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Technology-Enhanced Learning for Graduate Students: Exploring the Correlation of Media Richness and Creativity of Computer-Mediated Communication and Face-to-Face Communication

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Abstract: The objective of the research was to explore and compare the differences in potential creative thinking that media richness had on learners in creativity training through two different types of communication formats; computer-mediated communication, and face-to-face communication. The results indicated that the computer-mediated communication format performed better than the face-to-face in terms of the fluency, flexibility, and originality dimensions of creative thinking. The computer-mediated communication format also had a greater level of media richness perception (i.e., use of multiple cues, language diversity, and personal focus of the medium) than the face-to-face format. In terms of the combined effectiveness of computer-mediated communication, and face-to-face formats, the use of multiple cues, language variety of perception of media richness had direct effects on the fluency of creativity. There was also a positive correlation between the elaboration of creativity and the use of multiple cues, language variety, and personal focus of the medium in the perception of media richness. Furthermore, language variety was correlated with creativity and flexibility. The research findings highlighted the importance of the availability of immediate feedback on media richness, whereas creativity cognition should focus on the breadth and depth of the information, which contributes to enhancing the creativity of individuals or a group of employees.

Keywords: creativity; computer mediated communication; face-to-face; media richness; organizational learning

1. Introduction

In response to ever-changing technological development and globalization, corporations continue to build capacity in organizational learning and team innovation in order to maintain sustainable operations and competitiveness. Organization innovation relies on the creativity of the employees [1] and the focus has been on the sharing of knowledge and encouraging creative thinking that seek to develop innovative solutions to address existing or future business challenges [2,3]. While a

corporation's sharing of internal knowledge through organizational learning can increase the individual employee's skill and learning effectiveness, it also helps to drive a collective innovation process that will contribute towards the corporation's overall sustainable efficacy and development [4–6]. Such an emerging trend has prompted the need to review the relationship between sustainable business development and management education that seek to facilitate effective communication of key abilities such as adaptability to face uncertainty, creativity, or detection and processing emotions, confidence, respect, dialogue, critical thinking and systematic thinking [7].

Perry-Smith (2006) states that creativity involves the attitude and action of an employee to take risks [8]. However, it is imperative that managers provide a supportive environment, and incentives to encourage their employees to think creatively and explore innovative solutions to assist in making more informed strategic decisions [9]. An individual employee's ability to be creative is directly influenced by factors such as diverse skills and autonomy in the organization [10]. Brown and Fridman [11] indicate that feedback (e.g., audio-visual, written) also plays an important role in encouraging creativity. Computer-mediated communication (CMC) and face-to-face (FtF) communication are two forms of feedback communication format that are used to foster creativity whereby CMC is considered having greater media richness than the traditional FtF approach [12]. Although studies [13–15] have revealed that CMC is a more relaxing and engaging feedback communication format than FtF, but there has been a lack of investigation into the correlation between communication formats and creativity.

The research attempts to fill this gap by combining the media richness theory and creativity to explore the relationship between the features of media richness and creative thinking by focusing on creativity training via two different communication formats (i.e., CMC and FtF). The following research questions are proposed:

1. Will the use of different communication formats (i.e., CMC and FtF) have an impact on potential creative thinking?
2. What is the correlation between media richness and potential creative thinking through the use of the above two types of communication format?

2. Literature Review and Hypotheses

2.1. Media Richness

Media richness theory believes that the richness of information relies on the capacity of communicating information by the media. A communicating media is considered as a 'rich media' when the targeted audiences can better understand the information transmitted. Conversely, if more time is required to understand the information received, then it is considered as a 'lean media' [16,17]. The level of media richness has four key features; namely the availability of immediate feedback; use of multiple cues; language variety; and personal focus which have significant effects on information equivocality and uncertainty [16,17]. Handke et al. [18] state that the efficacy of the organization depends on the extent to which media richness conforms to the information required by the task and further propose that the use and cognition of media are the dynamic combinations of people and technology. On the other hand, Chidambaram and Jones [19] argue that while a greater level of media richness has the ability to better manage uncertain information, it has limited effect on reducing the equivocality of the information. Instead this may increase the complexity and diversity of the communication process and content.

Previous studies [20–23] reveal that the FtF (e.g., communication with language, non-verbal cues) communication format has the highest level of media richness, and this is followed by CMC (e.g., audio-visual), media with only audio and written media. However, as the difficulty and cost of information transmission is reduced due to the advancement of modern technologies, CMC has increasingly been utilized as a communication format. This is particularly evident with the introduction of mobile immediate messaging software, which can be customized to facilitate interactive

communication that occurs anytime and anywhere. Its ability for data storage, indexing, searching, and the convenience of using the media by an individual is also greatly enhanced [24].

The synchronized interaction in CMC can offer the similar effect of real-time communication as that of FtF through instant text, voice, and video transmission [24,25]. Studies [26–28] suggest that learners were more likely to perform better in generating new ideas for new product development under the FtF communication format than their counterparts who undertook the CMC format. However, CMC may have potential advantage in terms of creativity learning and performance within a team context [29]. In a study conducted by Hatem et al. [30], the production rate, communication efficiency, and level of cooperation of CMC indicated by the total quantity of information exchange is much higher than that of FtF because users have experienced more interactions under the CMC format. It is the relatively higher equivocality that enables CMC users to exhibit a greater level of active participation and effort, given that space and time barriers have been broken down that enable team members to cooperate more effectively and efficiently on a common task [20,29]. CMC communication via the virtual world is regarded as more fun, and pleasurable than FtF [15]. Croes et al. [13] also suggest that selecting between FtF or CMC is significantly influenced by the perception of the user on controllability, anonymity, and co-existence. As compared to CMC, FtF communicators deliver more facial expressions and any changes in tone of voice may increase the level of tension during communication [14].

The CMC interactive environment also offers more personalized information and differential interactive communication, which has a higher degree of freedom, giving more time and space to the learners to review the appropriateness and completeness of their opinions before they put forward their views [31,32]. Furthermore, CMC provides more time to the users to contemplate on the transmitted information during the interaction and to have a considered response by integrating the information with existing knowledge [29]. On the other hand, FtF does not allow much time for analysis and discussion of different viewpoints, especially when participants are shy or are not ready to share which will lower the participation interaction and affect creativity performance [33]. Furthermore, a relaxing learning situation will help elicit a greater level of creative thinking from the learners. Research [34] shows that creativity rarely emerges under stressful circumstances and thus it is important to keep learners in a relaxed mental state where the subconscious can do the nurturing and forming thoughts that give rise to creative thinking. Therefore, considering the interactivity and advances of the CMC communication format, its media richness has grown significantly in recent years [35,36].

2.2. Creativity

Some studies [37–39] suggest that creativity derives from the structure of intelligence that includes cognition, memory, divergent thinking, convergent thinking, and assessment, but other researchers [8,40–45] take on a broader definition. Creativity can be perceived as the ability to generate new viewpoints, relationships, or meanings to produce an innovative idea that is different from the original by reprocessing, amending, integrating or recombining linkable factors based on the original knowledge structure that satisfies a special need or meaningful purpose and exhibits a new originality which has its own unique values [37,46,47]. While studies [48] indicate that knowledge sharing can limit creativity, other researchers [49] argue that the sharing of such knowledge enhances creation skill, openness, and independence which are key characteristics of creativity. Therefore, creativity is the foundation of innovative knowledge; and innovation is the result of expressed creativity.

Creativity is the process of developing innovative solutions to solve problems, but such a process usually differs as a result of differing contexts [50–53]. Accordingly, the need for assessing creativity is well supported by several studies [54,55], and one of the different techniques used is cognitive assessment [56]. The most commonly used cognitive assessment examines the level of fluency, flexibility, elaboration, and originality of the thought process as an assessment index [37,57]. The Torrance Tests of Creative Thinking (TTCT), developed by Torrance [58] adopt a more stringent graphic and language written testing that measures creativity potential.

Prior studies [59–62] have indicated that through well-designed training, creativity can be elevated and further enhances the skill and efficacy of individual employee, which will have a flow on effect to the collective innovation process. This can significantly contribute to the overall effectiveness and growth of sustainable operations in a corporation [4–6]. This study will focus on investigating the impact of communication formats (specifically CMC and FtF) in creativity training on potential creativity, which seek to address the two proposed research questions identified earlier.

2.3. Research Hypotheses of Media Richness and Creativity.

Media richness and creativity have been researched extensively within their respective contexts, and this has been evident in the extant literature. Media richness has gained much attention in recent years given the advancement of modern technologies that facilitated the enhancement of media delivery and quality, influence, and outreach. Some of the key domains that have been previously explored include: the effects of media richness on social media [63], education learning [64], trust and loyalty [65], organizational learning [66], information quality [67], marketing [68], and communication [69].

On the other hand, creativity has been a longstanding research theme from both an individual and organizational perspectives where the focus has been on instigating new ideas, new ways of thinking, and problem-solving. Previous studies have investigated creativity in different aspects, including: the influence of creativity on business performance [70], education teaching and learning [71], personal development and growth [72], marketing and new product development [73], and creativity assessment [54].

However, there have been limited studies that explore the correlation between media richness and creativity. This research will explore specifically the relationship between the availability of immediate feedback of media richness, use of multiple cues, language variety, and personal focus of the medium with the four indices of fluency, flexibility, elaboration, and originality of creativity. The definitions of these key terms are briefly outlined in Tables 1 and 2.

Table 1. Definitions of key terms related to media richness.

Term	Definition
The availability of immediate feedback	The speed at which the user of communication media can receive immediate response when transmitting information and amend and revise the information.
Use of multiple cues	The degree of closeness to the actual situation of the language and non-verbal cues covered in the transmitted information through communication media.
Language variety	The degree of ease of interpretation or thinking without spending extra effort by the user when transmitting meanings of the language and symbols through the communication media.
Personal focus of the medium	The flexibility and adjustability of the communication media for the user.

Adapted from Daft and Lengel (1984) and Ishii, Lyons and Carr (2019) [16,17].

Table 2. Definitions of key terms related to creativity.

Term	Definition
Fluency	The ability to generate large quantity of thoughts.
Flexibility	The ability to look at familiar thought or situation in different ways.
Elaboration	The ability to add more details to existing thought.
Originality	The ability to produce new concept that others cannot think of.

Adapted from Guilford (1967), Torrance (1968) and Chen (2005) [37,39,57].

Given the above discussion, the following variables are proposed to be investigated in the research and are briefly explained accordingly. Figure 1 presents a hypothetical model for this research study.
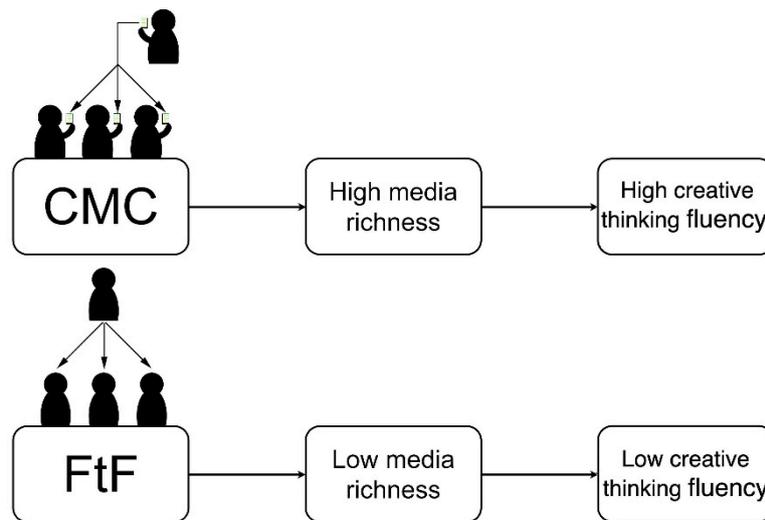
Figure 1. Research hypothetical model (e.g., media richness vs. creative thinking fluency) of the hypnotized impact on creativity potential after creative training by media richness.

2.3.1. Independent Variable

The independent variables of the research are the creativity training by different communication types. The experimental group adopts the CMC method that involves using a software (i.e., WeChat), which is most widely used social media in China. As for the control group, participants will receive traditional FtF creativity training.

2.3.2. Dependent Variable

The dependent variables in this study are derived from the 'Abbreviated Torrance Test for Adults (ATTA)' which is a projective assessment of potential creative thinking abilities that included key indicators such as fluency, flexibility, originality, and elaboration [37,57,74].

2.3.3. Intervening Variable

In this research, media richness perception is used as the intervening variable to determine if there is an impact on potential creativity by the creativity training through different communication types.

2.3.4. Control Variable

The control variables adopted in this study during the preparation and experiment stages are the uniform content, procedure, time, and lecturers.

2.3.5. Hypotheses

Based on the above discussion and the research from Guilford, Torrance, Wu, et. al., Hatem, et. al. and Smith [37,57], this research posits the following hypotheses to be investigated:

Hypothesis 1 (H1): *The potential creativity cognition performance of the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 1a (H1a): *The fluency performance of the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 1b (H1b): *The flexibility performance of the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 1c (H1c): *The originality performance of the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 1d (H1d): *The elaboration performance of the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 2 (H2): *The overall media richness perception of the CMC learners of the experimental group is better than the FtF learners of the control group.*

Hypothesis 2a (H2a): *The perception of the availability of immediate feedback by the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 2b (H2b): *The perception of the use of multiple cues by the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 2c (H2c): *The perception of language variety by the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 2d (H2d): *The perception of personal focus of the medium by the CMC learners in the experimental group is better than the FtF learners in the control group.*

Hypothesis 3 (H3): *The perception of media richness is significantly correlated to potential creative thinking.*

3. Materials and Methods

3.1. Preparation Stage

The research, based on the hypotheses, use common creativity methods that have undergone an experiment of creativity training [49]. Next, the Abbreviated Torrance Test for Adults (ATTA) projective assessment of potential creative thinking abilities measurement was employed to evaluate the result of creativity potential after the learning process [74]. A survey was also conducted with postgraduate students (who were also currently working as full-time business professionals in organizations) about their perception on media richness (Table 3) and has adopted a five-point Likert scale (i.e., 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree) as a measurement to the respondents' answers about their perception of media richness.

3.2. Experimental Stage (Quasi-Experiment)

The research was conducted at Shanghai where it has been regarded as having one of the most conductive and open business environments in China. The subjects selected for this study were specifically targeted at postgraduate students who were also currently working as full-time business professionals in organizations within the master's program (major in communication management, business administration, and public relations and advertising) at the Shanghai College of Shih Hsin University.

Two groups of a total of 67 students (i.e., CMC experimental group, *n* = 33; FtF control group, *n* = 34) from the communication management, business administration, and public relations and advertising major studies were randomly selected to participate in this study. The two groups were taught by the same lecturer for creativity training that involved a three-hour class session whereby the CMC experimental group used the mobile communication software (i.e., WeChat) for communication, whereas the FtF control group utilized traditional communication format. Upon finalizing the subjects and experimental methods, as well as setting the time for rehearsal, the official training and surveys were subsequently conducted with the two groups separately.

Table 3. Media richness perception measurement items.

Dimension	Survey Content	Source
Availability of immediate feedback	1. The design of the learning process provides me with effective information to help me communicate quickly. 2. The design of the learning process allows me to ask and understand immediately. 3. The design of the learning process makes it easier for me to communicate and exchange ideas with others. 4. The design of the learning process makes it easier for me to understand the content when I am communicating with others. 5. The design of the learning process allows me to grasp the status of information transmission immediately.	Carlson and Zmud (1999), Dennis, Kinney and Hung (1999), Rice, et al. (1987) [75–77]
Use of multiple cues	6. The design of the learning process offers the option of attaching elements like pictures and graphs that can help with understanding the information when transmitting the information. 7. The design of the learning process allows me to use, besides language and numbers, other non-verbal cues when communicating with others (such as facial expression, body language, audio-visuals, pictures, graphs). 8. The design of the learning process allows me to provide more detailed non-verbal cues as auxiliary information when I am communicating with others.	Carlson and Zmud (1999), Johnson et al. (2006), Rice, et al. (1987) [75,77,78]
Language Variety	9. The design of the learning process provides a more flexible way of expression that allows me to freely use the language with which I am familiar, such as Chinese, English, digital, graphics, symbols, that can help convey clearly the intended message. 10. The design of the learning process offers me richer and more diverse ways to accentuate the meaning of the words (such as punctuations, font size, color).	Carlson and Zmud (1999), Johnson et al. (2006) [75]
Personal focus of the medium	11. The design of the learning process is a medium where I can exhibit my personal features such as looks, forms. 12. The design of the learning process offers me the ability to display and edit personalized information.	Carlson and Zmud (1999), Johnson et al. (2006), Rice et al. (1987) [75,77,78]

Written consent forms were delivered to all students to obtain their agreement to participate in this study, and at the same time informed them about their rights to withdraw from the research at any time without penalty. The questionnaire survey proceeded after permissions to participate had all been received and was conducted in the classroom setting at the respective classes. The participants were given approximately 30 minutes in class to complete the questionnaire and the class teacher collated them when completed.

3.3. Analysis

The research has adopted the Cronbach's α to examine the reliability of the questionnaire in order to understand the consistency of the questions in it (Table 4). The result of the internal consistency reliability test indicated that the Cronbach's α value for the availability of immediate feedback was 0.866; use of multiple cues was 0.650; language variety was 0.776; and personal focus of the medium was 0.833, which were all at an acceptable level. In addition, the Cronbach's α values of the entire questionnaire ranges between 0.650 to 0.886, with an overall reliability value of 0.883. As such, this questionnaire has passed the reliability test since a Cronbach's α value of 0.8 and above denotes excellent reliability [79–82].

Table 4. The questionnaire reliability of media richness.

Dimension	Survey Content	Mean (M)	SD (Standard Deviation)	Cronbach's α
Availability of immediate feedback	1. The design of the learning process provides me with effective information to help me communicate quickly.	4.35	0.63	0.866
	2. The design of the learning process allows me to ask and understand immediately.	4.24	0.69	
	3. The design of the learning process makes it easier for me to communicate and exchange ideas with others.	4.16	0.71	
	4. The design of the learning process makes it easier for me to understand the content when I am communicating with others.	4.19	0.65	
	5. The design of the learning process allows me to grasp the status of information transmission immediately.	4.27	0.66	
Use of multiple cues	6. The design of the learning process offers the option of attaching elements like pictures and graphs that can help with understanding the information when transmitting the information.	3.56	1.30	0.650
	7. The design of the learning process allows me to use, besides language and numbers, other non-verbal cues when communicating with others (such as facial expression, body language, audio-visuals, pictures, graphs).	3.24	1.18	
	8. The design of the learning process allows me to provide more detailed non-verbal cues as auxiliary information when I am communicating with others.	3.71	0.88	
Language variety	9. The design of the learning process provides a more flexible way of expression that allows me to freely use the language with which I am familiar, such as Chinese, English, digital, graphics, symbols, that can help convey clearly the intended message.	3.40	1.15	0.776
	10. The design of the learning process offers me richer and more diverse ways to accentuate the meaning of the words (such as punctuations, font size, color).	3.11	1.10	
Personal focus of the medium	11. The design of the learning process is a medium where I can exhibit my personal features such as looks, forms.	3.53	0.74	0.833
	12. The design of the learning process offers me the ability to display and edit personalized information.	3.65	0.70	
Overall reliability				0.883

In terms of validity, three communication scholars from Shanghai Jiao Tong University and Taiwan's Shih Hsin University were invited to examine the validity of the questionnaire. The convergent validity, which is used to examine the degree of correlation between each dimension and its question [83], of this research had reached par level because the Pearson Correlation Coefficient for every item has attained a significant level, indicating a good convergent validity. As for the discriminate validity, which is used to examine the result of discrimination among the dimensions for which regular factor analysis is employed [83], this research has adopted the factor analysis method. The factor loading for every item (except for questions 6, 7 and 10) was greater than 0.5, and the Pearson correlation coefficient for all questions have reached significant level ($p < 0.0001$). The results of the convergent validity and discriminate validity of media richness perception were outlined in Table 5, which suggested that the research questionnaire had attained a satisfactory overall validity.

The Statistical Package for the Social Sciences (SPSS v.22) was used to analyze the information collected in this study, and tests such as the independent sample *t*-test and Pearson correlation coefficient were conducted to examine if correlations existed between the key constructs in this study.

Table 5. The questionnaire validity of media richness.

Dimension	Item	Factor Loading	Pearson Correlation Coefficient	*p*-Value
Availability of immediate feedback	1	0.653	0.764 **	$p < 0.0001$
	2	0.713	0.830 **	$p < 0.0001$
	3	0.734	0.834 **	$p < 0.0001$
	4	0.773	0.875 **	$p < 0.0001$
	5	0.688	0.733 **	$p < 0.0001$
Use of multiple cues	6	0.422	0.821 **	$p < 0.0001$
	7	0.276	0.761 **	$p < 0.0001$
	8	0.720	0.734 **	$p < 0.0001$
Language variety	9	0.526	0.908 **	$p < 0.0001$
	10	0.376	0.900 **	$p < 0.0001$
Personal focus of the medium	11	0.746	0.930 **	$p < 0.0001$
	12	0.603	0.922 **	$p < 0.0001$

** Denotes significant level less than 0.01.

4. Results

4.1. Distribution of Demographic Profiles

A total of 67 students participated in the experiment, of which 41 were males (61.2%) and 26 were females (38.8%). A majority of the respondents were aged between 41 to 50 years old (50.7%), and this was followed by over 50-year-olds (28.4%), between 31 to 40 years old (13.4%), and under 30 years old (7.5%). Table 6 below briefly presented the overall demographic distribution of the respondents.

Table 6. Overall demographic distribution.

Variable	Item	Number	Percentage
Gender	Male	41	61.2%
	Female	26	38.8%
Age	Under 30	5	7.5%
	31–40	9	13.4%
	41–50	34	50.7%
	Over 50	19	28.4%
Total		67	100%

In terms of the demographic distribution for the CMC experimental group, there were a total of 33 students (18 males and 15 females). The respondents in this experimental group were represented by the following age groups: between 41- to 50-year-old (54.5%), over 50-year-old (27.3%), between 31- to 40-year-old (9.1%), and under 30-year-old (9.1%). As for the FtF control group, there were more males (67.6%) than females (32.4%) with a total of 34 students. A majority of the respondents of this control group were aged between 41 to 50 years old (47.1%), with the others in the following age categories: over 50-year-old (29.4%), between 31- to 40-year-old (17.6%), and under 30-year-old (5.9%). Tables 7 and 8 below briefly outline the demographic distribution of the respondents for both the CMC experimental and FtF control groups, respectively.

4.2. Torrance Creativity Cognitive Performance

The research adopted ATTA as the tool to measure creativity potential, with score based on norm of fluency, flexibility, originality, and elaboration. The results (as shown in Table 9) of the independent

sample *t*-test for the Torrance creativity cognitive performance ATTA indicated that the overall mean score of the CMC experimental group was higher than the FtF control group in terms of creativity cognition ($p = 0.012$, *t*-test). This signified that participants in the CMC group had a greater creativity than those in the FtF group. Although there was no significant difference ($p = 0.052$, *t*-test) in the elaboration performance between the CMC and FtF groups, the CMC group (mean = 16.79) had a slightly higher mean score than the FtF group (mean = 15.70). On the other hand, the findings revealed that there were significant differences in the performance of the fluency, flexibility, and originality variables between the CMC group and the FtF group. The CMC group had a better fluency performance that suggested a greater level of ability to generate a larger quantity and meaningful thoughts than the FtF group. The CMC group also performed better in the flexibility performance than the FtF group whereby they could better describe more capabilities to easily modify their willingness to change their existing thoughts. In terms of originality performance, the CMC group outperformed the FtF group with a greater ability to produce new concepts and unique ideas toward problem solving. Therefore, Hypotheses H1 ($p = 0.012$, *t*-test), H1a ($p < 0.0001$, *t*-test), H1b ($p = 0.039$, *t*-test), and H1c ($p = 0.014$, *t*-test) were supported, whereas Hypothesis H1d ($p = 0.06$, *t*-test) was rejected.

Table 7. Demographic distribution for the computer-mediated communication (CMC) experimental group.

Variable	Item	Number	Percentage
Gender	Male	18	54.5%
	Female	15	45.5%
Age	Under 30	3	9.1%
	31–40	3	9.1%
	41–50	18	54.5%
	Over 50	9	27.3%
Total		33	100%

Table 8. Demographic distribution for the face-to-face (FtF) communication control group.

Variable	Item	Number	Percentage
Gender	Male	23	67.6%
	Female	11	32.4%
Age	Under 30	2	5.9%
	31–40	6	17.6%
	41–50	16	47.1%
	Over 50	10	29.4%
Total		34	100%

Table 9. Torrance potential creativity cognitive performance in an original-score evaluation.

	CMC (*n* = 33)		FtF (*n* = 34)			
Variable	Mean	SD	Mean	SD	*t* value	*p*
H1a: Fluency	16.60	1.77	14.79	1.72	4.25 ***	$p < 0.0001$
H1b: Flexibility	15.97	2.19	14.85	2.16	2.10 *	$p = 0.039$
H1c: Originality	17.45	1.77	16.29	2.01	2.50 *	$p = 0.014$
H1d: Elaboration	16.79	2.22	15.70	2.46	1.90	$p = 0.06$
H1: Potential creativity cognition performance	16.70	1.99	15.41	2.09	2.58 *	$p = 0.012$

***: $p < 0.001$, two-tailed test; **: $p < 0.01$, two-tailed test; *: $p < 0.05$, two-tailed test.

4.3. Independent Sample t-Test Analysis of Media Richness Perception

Findings (Table 10) of the independent sample *t*-test for media richness perception indicated that the overall mean score of the CMC experimental group was significantly higher than the FtF control group. The outcomes implied that the CMC group had a higher level of perceived media richness in which they attained a more effective understanding of the information through the communication media used, while there was no significant difference between the CMC group and FtF group in terms of availability of immediate feedback ($p < 0.094$, *t*-test), and personal focus of the medium ($p < 0.028$, *t*-test); however, significant differences existed between the groups for the use of multiple cues ($p < 0.001$, *t*-test), and language variety ($p < 0.001$, *t*-test).

Table 10. Independent sample *t*-test analysis of media richness perception in a norm-referenced evaluation.

	CMC (*n* = 30)		FtF (*n* = 32)			
Dimension	Mean	SD	Mean	SD	*t* Value	*p*
Availability of immediate feedback	4.13	0.61	4.36	0.44	−1.70	0.094
Use of multiple cues	4.04	0.64	3.00	0.75	5.88 ***	< 0.001
Language variety	3.88	0.77	2.67	0.87	5.79 ***	< 0.001
Personal focus of the medium	3.68	0.65	3.50	0.68	1.08 *	0.028
Media richness perception	3.99	0.59	3.59	0.43	3.01 **	< 0.01

***: $p < 0.001$, two-tailed test; **: $p < 0.01$, two-tailed test; *: $p < 0.05$, two-tailed test.

4.4. Correlation between Media Richness Perception and Potential Creativity Cognition Performance Variables

As shown in Table 11, the findings revealed no significant correlation ($r = 0.23$, $p = 0.079$) between the overall media richness perception and potential creativity cognition. However, there were significant correlations between the "fluency" variable of the potential creativity cognition performance and two media richness dimensions; namely the "use of multiple cues" ($r = 0.42$, $p < 0.001$), and "language variety" ($r = 0.38$, $p < 0.001$). Results also indicated that significant correlations were not only present between the "elaboration" variable of the potential creativity cognition performance and the overall media richness ($r = 0.30$, $p < 0.05$) but also with three media richness dimensions; "use of multiple cues" ($r = 0.29$, $p < 0.05$), "language variety" ($r = 0.33$, $p < 0.001$), and "personal focus of the medium" ($r = 0.34$, $p < 0.001$. Furthermore, the findings also suggested significant relationships existed between the "language variety" dimension of the media richness with the overall potential creativity cognition performance ($r = 0.39$, $p < 0.001$) and its "flexibility" variable ($r = 0.36$, $p < 0.001$).

Research Hypotheses

There were 12 hypotheses examined in this study (see Table 12). The findings (as shown in Table 10) revealed support for eight hypotheses and rejected the remaining four hypotheses. The overall potential creativity cognition performance of the CMC learners in the experimental group was deemed to be better than the FtF learners in the control group (H1 supported). In terms of the fluency, originality, and elaboration variables of the potential creativity cognition performance, the CMC learners of the experimental group performed better than the FtF learners of the control group (H1a, H1c, H1d supported). However, the CMC learners of the experimental group did not perform better than the FtF learners of the control group with regards to the flexibility variable of the potential creativity cognition performance (H1b rejected).

Table 11. Correlation between media richness perception and potential creativity cognition performance variables.

	Fluency	Originality	Elaboration	Flexibility	Overall Potential Creativity Cognition Performance	The Availability of Immediate Feedback	Use of Multiple Cues	Language Variety	Personal Focus of the Medium	Overall Media Richness Perception
Fluency	-									
Originality	0.55 **	-								
Elaboration	0.42 **	0.21	-							
Flexibility	0.37 **	0.10	0.44 **	-						
Overall potential creativity cognition performance	0.77 **	0.65**	0.69 **	0.56 **	-					
The availability of immediate feedback	0.03	−0.08	0.05	−0.12	−0.09	-				
Use of multiple cues	**0.42 **	0.16	**0.29 ***	0.18	0.27 *	0.31 *	-			
Language variety	**0.38 **	0.09	**0.33 **	**0.36 **	**0.39 **	0.24	0.57 **	-		
Personal focus of the medium	0.12	−0.11	**0.34 **	0.23	0.19	0.50 **	0.55 **	0.50 **	-	
Overall media richness perception	0.32 *	0.04	**0.30 ***	0.18	0.23	0.71 **	0.81 **	0.74 **	0.78 **	-

Note: Two-tailed test was deployed on the correlation coefficients, * $p < 0.05$; ** $p < 0.01$.

Table 12. Research hypothesis results.

Hypothesis	Result
H1: The overall potential creativity cognition performance of the CMC learners in the experimental group is better than the FtF learners in the control group.	Supported
H1a: The fluency performance of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H1b: The flexibility performance of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H1c: The originality performance of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H1d: The elaboration performance of the CMC learners of the experimental group is better than the FtF learners of the control group.	Not Supported
H2: The overall media richness perception of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H2a: The perception of the availability of immediate feedback of the CMC learners of the experimental group is better than the FtF learners of the control group.	Not Supported
H2b: The perception of use of multiple cues of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H2c: The perception of language variety of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H2d: The perception of personal focus of the medium of the CMC learners of the experimental group is better than the FtF learners of the control group.	Supported
H3: Media richness perception is significantly correlated to potential creative thinking.	Not Supported

As for the overall media richness perception, the CMC learners of the experimental group had performed better than the FtF learners of the control group (H2 supported). In addition, the CMC learners of the experimental group also did better in their perception of use of multiple cues, language variety, and personal focus of the medium as compared to the FtF learners of the control group (H2b, H2c, H2d supported). Conversely, the FtF learners of the control group performed better than the CMC learners of the experimental group in their perception of the availability of immediate feedback (H2a rejected). Hypothesis 3 was also rejected since there was no evidence to suggest a significant correlation between media richness perception and potential creative thinking.

5. Discussion

The aim of this research was to explore the correlation between media richness and potential creativity through the use of the CMC and FtF communication formats. In relation to the first research question: "Will the use of different communication formats (i.e., CMC and FtF) have an impact on potential creative thinking?", the research results showed that the CMC communication format had achieved a higher potential creativity in fluency, flexibility, and originality than the FtF communication format. This suggested that the relatively higher communication equivocality by the CMC communication format had helped individuals to overcome the limitations of space and time, and could more actively focus on the exchange of transmitted information [20,29,31]. This outcome aligned with studies in the past that supported CMC communication format in delivering remarkable production and communication efficiency for potential creativity thinking [29,30]. Furthermore, the virtual communication environment of the CMC format offered more relaxing, anonymous, and less tense facial expression and change in tone of voice than that of FtF [13–15]. However, other research studies found that the performance of innovative thinking via the FtF communication format to be better than that of the CMC format, particularly in the context of education research and new product development [26–28,84].

For the second research question: "What is the correlation between media richness and potential creative thinking through the use of the CMC and FtF communication formats?", the research findings discovered that the perception of CMC communication format was stronger than the FtF format in terms of media richness, use of multiple cues, language variety and personal focus of the medium. This

outcome was supported by the previous studies [37,57]. In contrast, the perception of the availability of immediate feedback through the CMC communication format was not evident. This could be explained by learners who considered the use of such a format to be a more flexible way of communication that enhanced their understanding and way of thinking about the information received. Such an outcome corresponded with the study by Culnan and Markus [24].

Other researchers also pointed out that the synchronized interaction in CMC communication format had a similar effect to real time face-to-face communication. The combination of text, voice, and video would also remedy what was lacking in oral conversation. Therefore, the CMC communication format might not necessarily be less effective than the FtF format [24,25]. However, this finding was different from some earlier studies in the 1970s, which argued that the FtF format had the highest communication richness [20–23]. While the research findings revealed no significant difference between the CMC and FtF communication formats in the perception of the availability of immediate feedback, previous studies did argue that the CMC media richness for interactivity was still behind the FtF format [11,35].

The research findings indicated that of the four dimensions of media richness, only the availability of immediate feedback had no significant correlation with potential creativity cognition performance. This outcome was supported by previous studies [37,57]. However, the use of multiple cues, and language variety dimensions of media richness, did have an effect on the fluency variable of the potential creativity cognition performance. The three media richness dimensions; use of multiple cues, language variety, and personal focus of the medium also had a positive correlation with the elaboration variable of the potential creativity cognition performance, whereas the language variety dimension was correlated to the flexibility variable of the potential creativity cognition performance. These findings suggested that it would be easier for the learners of creativity to interpret and contemplate language and symbols transmitted by the media format that had better performance of fluency, flexibility, and originality in creative thinking. The availability of immediate feedback focused on the speed of information, meaning it has the ability to receive immediate response and to make corrections, as in FtF when transmitting and receiving information. The creativity cognition focused on the breadth and depth of the information, which contributed to enhancing potential creative thinking. Therefore, the CMC and FtF media influenced the result of creativity cooperation and new product development [29–33,84,85].

Although there were studies [12,29,30,84] conducted to explore the creative results and communication satisfaction of different groups of people through different media, very few were related to media richness and creativity. This research study had attempted to fill this gap whereby the findings suggested that the CMC communication format could transmit better language variety and use of multiple cues of media richness that helped with fluency and elaboration of creative thinking. This result was different to previous studies that argued FtF is more effective in this space. Therefore, the findings on the four dimensions of media richness and the four variables of creativity brought forth by this research had further expanded the relevant research field and the extended the depth of other original similar prior studies.

In conclusion, the research explored the impact on potential creative thinking by media richness perception through creativity training via the CMC and FtF communication formats. The result provided a theoretical and practical reference for corporations facing future challenges, method of utilizing media to acquire effective information, promoting education of sustainable development, and enhancing the individual or group creativity of the employees to help with maintaining sustainable operational competitiveness by social communication activities.

6. Limitation

6.1. Limitation of Subjects

The research selected students who had actual business administration experience and enrolled in the master's degree program at the Shanghai Shih Hsin University as experimental subjects. This

study was limited by the time and resources provided by the corporations that coordinated with the scholastic research institution and by the limited number of experimental subjects (i.e., 67). Therefore, the results could not be generalized to the population at large. In addition, the samples did not represent students without a master degree or non-managers. Also, the research could not extend the deduction to students at different stages of learning, different corporate organizations, or all workers, to verify the correlation between the theory and research structure. A more representative sample would be required for any future research.

6.2. Limitations of Research Method and Tools

The study focused on exploring the impact of creativity training of different types of communication formats on potential creative thinking. It was limited to only creativity training as planned in the social-media experiment. Thus, the results could not be interpreted for other contexts. The research chose the more frequently used face-to-face method and mobile communication software, WeChat, for the experiment. Therefore, the research results can be compared less with other traditional or new media. The relevance of the results to other computer-mediated communication media would require further verification. The experiment of the research had no control over the actions of the experimental subjects, the status of the internet, and disturbances by environmental factors during the investigation even though the researcher executed procedure control over the plan before and during the experiment being conducted.

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