of cooperation. Because SJs are stable and dependable, they trust others in the team and want their work to be acceptable, NFs pay attention to those around them and want to be happy with everyone. But when the two are high on the team, decision-making and planning may become their challenges. Rare NTs are therefore strongly linked to team success.

However, when the learning mode was changed to an online form, a high proportion of NFs was positively correlated with the learning outcomes, since they are good at empowering others in an online environment. This trait encourages the participation of all team members in conditions of more alienated relationships. Although stable and reliable SJs are the stabilizers of the team, in this environment, it is difficult for them to integrate quickly as they are quieter and introverted.

Correlation Between Communication Styles and Learning Outcome

The distribution of the personality temperament in each of the groups and the project success of the two academic years are shown in Figure 7.

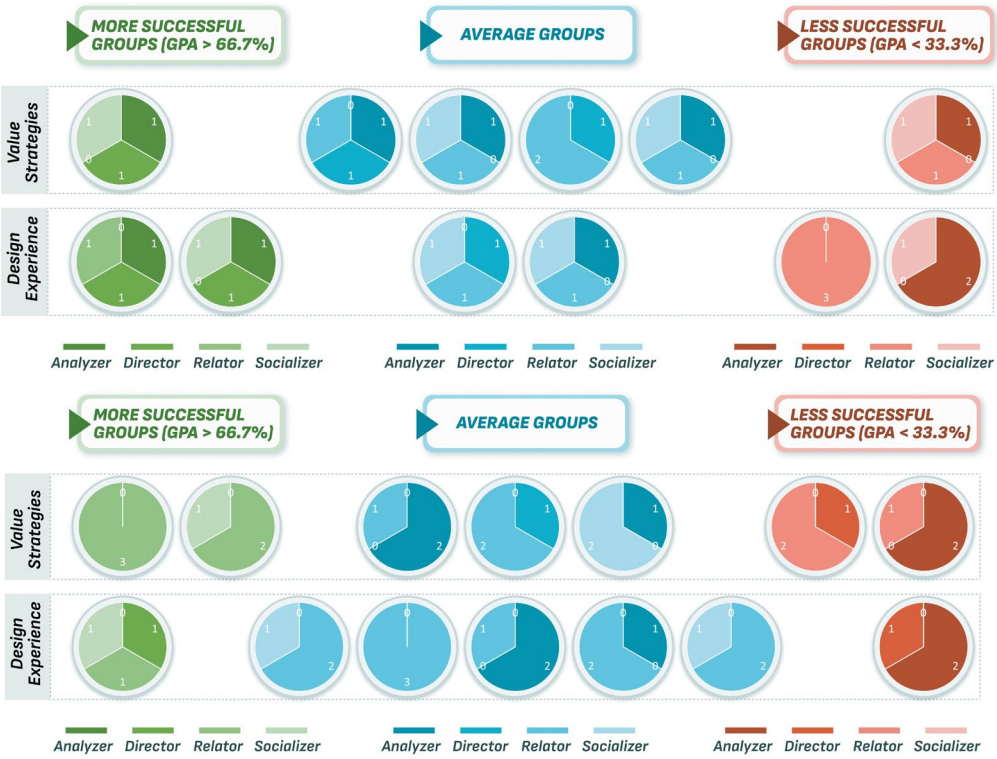


Figure 7: Distribution of Communication Style in Each Group of Students at 2019-2020 (above) and 2020-2021 (below)

The relationship between various communication styles according to the overall learning outcomes ranking of students has been illustrated in Figure 8.

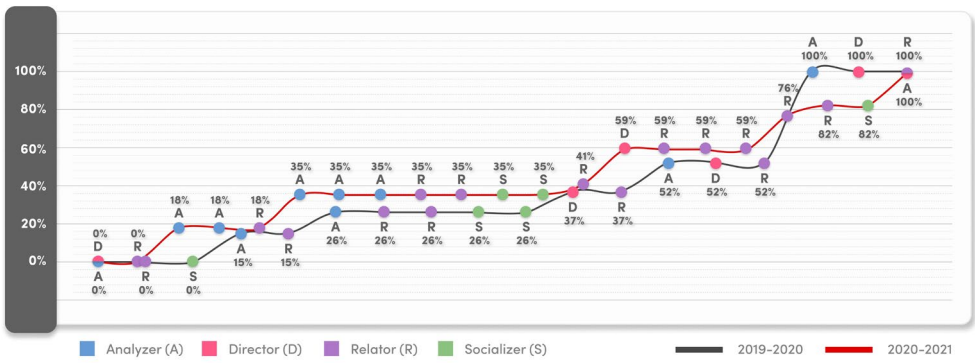


Figure 8: Relationship of Communication Styles and Learning Outcomes of Students Between 2019-2020 and 2020-2021

Different communication styles have different correlations with learning outcomes in online and offline collaborative learning projects (Table 7). In the offline environment, the proportion of the director is most strongly correlated with the outcome and had a positive impact (r = 0.36), while the proportion of relators is negatively correlated with learning outcomes (r = -0.36). However, in the online environment, the proportion of socializers is most closely related to the final results (r = 0.28). When the proportion of socializers in the group increases, the learning outcome is better. The proportion of analyzers has the most obvious negative correlation with learning outcomes (r = -0.41).

Table 7: Spearman Correlation Between Communication Styles and Learning Outcomes

Communication Styles	**Relator**	**Socializer**	**Director**	**Analyzer**
r (2019-2020)	-0.36	0.05	0.36	-0.07
r (2020-2021)	0.4	0.28	-0.32	-0.41

Directors and socializers both tend to use more direct and fast-paced communication approaches, and group members who tend to communicate in this way help make decisions faster. Overall, this communication behavior is more conducive to the learning outcomes of design collaborative learning. The main difference between director and socializer is that the director focuses more on the task itself, while the socializer focuses more on people. Socializers enjoy being with people and working with others freely. In the online environment, socializers can build connections with others directly and quickly, and they are the shapers of a team atmosphere. In face-to-face learning, members get along more frequently. Under these conditions, directors can exert their management skills and organize teamwork in an orderly manner.

Relators and thinkers are both groups of people who tend to adopt indirect communication behaviors and act as listeners in groups. Therefore, when the proportion of this type of member in the group is high, it rarely creates conflicts in the group, but the cooperation efficiency may be lower, and it is more difficult to make decisions. For courses that require creative ideas, group discussions are often meandering when there are more members with this trait. In offline learning, relators focus more on personal feelings, which further increases the difficulty of critical analysis during group discussions. In the online environment, thinkers pay more attention to the characters themselves, which further exacerbates the difficulty of their integration into the group.

Difference Between Online and Offline Collaborative Learning

For design students, both personality types and communication styles are associated with collaborative learning outcomes and are expressed differently in online and offline environments. In offline group learning, the high proportions of T and J have the greatest positive correlation with learning outcomes, and group members with NT temperament have the most important role in promoting collaborative learning outcomes. There is a positive correlation ($r = 0.39$) between having a director's communication style and team success. While studying online, a high proportion of E has the greatest positive correlation with learning outcomes. NF group members have the most obvious positive relationship with learning outcomes, while SJ group members have the most obvious negative relationship with learning outcomes. Furthermore, the presence of socializers had the greatest correlation with team success.

To a great degree, the main challenge in designing student collaborative learning in the offline environment is how to reach agreement among numerous ideas, conduct systematic analysis, and make decisions. Therefore, whether it is analyzed in terms of personality type or communication style, the ability to have a more rational and logical analysis will greatly promote the success of the group, such as group members with the NT personality trait or with director communication style. But when transitioning to online classes, the main challenge students face turns into creating a good group atmosphere and interactive environment. Compared with face-to-face communication, it is more difficult for participants to understand each other's emotions and thoughts during online communication, and it becomes more difficult to get acquainted with each other (Mallen, Day and Green 2003). Students often face their greatest difficulties in the early stages of group work. Therefore, it is particularly important to have members who can create an active atmosphere and build a free group atmosphere, such as members with extroverted E, or socializers who tend to encourage group members to get involved and participate in the communication. For educators, organizing online and offline collaborative learning activities needs to pay attention to the different difficulties and challenges faced by students, to help cultivate students' collaborative ability and achieve enhanced learning outcomes.

Conclusion

This study collected the performance of graduate students in the Master of Design (Design Practices) programme in two collaborative learning courses over two academic years and analyzed the correlation between their personality traits, communication styles and learning outcomes. The study compares the different correlations between student personal characteristics and learning outcomes when collaborative learning is conducted online and offline. This research contributes to the efficient organization of collaborative learning activities by educators. First, this study demonstrates the relationship between student personality, communication style and learning outcomes. Although it is difficult to

conclusively forecast about what kind of group composition can guarantee the success of the group, the results of this study can guide educators to organize group activities more scientifically and bring forth the students' potential. By understanding students' personalities, teachers can better provide all students with an equal chance of success in the group project. Second, this study compares different outcomes in online and offline educational settings. Online technologies are increasingly supporting collaborative learning, especially under the influence of COVID-19, educational activities based on online technology have further expanded. Various research results indicate that students face different challenges compared with offline activities. The results of this study point to different issues that teachers need to focus on in different educational settings, aiming to guide teachers to help students achieve better learning outcomes. It can also assist in the development of future courses that are sensitive to these considerations, given that different modes of instruction produce a range of different learning outcomes.

Limitation of the Study

It is imperative to acknowledge the limitations of this study despite its interesting insights. The relatively small sample of 39 participants is an impediment. Although the study aimed to include participants with diverse backgrounds and experiences, the limited number of participants may restrict the applicability of the findings to a larger population of design students. While students were chosen from two academic years, the overwhelming majority of students share a common cultural background. The study's conclusions primarily target design students in China, and students from different cultural backgrounds are not included, which is a limitation of this study. Another downside to the online mode of teaching is that introverted students are more likely to establish teams with their acquaintances without the opportunity to explore the possibility of forming teams of truly unique colleagues with varying temperaments. While the generalizability may be limited, the practical implications of the study can positively impact teaching approaches and curriculum development.

Further Scope for Research

For analyzing the study, students' personalities and communication styles were collected through questionnaires. Compared with direct observation, since each individual is complex and variable, simply classifying the sample into types may ignore the individual's performance and motivation in different situations. In future research, research methods such as observation can be further introduced to analyze the direct feedback of students in different situations. A wider range of perspectives could be provided by research that involves multiple locations or institutions. Also, participants' qualitative insights might add a wealth of detailed knowledge. The study can be replicated and be done on a larger sample size with more international students to add the effect of diversity into the study as well.

AI Acknowledgment

- Generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete essential authoring tasks in this manuscript.

Informed Consent

The authors have obtained informed consent from all participants.

Conflict of Interest

The author declares that there is no conflict of interest.

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ABOUT THE AUTHORS

Mohana Das: PhD Candidate, School of Design, The Hong Kong Polytechnic University, HKSAR
Corresponding Author's Email: mohana.das@connect.polyu.hk

Newman Lau: Associate Professor, School of Design, The Hong Kong Polytechnic University, HKSAR
Email: man.lung.lau@connect.polyu.hk

Wenjing Zhang: PhD, School of Design, The Hong Kong Polytechnic University, HKSAR
Email: wenjing.zhang@connect.polyu.hk

Kelly Tang: UX/UI Designer, School of Design, The Hong Kong Polytechnic University, HKSAR
Email: kelly.tang@connect.polyu.hk

Dominic Leung: Teaching Fellow, School of Design, The Hong Kong Polytechnic University, HKSAR
Email: domi.leung@polyu.edu.hk