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Creativity

Edited by Sílvio Manuel Brito and João P. C. Fernandes Thomaz

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Meet the editors

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Contents

Preface

Creativity is more than a single attitude; it is a way of life! This book is a discussion of creativity in four sections: creativity behaviour, creativity learning, creativity in science and arts, and creativity tendencies.

In the first section, we focus on parental styles and maternal relationships with creativity in children, especially on indirect effects to promote and motivate creative development in childhood. Then, we present an approach to creativity at the emotional level, and how they influence this attitude through personality traits and emotional intelligence use.

The second section discusses creative learning and its meaning, approaching fluency and flexibility in the elaboration of the educational curriculum, making it useful for career development and management. Then, we present our vision for a creative approach in educational management where various attitudes such as clarity and curiosity contribute to education promotion as a fundamental instrument of individual and social development.

In the third section, we present a creative practice, and theoretical approach to interaction via several examples in science and arts, namely, computer vision, 3D models, sculptures, and super quadrics.

Finally, we conclude as a trend, forward-looking creativity, the most critical project movement, where the focus of perspectives changes, namely the evaluation of creative thinking, distance and semantic analysis, linguistics, creativity mapping, and modelling. Next, we will look at future creative skills and a religious perspective on the knowledge of creativity in Islamic culture.

Using creativity, we shape the future!

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Section 1

Creativity Behaviour

Chapter 1

Introductory Chapter: Creativity in Decision Making

Sílvio Manuel Brito and João P. C. Fernandes Thomaz

1. Introduction

Creativity is an attitude [1], even more, studied in the world competing with leadership, the most studied concept of all time. Both realities have a common denominator: They are innovation stimulators [2] and use technology to develop people and organizations. These have to make business and contract people to give new ideas and take decisions, and in what concern with this last element, the decision making is fundamental to leave organizations to make up mind itself. So what is creativity in decision making? Does it depend on leadership to innovate? Does it depend on the decision, nature, or level, itself? What kind of creativity do we need to make good decisions? It seems a higher kind of creativity originates from excellent decision making if we explore several possibilities or identify the necessary fundamentals to understand this problem. To understand this we believe that creativity and decision determine the impression of people's attitudes to creating namely social status, attitude in general and power, prestige, opinion, and decision [3]. As we leave in a turbulence era of big unknown changes, people try to solve the problems taking the decision making as a reference but supporting through a creative attitude; in other words, to develop overcome and resilience creativity help to highlight the evident factors that must overcome information limitations and prejudices that compromise decision making [4].

The creativity approach has an origin in lateral subject perspectives that characterize the relationship between people that use the brain to bring people together to a new world or a new form of human life [5] using to make up their minds and change their behaviors empower that relationship bringing reality closer to thought. This presupposes competencies learning, replacing inertia with activity in people establishing connections and turning every day into opportunities [6]. But what about creativity and decision-making? Observing the Eisenhower Matrix [7] we can see two important aspects: importance and urgency, but we know importance is a good catalyst for decision [8], and urgency is important for critical decision [9], so it seems us, to prioritize factorially, we'll need the creativity support. According to this, the greater the importance and the lower the urgency, the decision is based on a schedule, if the importance and urgency are low, it is best not to decide, if the importance remains low and the urgency is high, we decide to delegate to someone, if the importance and urgency are high, then you must decide, and now!

2. Literature review

2.1 Creativity

Creativity could be defined as the artist's production capacity, the discoverer, and the inventor, which is manifested by inventive originality or, even, by the ability to find different and original solutions in the face of new situations (innovation). According to several authors that follow the complexity of the phenomenon, this concept gains one or another meaning. However, the various definitions proposed are grouped, centered, and interconnected in four perspectives: (i) the person; (ii) the processes/techniques/means/acts; (iii) product/object/purpose/objective; and (iv) climate/environment.

Torrance [10] and Alencar [11], among others, refers to three mental capacities that can be considered intimately linked to creativity: (i) Fluency–"the abundance or quantity of different ideas on the same subject or answers to a question" or "the ability to think of a large number of ideas or possible solutions to a problem"; (ii) Flexibility–"the ability to alter the course of thought or devise different categories of responses" or "the ability to think in different methods or strategies"; and (iii) Originality–"the ability to think of unique or unusual possibilities" or the "rare, infrequent, or uncommon" but possible responses. Creativity is the expression of a potential human capacity for achievement that manifests itself through human activities, of inventive originality or innovation, and that generates products in the course of its process [12, 13].

2.2 Decision and decision making

Kirkwood [14] asks: "What is the decision?"

For any situation, the question is: What should be done? What is the decision to make? Has the problem been identified? What are the possible alternative solutions. A possible answer would be to consider the decision as a complex and comprehensive process that begins with the perception of the need for change and ends with the choice and implementation of a course of action, among the several viable ones [14].

March [15] states that decision-making is the activity that interprets the action as a rational choice. For this author, the term rational is usually interpreted as equivalent to "smart" or "successful", which describes actions as having the desired results. Rationality, in turn, is defined as a set of procedures, particular, and natural, for making choices. The views of rationality can be observed from two main perspectives, one based on Unlimited Rationality (Locke and Laplace) and on "Optimization with Constraints" and another based on Bounded Rationality developed by Herbert Simon in 1957 in his book "Heuristic of Satisficing" and, more recently, in "Quick and Simple Heuristics" [16] and the organizational decision-making mixes the two styles, rational and administrative [17].

2.3 Creativity and decision making

Clemen [18] states that creativity plays an important role in decision-making because it can be much more than an activity that generates new alternatives that determine the limits (boundaries) of the decision. An active decision-maker looks for decision opportunities and tries to create them whenever possible, looking for new

and better alternatives. Techniques such as Fluent and Flexible Thinking, List Building, Brainstorming, and Metaphorical Thinking can help to achieve high levels of creativity in decision-making processes. Group discussion techniques can promote creativity by appropriately managing group interactions and improving the creative environment (climate of creativity).

3. Methods

3.1 Objectives

As a general goal, we try to know if there's the possibility to people decide creatively in a global way. Specifically, we want to know what kind of creativity manner is necessary to take excellent decisions making and if the people develop creativity to do that and what's the consequences about it.

3.2 Sample

We consider a population from an industrial society composed of 45 subjects from a group of 71 resulting in the respective non-probabilistic sample fraction with a total of 63% being n the population and N the universe we have: n = 45 N = 71 (n/N = 45/71 = 0,63).

3.3 Hypothesis

According to the problem, we formulate the following hypothesis:1. The subjects present creative potential to decide.2. The knowledge level supports the creative decision. 3. Gender helps to decide creatively. 4. The potential to decide creatively depends on age. 5. The career progression increases the creative potential to decide. 6. The creative decision will be a myth or a reality.

3.4 Instruments and procedures

We proceed with three analyses. First using the Hermann Creative Potential Test [19] indicates that creative potential originates in the brain, more properly in the left and right cerebral hemispheres which represent both sides 2 of the human brain, analytical and creative functions representing the past and future, control the hands, and act according to the four mediators: rational, cautious, experimental, and sensitive. According to this, he introduced us to the second strategy we will examine, with the application of a questionnaire, the detection of the creative potential of each subject arising from the biological basis of brain function [20].

We then carried out a second analysis, to confirm the aimed potential existence, using the Borda method [21], a support decision method, where we analyzed all preferences organizing the subjects according to their choices preferences and received points for that. 1 point for the last preference, 2 points if it's the second preference, and N points if it's the first preference. Whoever, in this case, has more points approximately powers greater decision-making ability. Finally, we used the third, simply descriptive, analysis to find options for the expected average that's 3 searching hypothesis confirmation.

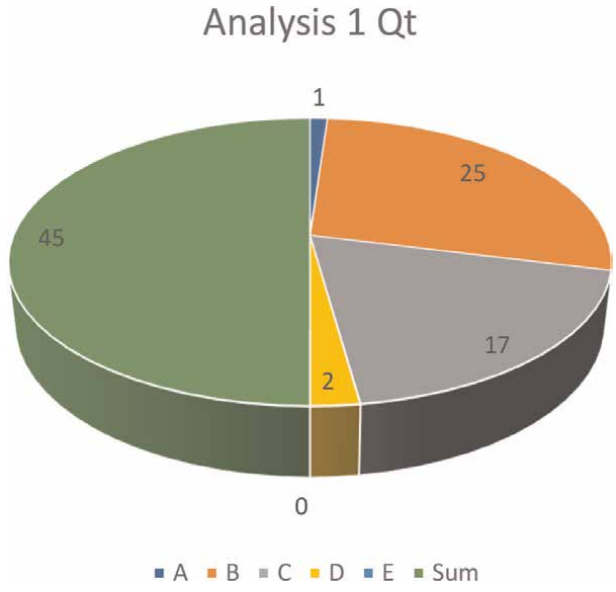

Figure 1.
Subject's creative potential.

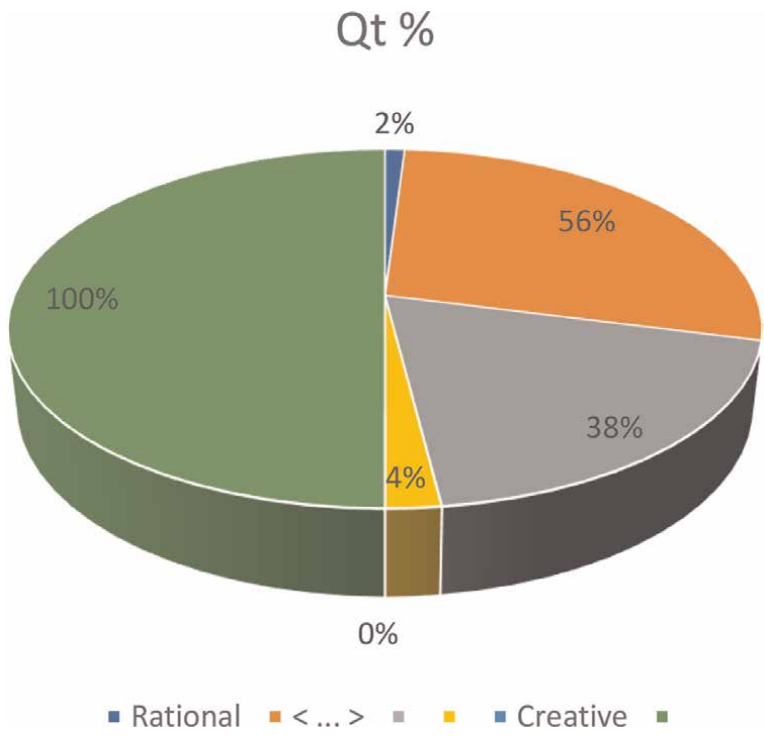

Figure 2.
% Subjects creative potential.

		A	B	C	D	E	Sum
Analysis 1	Qt	1	25	17	2	0	45
		Rational		**< ... >**		***Creative***	
	Qt %	2%	56%	38%	4%	0%	100%
		96%			4%		

Table 1.
Subject's creative potential.

	Points	0	1	2	3	4	Sum
Analysis 2	weighted amount	0	25	34	6	0	65
Borda Method	weighted amount. %	0%	38%	52%	9%	0%	100%
		91%			9%		

Table 2.
Subjects' creative potential confirmation.

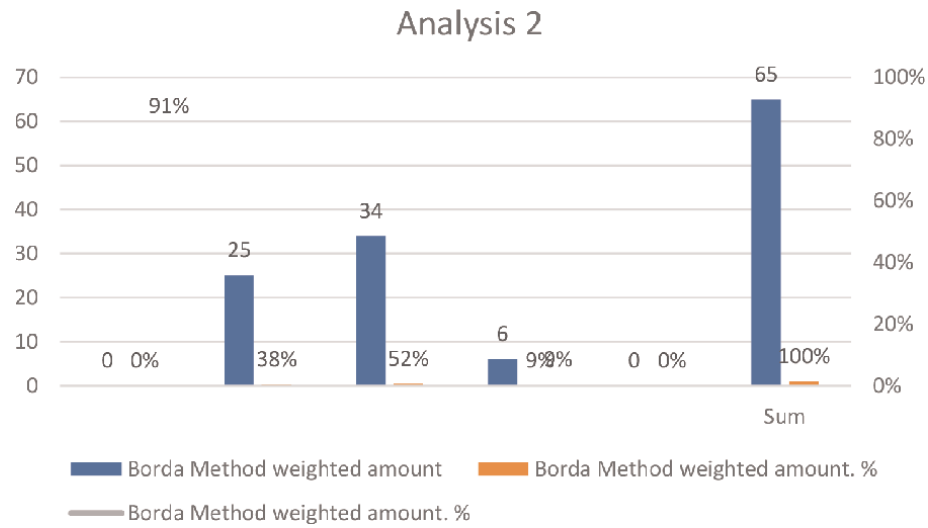

Figure 3.
Subjects' creative potential confirmation.

4. Results

4.1 Analysis 1

According to the table above, we see that the majority of people are more rational ahead than creative despite the attitude being present but blocked, which makes us suppose that there may be created in their decisions, but not at this moment (**Figures 1** and **2**) (**Table 1**).

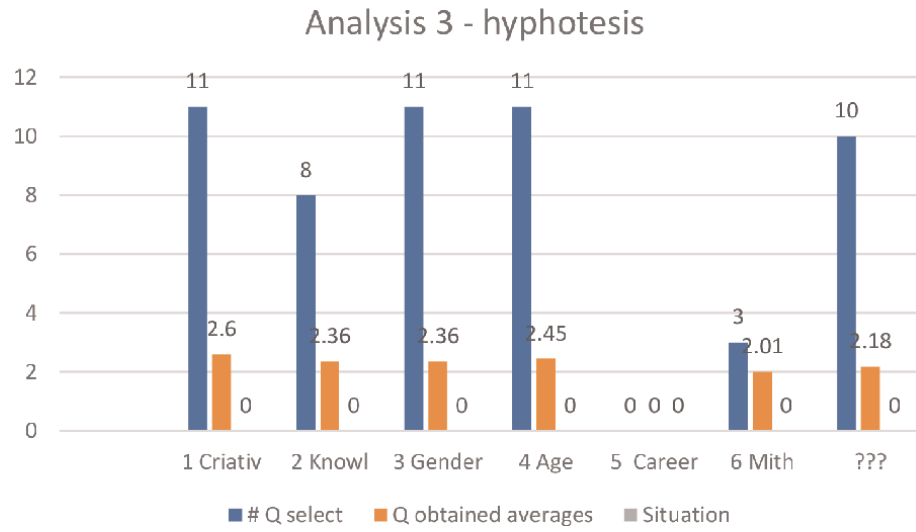

Figure 4.
Hypothesis confirmation.

	Hypothesis		Questionnaire corresponding questions 16 / 32	Selected questions	Averages obtained by questions	Results*
Analysis 3	1. The subjects present creative potential to decide.	**1 Creative**	Q01B, Q02A, Q03A, Q04B, Q05B, Q07B, Q09B, Q11B, Q14B, Q15A, Q16B	11	**2,60**	under
	2. The knowledge level supports the creative decision.	**2 Knowledge**	Q02B, Q05A, Q06A, Q07A, Q10B, Q13A, Q14A, Q15B,	8	**2,36**	under
	3. Gender helps to decide creatively.	**3 Gender**	Q01B, Q02A, Q03A, Q04B, Q05B, Q07B, Q09B, Q11B, Q14B, Q15A, Q16B	11	**2,36**	under
	4. The potential to decide creatively depends on age.	**4 Age**	Q01B, Q02A, Q03A, Q04B, Q05B, Q07B, Q09B, Q11B, Q14B, Q15A, Q16B	11	**2,45**	under
	5. The career progression increases the creative potential to decide.	**5 Career**	(without relation to potential)	0	**0,00**	none
	6. The creative decision will be a myth or a reality.	**6 Mith**	Q01A, Q06B, Q08A,	3	**2,01**	under
		Questions ahead of the hypothesis	Q03B, Q04A, Q08B, Q09A, Q10A, Q11A, Q12A, Q12B, Q13B, Q16A	10	**2,18**	none

Table 3.
Hypothesis confirmation.

4.2 Analysis 2

Considering **Table 2** where the 45 respondents are affected by the factor 0 to 4 which makes their sum equivalent to 65 (for the percentage calculation). That is, 0 x1 + 1 x 25 + 2 x 17 + 3 x 2 + 4 x 0 = 65. So, according to with that we see the preferences choices on rationality as we saw in the first table. We verified that the principle of rationality is the choice that is imposed in this studied group, which confirms the blocking of the creative attitude and the correspondence with the two analyses (**Figure 3**).

4.3 Analysis 3

All results are below 3, the expected confirmation means.

According to the questionnaires, average answers through descriptive analysis to confirm eventual creative potential results represented by the average 3 we obtained the following averages considering the hypothesis and the questions selected from the total of the questionnaire (32) (**Figure 4**) (**Table 3**).

In face to obtained results, we can consider that any hypothesis is confirmed, because being under the average (3 points) and one that has no relation to the aimed theme. We have also isolated issues that have nothing to do with the hypotheses in question.

5. Conclusions

We can think that the subjects act with strong rationality and knowledge, being able to decide, however, without using creativity, regardless of age and gender, and career either. The creative decision, in this case, is a reality but not present now, and we consider that it is not a myth. The decision exists, it is an attitude [22], and it is present, as well as the latent creativity, according to the first two analyses. We think that the block is found in the way people learn and associate information, often in a memorized way, instead of solving problems using thought and words while practicing a decision-making activity, given that we retain 90% of what we say while we do it [23]. Regarding the study, we think that it should be extended to other organizations with more diversified and expanded samples to contribute to the improvement of culture management in organizations, namely in the processes of change, negotiation, and conflict.

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Chapter 2

Indirect Effects of Parenting Style on the Relationship between Maternal Personality and Children's Creativity

Shuyang Lu, Keang Ieng Peggy Vong and Shing On Leung

Abstract

Mothers are important persons in the development of creativity in young children. The aim of this study was to examine whether and how mothers influence the creativity of their children. We investigated maternal personality and parenting style through parents' reports, while children's creativity of 88 Chinese kindergarten children (age M = 5.50, SD = 0.567) was rated by Torrance TCAM. There was an indirect effect of authoritarian parenting in the relation between maternal neuroticism and children's creativity in terms of originality. Neurotic mothers may tend to be more authoritarian and in turn, reduce their children's creativity. Further, parenting style related to not setting any guidelines at all (or NGA) may have indirect effects on the relation between maternal conscientiousness and openness toward children's creativity. The opposite direction between Chinese parents' preferential parenting and creativity encouragement parenting was found.

Keywords: creativity, maternal personality, parenting style, indirect effects, kindergarten children

1. Introduction

In this information age where ideas, exchanges, and the development of concepts are fast changing, creativity is needed and is considered as a key learning outcome. An individual's overall development is believed to be critically linked to their social world, especially via their family lives early on (e.g., [1]). Studies have explored maternal personalities' influence on family atmosphere provided to students (e.g., [2]), as well as family factors' influence on students' creativity [3–7]. However, no relevant studies were found to link maternal personalities, family factors, and students' creativity together. Besides, culture, groups accumulated common experiences, and influence on creativity also drew many researchers' attention [8–11]. Since Chinese society has, in recent years, paid increasing attention to the development of children's creativity, how Chinese culture react to the mother-child relationship and further influence children's creativity need more exploration. This study aims to investigate how mothers' personality traits and parenting behaviors link to children's actual creativity

performance, as it may lead to insights into mother-child relationships in terms of creativity, fostering family environments, and, in particular, mothers' parenting style adopted in Chinese societies.

2. Literature review

Even though creativity studies have been oriented toward the creative process and understanding its dynamic and evolving momentum [12], children's everyday experiences with their significant others may influence their motivation, perseverance, competence, and so on, required for the fine elements in children's thinking [13]. Having said that, the casual relationship between mother's personality and children's creativity may be more complicated than one might assume. For example, it may be possible, depending on the conditions, that children's creativity has some effects on parent's personality, and there may be other factors such as socio-economic status which affect children's creativity [14, 15].

2.1 Maternal personality and children's creativity in Chinese societies

Studies of the relationship between parents' personalities and children's creativity have conflicting results. On the one hand, studies showed mothers have an effect on children's creativity. Kwaśniewska and Lebuda [16] conducted 27 qualitative interviews with mothers and found that creative mothers foster a climate conducive to children's creativity. Kwaśniewska et al. [2]'s study showed that mothers who possess openness and extraversion traits more may show higher creative potential, while highly neuroticism parents may have less creative potential. And mothers with openness traits have a positive attitude to creativity, as well as are willing to provide the "climate" for creativity in a parent-child relationship. Since mothers are usually the primary caregivers who have been shown to play a key role in children's development, more studies are needed to examine the parent-child relationship in terms of mother's personality and children's, especially young children, creativity performance as it will shed light on creativity development in the early years, an issue that has drawn people's attention in recent years. On the other hand, Fu et al. [17]'s research showed that there was no indication of any significant relationship between maternal personality and preschoolers' creativity. The conflicting results may be due to the limitation of samples, or the measurements applied to measuring creative abilities.

From above, the relationship between maternal personality and children's creativity could be further discussed. Furthermore, considering the cultural factor, assessment of Chinese personality indicated that neuroticism, extraversion, agreeableness, and conscientiousness factors were jointly listed in the widely used Big Five inventory, but openness factor was not [18]. The openness factor was more identifiable in individualist cultures but was negatively correlated with collectivism [19]. Chinese society is more inclined to collectivism. However, previous studies showed that the openness factor was highly correlated to creativity [20]. Even the compatibility between cultural personality and creative personality in China was discussed (e.g., [21, 22]), the impacts of mother's personality on children's creativity require further investigations.

More importantly, it may be difficult to measure children's creativity as young children's manifestations of creativity are subtle and nonverbal. Therefore, the Thinking

Creatively in Action and Movement (TCAM) measure [23], which takes around 30 minutes for each child, is used in this study. Details will be given in the Section 3. This paper aims at finding the direct and indirect effects of maternal personality on children's creativity. For indirect effects, we conjecture that parenting style may be one of the possible mediators. So, we shall look at previous studies on the relationship between parental personality and parenting style.

2.2 Parental personality and parenting style

Parents play an important role in children's development [24, 25]. Clark et al. [26] and van Aken et al. [27] study showed that parents' personality relates to their parenting behaviors, and in turn children's behaviors generally. Smith et al. [28] found that mothers with higher levels of agreeableness showed more warmth and support toward their children. Mothers with higher extraversion showed more maternal warmth and, thus, were more likely to support their children's autonomy, but such mothers also exercised higher power assertion over their children [28, 29]. Furthermore, mothers with high conscientiousness levels displayed support toward their children's autonomy, yet these mothers were more controlling and restrictive; but at the same time, less forcefully disciplinarian [26, 30]. Such mothers provided more rational, structured, and less forceful parenting to their children [30]. Coplan et al. [31] concluded that maternal neuroticism may lead to an overprotective parenting style, while higher agreeableness in mothers represented a low, harsh parenting style.

There are possible relationships between maternal personality and maternal parenting style. According to Baumrind [32] research on parenting authority, there were three categories: authoritarian (high in control and maturity demands, low in responsiveness and communication), authoritative (high in control, maturity demands, responsiveness, and communication), and permissive (high in communication and responsiveness, but low in control and maturity demands). In China, Xu et al. [33]'s research showed that Chinese mothers prefer authoritarian and authoritative parenting. Results showed that authoritative parenting could increase children's creativity while authoritarian parenting plays a negative role in children's creativity in high-school students [34]. The relationship between parenting style and children's creativity is worth studying, given the importance of the early years which are known to set the foundation for later development.

2.3 Parenting style and creativity

Maternal parenting style is one of the factors that influence children's development [35]. Feldman and Klein [36] found that mothers who give warm and sensitive feedback to their children's needs may lead to positive and effective interactions between mother and child. Also, children who accept their parents' advice may be more willing to correct misbehavior [37]. In contrast, negative interactions between parents and children, or even worse, punishment, may intensify children's misbehavior [38, 39]. Few studies have focused on the relationship between parenting and creativity, but some are described as follows.

Fan and Zhang [40] found that perceived parental involvement is positively related to a creativity-generating thinking style. Siegelman [7] found that students who perceive lower parental attention show higher creative potential than those who perceive parental love, and we will return to this with our results in the Section 5. Both studies focused on university students and not on young children. Fearon et al. [13]

investigated the inter-relationship among parents' creativity, parenting styles, and children's creativity for primary school students, and the Torrance Tests of Creative Thinking (TTCT) were used. Results showed that there were significant effects of parents' creativity and parenting styles on children's creativity. In this study, the importance of maternal personality in affecting young children's creativity, instead of children's creativity level or performance, is emphasized.

2.4 Research objectives

Some previous studies have shown the relationships between two variables, namely parents' personality and parenting style, or between parenting style and children's creativity for primary school students. Meanwhile, the cultural issues that were highlighted in previous studies are still contested. This study, therefore, investigates the direct and indirect effects of maternal personality on 4- to 8-year-old children's creativity under the Chinese context. For indirect effects, parenting style is treated as a mediator. And before we do that, we explore the interrelationships among maternal personality, maternal parenting style, and children's creativity.

3. Method

3.1 Participants

Five provincial-level kindergartens in Zhuhai city of Guangdong province, China, participated in this study, with a total sample of 127 children. Ethical consent was obtained from both parents and teachers, as the children were very young. Each child participated in a 30-minute Thinking Creatively in Action and Movement (TCAM) [23] test to assess creativity. Their mothers filled out the Chinese Big Five Personality Inventory (CBF-PI) and Parental Authority Questionnaire (PAQ), with a total of 70 items. Excluding 98 (77%) children participated and 88 (70%) records were valid. The mean and SD of children's age were 5.50 and 0.567 years, respectively, with 47.7% girls and 52.3% boys. Missing values were imputed by using the linear interpolation method in SPSS.

3.2 Instruments

3.2.1 Thinking creatively in action and movement (TCAM)

The TCAM test was used to measure children's creativity. As the subjects were Chinese, we used the revised Chinese version by Chang [41], which was fully validated. The TCAM consists of four activities with the first, third, and fourth activities scoring both children's fluency and originality in creativity, while the second activity scores imagination. Fluency measures cumulatively in how many ways do children react. Originality measures the uniqueness of responses based on a large cardinal number of participants tested in the Taiwan Chinese version. And, imagination measures how many unique scenes children could act out.

The details of the four activities are as follows. Activity one (How many ways?) asks children to use diverse ways to get from one place to another. Activity two (Can you move like a tree/rabbit/fish/snake?) asks children to pretend to be something or to play a prescribed role (driving a car at high speed and pushing an elephant away

	Test		Retest		
Measure	Mean ± SD	α	Mean ± SD	A	ICC
Fluency	25.82 ± 19.26	0.70	24.43 ± 18.67	0.68	0.98
Originality	25.12 ± 19.41	0.55	24.52 ± 19.05	0.58	0.99
Imagination	15.46 ± 3.52		15.99 ± 3.89		0.93

Table 1.
Mean, SD, and Cronbach's α for the three constructs in creativity in test and retest and ICC.

from desired things). Activity three (What other ways?) asks children to use diverse ways to put a number of paper cups into a box. The last activity (What might it be?) requires children to think about playing with and using paper cups. Testing one child takes around 30 minutes. Each activity was restricted to 10 minutes with a total time of under 30 minutes.

All activities were conducted in the kindergartens' activity rooms, which provided enough space for children to move around freely. A five-minute warm-up exercise was used so that the children feel relaxed and trust the experimenter. We complied strictly with the TCAM (Taiwan version) test manual.

TCAM-Taiwan version has already been validated by Chang [41] in Chinese writing. We obtained consent from parents for the digital recording of participants' movements in the testing areas. The dataset was scored again 2 weeks later by the same trained research assistant. The test-retest reliabilities of the first to fourth activities and the overall scores were, respectively, 0.72, 0.76, 0.70 and 0.60, and 0.75.

Following Zachopoulou et al. [42], the reliabilities were assessed via means, SD and reliability of internal consistency Cronbach's α in test and retest, and the Intraclass correlation (ICC). These results are reported in **Table 1**.

In **Table 1**, the means, SD, and reliability of internal consistency α's are all very similar between test and retest. The means for fluency, originality, and imagination are, respectively, 25.82, 25.12, and 15.46 with the corresponding SD being 19.5, 19.5, and 3.4. These values are comparable with Zachopoulou et al. [42]. The temporal stability of TCAM was examined using the intraclass correlation (ICC) between test and retest, which were at least 0.93. The test was reliable.

3.2.2 Chinese big five personality inventory (CBF-PI)

Maternal personality was measured by Wang et al. [43] the Chinese Big Five Personality Inventory (CBF-PI) brief version, with the original version created by McCrae and Costa [44]. It uses a 6-point Likert scale, ranging from 1 (=extremely disagree) to 6 (=extremely agree), and has five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN), with eight items for each. CBF-PI has been validated and has internal consistency reliabilities ranging from 0.764 (Agreeableness) to 0.814 (Neuroticism). The test-retest reliabilities range from 0.672 (Agreeableness) to 0.811 (Openness) [43]. Here, the reliabilities of internal consistency for OCEAN and the overall scales are, respectively, 0.799, 0.784, 0.716, 0.705, 0.778, and 0.790.

3.2.3 Parental authority questionnaire (PAQ)

Parenting styles were measured by the Parental Authority Questionnaire (PAQ) [45], with the Chinese translated version validated by Deng [46]. It uses a 5-point

Likert scale, ranging from 1 (=extremely disagree) to 5 (=extremely agree), with 30 items, three dimensions (authoritative, authoritarian, and permissive), and 10 items in each dimension. The reliabilities of internal consistency for authoritarian, authoritative, and permissive dimensions are, respectively, 0.72, 0.77, and 0.76 in Reitman et al. [45]'s original study; 0.78, 0.70, and 0.68 in Deng [46]; and 0.73, 0.71, and 0.62 in the present study.

3.3 Special single items

Single items have the advantages of having good content validity and decreasing subjects' confusion [47], and only content validity is the real validity and others can be considered as a validation process [48]. In addition to the three domains of parenting, we used one special item in each of the three domains in parenting styles as they have some special properties, as follows. Traditional Chinese parent-child interaction emphasizes parents' "training" of children [49], which implies high maternal involvement for promoting children's success. The first item was "it is for my children's own good to require them to do what I think is right, even if they don't agree" in the authoritarian domain. This was the only item in the domain that emphasized doing something entirely *for the sake of children's good*. All others emphasized ordering without mentioning children's good. We name it FCG (for children's good), hereafter. The second item was "I always encourage discussion when my children feel family rules and restrictions are unfair" in the authoritative domain. This was the only item in the domain that *encourages, by words*, parent-children interactions. Others do encourage interactions but not by words and are less explicit. We shall name it EBW (encourage by words). The third item was "I usually don't set firm guidelines for my children's behavior" in the permissive domain. This was the only item in the domain where parents set *no guidelines at all*. We name it NGA (no guidelines at all). According to Chao [49]'s discussion on Chinese parenting, FCG, EIW, and NGA items represent descending order for "training." We shall see later that NGA has more indirect effects on children's creativity.

3.4 Mediation methods

The traditional approach to handle mediation analysis was proposed by Baron and Kenny [50]. It requires statistically significant conditions for: independent and dependent variables; independent variables and moderators; and mediators to predict dependent variables when controlling for independent variables. But it has been found that this procedure assumes no measurement error for mediators, which is impractical [51]. More importantly, an indirect effect can exist even though there is no direct effect [52, 53]. In our case, it may be possible that there is an indirect link between maternal personality and children's creativity without a direct link between the two variables. We will return to this in the Section 5. Hence, we used a more recent approach that uses the PROCESS (version 2.16.3) [54] procedure in SPSS with bootstrapping. Bootstrapping takes random samples with replacement of the original data. It has the advantage of not assuming normality and is particularly useful in small samples such as this case. If the "zero" point is not included in the confident interval as outputted, the indirect effect is said to be statistically significant [55]. Technically, if we denote X, Y, and M as independent variable, dependent variable, and mediator. The indirect effects are denoted by c, which equals a^*b, where a is regressing M on X, and b is regressing Y on M controlling for X.

4. Results

4.1 Demographic result and direct effect

To examine the direct relationship between maternal personality and children's creativity, we looked at the correlations between five personality characteristics and three creativity constructs. These correlations are reported in the upper part of **Table 2**.

Table 2 shows no significant correlations among the 15 combinations. Effect sizes were small, medium, and large if the magnitude of correlations is around 0.10, 0.30, and 0.50, respectively [56]. **Table 2** shows all correlations were below 0.10, except the correlation between conscientiousness and imagination (0.184), and between neuroticism and fluency (−0.115). There was no direct effect of maternal personality on creativity of children.

Next, we investigated the indirect effects of maternal personality on children's creativity through parenting style. First, we looked at the effects of maternal personality on parenting style for three domains and three single items. The results were reported in the lower part of **Table 2** for the economy of space. From **Table 2**, conscientious and openness personalities showed statistically significant correlations with an authoritative parenting style (r (88) = 0.375, p < 0.01 and r (88) = 0.421, p < 0.01, respectively). A significant result was found between neuroticism and an authoritarian parenting style (r (88) = 0.376, p < 0.01), and this in turn correlated significantly with creativity. For the three single items, a conscientious personality showed statistically significant correlations with NGA (r (88) = 0.393, p < 0.01, respectively). Neuroticism and agreeableness showed significant correlation with FCG (r (88) = 0.360, p < 0.01; r (88) = −0.282, p < 0.01). Openness significantly correlated with item EIW (r (88) = 0.348, p < 0.01, respectively). These single items were correlated with creativity as we shall see.

In terms of effect sizes, all those nonsignificant correlations were of small effect sizes. All those statistically significant correlations ranged from 0.249 to 0.421 and were of "medium" effect sizes. Next, we looked at how the three parenting styles and the three single items of parenting were correlated with the three creativity constructs, and the results are shown in **Table 3**.

	Neuroticism	Conscientiousness	Agreeableness	Openness	Extraversion
Fluency	−0.115	0.026	−0.068	−0.083	−0.084
Originality	−0.055	0.023	−0.073	−0.024	−0.044
Imagination	−0.066	0.184	0.064	−0.075	−0.079
Authoritarian	0.376**	−0.008	0.077	0.035	0.029
Authoritative	−0.205	0.375**	0.217	0.421**	0.054
Permissive	0.117	0.116	−0.095	0.190	0.158
FCG	0.360**	−0.144	−0.282**	−0.099	−0.145
EIW	−0.136	0.167	0.056	0.348**	0.111
NGA	−0.187	0.393**	0.187	0.249*	0.193

Note: Blank, "" and "**" represent nonsignificant and significant at 0.05 and 0.01 levels, respectively.*

Table 2.
Correlations between five personalities, three creativities, and three parenting styles.

	Authoritarian	Authoritative	Permissive	FCG	EIW	NGA
Fluency	−0.279*	0.033	0.065	−0.074	−0.077	0.242*
Originality	−0.278*	−0.082	0.058	−0.071	−0.126	0.220*
Imagination	−0.134	−0.168	−0.245	−0.228*	−0.259*	0.259*

Note: Blank, "" and "**" represent nonsignificant and significant at 0.05 and 0.01 levels, respectively.*

Table 3.
Correlations between three parenting styles and three creativities.

Out of the total 9 (=3 × 3) combinations of domain level, only the authoritarian parenting style showed a significant relationship with fluency and originality (r (88) = −0.279, p < 0.05; r (88) = −0.278, p < 0.05). And the correlation between permissive parenting style and imagination was marginal (r (88) = −0.245, p = 0.069). In terms of effect sizes, these three correlations were of small to medium effect, with the rest being small. For the three single items of parenting, item NGA showed a significant relationship with all the creativity constructs (fluency, originality, and imagination) (r (88) = 0.242, p < 0.05; r (88) = 0.220, p < 0.05; r (88) = 0.259, p < 0.05). Item FCG was significantly correlated with imagination (r (88) = −0.228, p < 0.05). Item EIW was significantly correlated with imagination (r (88) = −0.259, p < 0.05). The effect sizes of all these significant correlations were medium.

Combining the results in the previous steps, at the domain level, we found significant correlations between authoritative and authoritarian parenting and maternal personality, but only authoritarian parenting has significant correlations with two creativity constructs. Even when considering effect sizes, the results did not change, i.e., the only two possible indirect paths between maternal personality and children's creativity are from neuroticism to an authoritarian parenting style, and then from an authoritarian parenting style to fluency and originality.

For the three single items of parenting, we followed the above procedures and found nine indirect paths toward creativity. The following nine combinations have the sequence: independent variable, mediator, and dependent variable.

1. Openness, EIW, Imagination
2. Neuroticism, FCG, Imagination
3. Agreeableness, FCG, Imagination
4. Conscientiousness, NGA, Fluency
5. Conscientiousness, NGA, Originality
6. Conscientiousness, NGA, Imagination
7. Openness, NGA, Fluency
8. Openness, NGA, Originality
9. Openness, NGA, Imagination

There were total of 11 combinations, the regression models were shown in Appendix 1. Next, we investigated these indirect effects.

4.2 Indirect effects

We used the PROCESS procedure in SPSS to investigate if any indirect effects existed for the possible paths found. The results are presented in **Table 4**.

From **Table 4**, at the domain level, the confident interval (CI) of the indirect effects from neuroticism to fluency via authoritarian parenting is (−0.6427, 0.0331) with point zero included, indicating an insignificant result. For the indirect effects from neuroticism to originality via authoritarian parenting, the CI is (−0.505, −0.0134) with point zero excluded, indicating statistically significant results. Hence, there are no indirect effects of neuroticism on fluency via authoritarian parenting. But there are indirect effects of neuroticism on originality via authoritarian parenting.

			Coefficient			
X	**M**	**Y**	**a**	**b**	**c**	**CI of indirect effects**
Neuroticism	Authoritarian	Fluency	0.247	−0.855	−0.211	(−0.6427, 0.0331)
Neuroticism	Authoritarian	Originality	0.263	−0.704	−0.185	(−0.505, −0.0134)
Openness	EIW	Imagination	0.038	−1.596	−0.060	(−0.1355, −0.0115)
Neuroticism	FCG	Imagination	0.067	−0.684	−0.046	(−0.1166, −0.0053)
Agreeableness	FCG	Imagination	−0.064	−0.759	0.049	(0.0071, 0.1387)
Conscientiousness	NGA	Fluency	0.056	7.029	0.390	(0.1065, 0.8552)
Conscientiousness	NGA	Originality	0.056	6.351	0.352	(0.0776, 0.8097)
Conscientiousness	NGA	Imagination	0.054	0.992	0.053	(0.0086, 0.1177)
Openness	NGA	Fluency	0.031	6.162	0.194	(0.0398, 0.4709)
Openness	NGA	Originality	0.031	5.728	0.180	(0.0303, 0.5185)
Openness	NGA	Imagination	0.030	1.284	0.038	(0.0046, 0.1008)

Note: X, M, and Y stand for independent variable, mediator, and dependent variable, respectively. Coefficient a, b, and c stand for the path from X to M, M to Y, and indirect effects from X to Y via M. CI of indirect effects are confident intervals of coefficient c.

Table 4.
Indirect effects of five maternal personalities, three parenting styles, and three creativities.

The sign of the effects of neuroticism on an authoritarian parenting style was positive, indicating that more neuroticism will lead to more authoritarian parenting. But the sign of the effects of authoritarian parenting style on originality was negative, indicating that more authoritarian parenting will lead to lower originality. So, the combined indirect effect of neuroticism on originality was negative, indicating that mothers with more neurotic characteristics will indirectly lead to lowering originality in creativity in children.

For the nine possible paths from maternal personalities to creativity via three single items of parenting, results are shown in the lower part of **Table 4**. First, all CIs have point zero excluded and hence, all indirect effects are significant. Secondly, the signs of EIW and FCG on imagination were both negative, indicating that more parenting in EIW will lead to less imagination, and hence the indirect paths were negative from openness to imagination via EIW, and from neuroticism to imagination via FCG. However, since the sign from agreeableness to FCG was also negative, the overall indirect effect of agreeableness on imagination via FCG was negative, indicating more maternal agreeableness may indirectly lead to more imagination if the parenting style is FCG.

Thirdly, it is the results from the single item NGA (not setting guidelines at all) that are most significant and interesting. All signs for a, b, and c coefficients were positive. The b coefficients, indicating the effects of NGA on creativity, were especially high for fluency and imagination. And NGA affects all three creativity constructs. If the maternal personalities are either of conscientiousness or openness, and in addition, if the parenting style is NGA, children's creativity will be improved in all aspects. We will return to this in the Section 5.

5. Discussion

5.1 Maternal personality's influence on children's creativity via parenting style

This study investigated the effects of maternal personality on children's creativity. Since the subjects were 4- to 8-year-old children, the best way to measure their creativity seems to be assessing actions and movements by TCAM. TCAM is time consuming and what we used here. TCAM measures creativity in terms of fluency, originality, and imagination. Finally, we investigated both direct and indirect effects via parenting.

We did not find any direct effects of maternal personality toward children's creativity, but indirect effects of maternal parenting toward the relationship between their personality and children's creativity. Consistent with Fu et al. [17]'s early study, the relationship between mother's personality and children's creativity is not statistically significant. However, when adding parenting style, a mother's personality does influence children's creativity. The insignificant result may be caused by the distance from mother's self-report personality and their actual personality received by young children. It is not easy to obtain young age children's perceived maternal personality. This is one of our limitations. Another reason may be because another maternal characteristic, which is unknown, contributes more to children's creativity than maternal personality does.

We found a statistically significant indirect effect of neuroticism maternal personality on originality via authoritarian parenting. For the relationship between maternal neuroticism and authoritarian parenting, it is in-line with Coplan et al. [31]

who concluded that maternal neuroticism leads to an overprotective parenting style. For the relationship between authoritarian parenting and creativity, our result is in-line with Fearon et al. [13] who showed that authoritarian parenting has negative effects on students' creativity with a sample of Jamaican primary school students. Authoritarian parenting is a constraining parenting style and that may explain the negative effects on children's creativity. In layman's terms, sensitive (neurotic) mothers will probably be more restrictive (authoritarian) of children's behavior, thus possibly reducing children's motivation to try new things, and hence stifling creativity.

This study added three single items in each parenting domain to give additional insight. The single item EIW under the authoritative domain is the only item that explicitly expresses mothers' views on family rules. Results showed that EIW was negatively related to imagination and positively related to maternal openness. So, if mothers with open personalities choose to explain clearly those family rules and restrictions, this may have a negative effect on the imagination. This may be because if parents give clear family rules, it will leave limited room for children's activities. A similar result is found in Kwak et al. [57]'s study, the more maternal attention, the less the child's exploration.

The single item FCG under the authoritarian domain is the only item that emphasizes doing things for the children's good. Although authoritarian and FCG correlated with different creativity constructs, the signs were both negative. Both the whole domain and the single item tend to reduce children's creativity of some sort. Hence, the indirect effects of maternal neuroticism on creativity via FCG may follow a similar path via authoritarian parenting. Our results also showed that maternal agreeableness may lead to lower FCG. Or, more agreeable mothers may tend to exert fewer rules even if it is for the children's good, and then, in turn, this may lead to more positive effects on imagination. These uncovered results were not provided by the authoritarian domain.

The single item NGA, not setting any guidelines at all, under the permissive domain is most interesting. Both maternal conscientiousness and openness were positively related to NGA, but the whole domain of permissive parenting was not related to any of the maternal personalities. Besides, NGA was positively related to all three creativity constructs, but permissive parenting was not related to any of the creativity constructs. Finally, the *b* paths, effects of NGA on fluency and originality, were especially high. This was explained in Kwak et al. [57], whereby mothers who are more conscientious and open to experience may impose fewer restrictions, giving their children more freedom. And this, in turn, will lead to more exploration and higher creativity. This is consistent with Siegelman [7]'s finding that students who perceive lower parent's attention show higher creative potential than those who perceive parental love. To conclude, mothers with conscientious or open personalities may employ the parenting style of NGA, which in turn may lead to higher creativity. This has direct practical implications for nurturing children's creativity.

Further, FCG, EIW, and NGA items represent descending order for "training" under the Chinese context. The study's result shows that FCG and EIW have a negative effect on children's creativity, while NGA has a positive effect. On one hand, even "training" has a positive meaning in Chinese culture, it has a negative effect on children's creativity. On the other hand, NGA contradicted with traditional Chinese parents' preference on educational ideology, but it plays a positive role in children's creativity. Chinese parents' parenting preference on "training" may have negative influence on children's creativity. The contradiction between Chinese parents' preference of parenting and creativity encouragement parenting deserves research effort in the future.

5.2 Limitations and further research

As indicated above, the casual relationship between mother's personality and children's creativity is complicated. TCAM, an instrument widely used to tap young children's creativity, does not include "elaboration" in children's creativity, so elaboration is neither measured nor discussed in this study. There may be other possible factors affecting children's creativity, e.g., their socio-economic background and maternal education. Besides, in future research, the sample size needs to be larger for multiple regression. Further studies can explore other potential factors influencing young children's creativity. And our mediation methods used here may be fairly exploratory, especially the use of single items. In particular, the single item NGA (no guidelines at all) correlated with all three creativity dimensions. Future research can develop a scale with more items and correlate with creativity. This study employed a correlational design and hence an experimental design can be considered in the future.

A. Appendix

A.1. Appendix 1. Regression models of 11 parent's personality (X), maternal parenting style (M), and children's creativity (Y) combinations

	Fluency			**Originality**			**Imagination**		
	B	**SE(B)**	**Beta**	**B**	**SE(B)**	**Beta**	**B**	**SE(B)**	**Beta**
Neuroticism	−0.422	0.397	−0.145	−0.105	0.408	−0.036			
Authoritarian	−0.855	0.536	−0.218	−1.012	0.551	−0.253			
p	0.076			0.131					
R^2	0.089			0.071					
Adjusted *R*^2	0.056			0.037					
Neuroticism							0.01	0.067	0.018
FCG							−0.684	0.366	−0.227
p							0.154		
R^2							0.049		
Adjusted *R*^2							0.023		
Openness	−0.438	0.338	−0.148	−0.254	0.354	−0.082	−0.079	0.061	−0.146
NGA	6.162	2.815	0.25	5.728	2.95	0.224	1.284	0.51	0.284
p	0.075			0.155			0.038		
R^2	0.065			0.047			0.081		
Adjusted *R*^2	0.041			0.022			0.057		
Openness							0.02	0.064	0.037
EIW							−1.596	0.638	−0.295
p							0.04		
R^2							0.08		
Adjusted *R*^2							0.056		
Conscientiousness	−0.297	0.435	−0.082	−0.269	0.435	−0.075	0.062	0.075	0.099

	Fluency			**Originality**			**Imagination**		
	B	**SE(B)**	**Beta**	**B**	**SE(B)**	**Beta**	**B**	**SE(B)**	**Beta**
NGA	7.028	3.085	0.273	6.351	3.084	0.248	0.992	0.531	0.221
p	0.079			0.124			0.049		
R^2	0.064			0.053			0.076		
Adjusted *R*^2	0.039			0.028			0.052		
Agreeableness							−0.004	0.08	−0.006
FCG							−0.759	0.354	−0.246
p							0.091		
R^2							0.059		
Adjusted *R*^2							0.035		

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Chapter 3

Emotional Creativity

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Abstract

Creativity encompasses and is influenced by several emotions. Emotional creativity is a critical component in the creative process. It is the ability to create something new through the influence of emotions evoked from the personal or experiences of others. Creative works inspired by emotions are often original and greeted with Euphoria. This chapter demonstrates how different emotions inspire different forms and levels of creativity with examples of notable artists who experienced emotional creativity. This chapter discusses research linking emotions to creativity and the explanations of how the identification and regulation of emotions, which are often referred to as emotional intelligence, make a difference in whether creativity becomes useful, helpful, or hurtful. The dark side of creativity, which occurs when creativity becomes hurtful instead of helpful, and research into its causes is also discussed in this chapter. An example of a notable figure in the twentieth century, i.e., Adolf Hitler who masterminded World War II, is used to demonstrate how emotions played a role in this phenomenon. A conclusion alluding to the fact that creativity or creative outcomes are not necessarily bad but the application of creative work and the ability to identify emotions and regulate or control the emotions to drive creative performance validates emotional creativeness.

Keywords: creativity, emotional creativity, malevolent creativity, benevolent creativity, emotional intelligence, dark side of creativity

1. Introduction

Creativity is tilted heavily toward art more than a science discipline. There are no processes, steps, medication, or ingredients to guarantee creativity or creative performance. There are, however, many factors, such as environment, emotions, expertise, intrinsic motivation, etc., that enhance or improve the creative abilities of people. The aim of this chapter is to understand the relationship between emotions and creativity. Emotions are not a button one chooses to press or not to press. It is not thought or learned; it erupts when triggered by a phenomenon or a situation. Let us consider the emotional expression of a newborn. Have you ever wondered how newborns get to know how to cry? Most newborns announce their presence into the world with shrill noise referred to as Vitalis or the cry of life. Scientists have over the years tried to understand the message being communicated by the newborns through Vitalis without success, except to indicate that it is an expression of emotions of either distress or discomfort of being transitioned from one environment (womb) where they were completely dependent on their mother to a life outside the womb where

the baby has to depend on their own lungs to survive. Though science has not been able to decode the message of the cry of life, science tells us that the cry of life is an important expression in the first few minutes of human life. The lack of it, how high or low, and how persistent tells on the kind of attention, urgency of attention, how intense or detailed examination the child will receive. The universality and the tender age (day one) at which this expression of emotions occur make it clear that emotions are a natural and vital occurrence in the life of every human being. It is safe to say that every human being at one time in his or her life have encountered a situation where a story, movie, photograph, poetry, artwork, and music stirred up some emotion within them [1].

While the exposure to the creative work of people spurs the emotion of their audience, followers, or collectors, we also know that for people to achieve the impactful creative performance, they try to connect to certain emotions to power their creativity. They go to great lengths to transfer that emotional power into their creative works to captivate and inspire their audience to follow them or be hooked on their work or their person. Great artists such as Whitney Houston, Michael Jackson, Tailor Swift, Kojo Antwi, and Ibrahim Mahama have always been inspired by their emotions. Love, pain, fear, rejection, and several other emotions have invoked creativity in people over the years. Yet, the subject of emotional creativity is the least researched or discussed topic in creativity. Before we zoom in to what emotional creativity is all about, let us first try to understand what emotion is. Emotion is a spontaneous psychological and physical reaction, demonstration, or expression of feelings toward an experience or anticipation of a future event. A psychologist has told us over the years that emotions are solely an activity of the brain, but new evidence has shown that this is not the case. The Institute of HeartMath, a research center specializing in the study of the physiology of emotions, has identified a relationship between emotions, the brain, and the heart. The research center explains that as we encounter or anticipate an experience, erratic patterns are sent to the emotional centers of the brain by the heart and the brain responds with signals to the heart and body in forms known as feelings [2]. These findings are affirmed by the James-Lange theory, which states that witnessing or experiencing an external event leads to a physiological or physical response [3]. For instance, if you come into contact with a bear on a lonely street on a usual night walk, your body will start to tremble and then your heart will start racing, which will send signals or patterns to the brain; the James-Lange theory suggests that the brain after receipt of the signals will interpret the physiological or physical reaction as being frightened [3]. The signaling of the body to a particular emotion leads us to the making of decisions and choices. When the brain tells me that I am frightened at the sight of a bear, I then make a decision to run, scream for help, throw something at the bear, or remain calm. We make several choices in terms of what to eat, wear, where to go to, who to visit, and the tone to communicate with based on our emotions. It is, therefore, imperative to understand the intricacies of emotions, starting with the types of emotions and how they influence our actions and abilities especially in terms of creativity or creative performance.

2. Types of emotions

Paul Eckman advocated in 1972 that there were six basic emotions in the universe: fear, disgust, anger, surprise, happiness, and sadness [4]; this was expanded to include joy and acceptance by Pollack [5] in later years. Robert Plutchik in 1980,

however, argued that humans do not necessarily exhibit one type of emotion in reaction to a particular situation all the time. He opined that in most cases, there is what is called "mixed feelings," where two or more emotions combine as an expression over a situation. Therefore, though phycologist tells us that there are about 34,000 emotional feelings, American psychologist Dr. Robert Plutchik have argued that the 34,000 emotions are the permutations of the eight distinctive primary emotions that serve as a foundation to any form of emotion [6]. These are joy, sadness, surprise, disgust, anticipation, anger, acceptance, and fear [5, 7]. These emotions trigger certain physical and physiological activities in the body or brain such as crying, laughter, jumping, hugging, writing, dancing, or sicknesses such as depression and high blood pressure. This activity is often termed creativity depending on how unique, beneficial or detrimental, and visible the activity is to a third party, society, or the individual. When the activity is unique, visible, and beneficial and awakens the expression of joy, excitement, and surprise especially to many people, it is termed creative. When it is unique, visible, and detrimental and awakens the expression of sadness, shock, sorrow, and pain to anybody, it is termed the dark side of creativity. Continuing from the example of the bear in the last paragraph, if the person's reaction after being frightened leads to a unique or new, beneficial, or detrimental activity or a project upon seeing the bear, there establishes a link between a person's emotions and creative abilities. According to Hoffmann [8], emotions and feelings are intricately related to creativity, in that reactions triggered by emotions often lead to a person burying himself in work to develop a product, writing a poem, or development of "lessons learned," which becomes a solution to other people's problems.

2.1 What is emotional creativity?

Emotional creativity is defined as "a pattern of cognitive abilities and personality traits related to originality and appropriateness in emotional experience" [9]. It is a critical component in the creative process. It is the ability to create something new through the influence of emotions evoked from the personal or experiences of others. Creative works inspired by emotions are often original and greeted with Euphoria.

More often than not, people misconstrue emotions to be feelings or moods and even use them interchangeably, thus wondering how such traits can lead to creativity. There are, however, differences in these variables [10]. These differences are determined according to the timing of occurrence of these variables when a situation occurs, warranting emotional, feeling, or mood response and also the level of involvement or interactions with certain organs of the body. Emotions are triggered as a form of response to a situation; it involves interaction between the brain, the heart, and other organs of the body. Feelings come in mostly second after emotional processes have occurred, and the person is brooding over the issue and one feels physical and emotional sensations. It does not necessarily have to involve the heart; it is the reason someone can "feel cold" because of cold or icy weather, which has nothing to do with the heart as compared to feeling emotionally cold toward someone. It usually lasts longer than emotions. Moods are usually not necessarily triggered by an event, situation, or circumstances; there are times when people just wake up from sleep and claim they are not in the mood to talk or they are in a good or bad mood. In such circumstances, they sing all day when in good mood and when in bad mood wear a frown all day and bark at the least provocation; these scientists have attributed to the activities of "mood swing" hormones such as estrogen and progesterone. In situations where it occurs because of a specific situation, it can occur before feelings or after feelings have been expressed.

In all these variables, however, the determining factor for creativity or creative performance is what Psychologist Eddie Harmon-Jones calls emotional and motivational intensity. The intensity of emotional feelings, such as joy, anger, sadness, etc., generates motivational intensity, which provides the impetus for creativity [11]. According to motivational intensity theory, low motivational intensity broadens attention leading to the search for new goals to pursue. The discovery of purposeful goals increases the level of intensity for creative performance [6]. When the search for goals to pursue under low intensity is not discovered, boredom sets in, which sometimes leads to depression, stifling creativity. High motivational intensity narrows attention and focus leading to the completion of a specific goal. High intensity, therefore, fosters a high level of creativity [6]. Many argue that motivational intensity is a more important factor and a driving force in determining emotional creativity than the positivity and negativity of emotional experience. However, critics have been quick to point out that the positivity and negativity of emotional experiences form the basis for motivation. These critics have explained that the positivity or negativity of emotions is what motivates people to behave in a certain way, which sometimes leads to creative performance, and that if negative or positive emotions were not to exist, the motivational intensity would not exist for creative performance to happen. For instance, when someone is excited, the positive emotion is what will motivate the person to act in a manner, which exudes joy, and if they have been angered, then that negative emotion will motivate them to act violently against the person who offended them.

2.2 Positive versus negative emotions

Positive and negative emotions are inevitable in life; life experiences impose such emotions as part of human development or maturity. A positive emotion can be described as a pleasant feeling in reaction to a situation or a circumstance, while a negative emotion is explained as an unpleasant and undesirable feeling in reaction to a situation or a circumstance. Some examples of situations or circumstances that awaken some pleasant or unpleasant are discussed in the following. Let us consider a situation where one loses a loved one. The act of losing the loved one is the person's situation or circumstance; the expression of the emotion of sadness, sorrow, or emptiness is the feeling in reaction to an unwanted experience described as a negative emotion. Similarly, the joy of earning one's first paycheck after school is the person's circumstance, and the expression of the emotion of ecstasy is the feeling in reaction to a beautiful experience described as a positive emotion. As has previously been discussed, emotions are not always experienced or expressed in their pure forms as posited by Robert Plutchik; people sometimes experience a mixed form of these emotions [4]. For instance, getting married could invoke several different emotions, such as joy, anxiety, and fear of the unknown, in one person at the same time or at the varying time; in other words, the person is experiencing or is in a certain situation but experiencing different emotions. The mixed feeling, however, often occurs when the situation or circumstances are either within a period of expectation or situation not in finality. When the issue invoking the mixed feeling comes to finality in most cases, the individual experiences either a positive or negative emotion.

On March 10, 1999, Paul Njoroge kissed his wife Carole, three children Ryan, Kelly, Ruby, and his mother-in-law who were on board Boeing 737 Max goodbye. They were taking a short trip and were expected to return soon. He had barely made his way out of the airport when he heard from news update that the plane had crashed. He was in a state of fear and anxiety but at the same time filled with hope that God

will intervene and keep members of his family alive. All these mixed emotions engulfed his being as he drove defenselessly to the airport. A crowd of anxious relatives of persons on board the plane was mounting up. As information flow stagnated and the confirmation of survivors delayed, anger began to consume Paul's being, yet he hanged on to the slim rope of hope. He edged away from persons who had given up hope and were wailing even before hearing from officials. He did not want to entertain the thought of losing his entire family. When official confirmation reached Paul that there were no survivors and all 149 passengers had died, all hope of seeing his family immediately disappeared. He moved from fear, anxiety, and hope to anger and now pain and loneliness. Paul has since then been living with friends; he cannot bear to return home to see the shoes of his children at the living area where they had left them that day. He has a flashback of their tiny feet in those shoes, but he knows he will never see them running around the house or making noise again. Paul declared that he could never return to his house; the pain and the loneliness come alive whenever he pictures his family in that house. How Paul decides to channel this highly intense emotional trauma will determine an outcome that would be categorized as a creative performance or not. If the outcome is categorized as a creative performance, then we say his emotion has powered creativity; thus, emotional creativity has been fostered through his experience.

Negative emotions often power creativity in solitude or are championed as a solo project, while positive emotions often occur within a team. While the creative outcome of positive emotions is very helpful and impactful, it does not often strike a deep emotional chord in third parties as negative emotions do. Think about it, how many songs, artwork, architectural work, and discoveries that captivated the world were inspired by positive emotion, very few. However, if we were to survey many organizations to find out the number of groundbreaking inventions that were carried out because someone had the confidence, hope, and passion to invent, it will be numerous. Examples of creative performance or creative work inspired by positive performance though existing and prevalent, the outcome is often not traced to a specific positive emotion because positive emotions are difficult to sustain for a long period and often not centered on one person. The creative performance or creative works of negative emotions, however, gain popularity very easily, mainly for two reasons. First, negative emotions linger longer than positive ones; hence, the required intensity to motivate or inspire a creative work is often sustained until the completion of the work. Second, in many cultures around the world, people are brought up or trained to be empathetic and conditioned to think that empathy is feeling another person's pain. So, although empathy is understanding and sharing the feelings of others, the "feelings" in the definition of empathy have been replaced with pain. Therefore, when someone develops a creative piece and shares his source of inspiration for the work and has a tint of negative emotions, such as pain, rejection, loneliness, etc., there is the tendency for the work to enjoy the widespread expression of empathy leading to acceptance and popularity.

Negative emotions at the workplace are often not welcomed in organizations. Such negative emotions, like jealousy and envy, could be detrimental to the creative and general performance of an organization [12]. A person envious of a colleague could frustrate efforts at developing a creative process or product just so recognition for good work does not go to someone other than him or her. Positive emotions that are highly desirous in organizations tend to inspire, engage, and empower the team to creative performance. Joe Forgas, a social psychologist, asserts that though negative emotions are often assumed to be detrimental to creativity or humanity, they

sometimes catalyze creative production [11]. He explained that although both positive and negative emotions take varying paths, they can both lead to creativity. Joe Forgas posited that while positive feelings stimulate creativity out of the satisfaction of life, negative emotions such as sadness sharpen attention, making a person more focused and diligent toward creative performance [11]. Happenings around the world tell us that creativity and creative performance are not always an outcome of positive emotions; negative emotions can also generate creativity depending on where the aggressiveness that usually characterizes such emotions is channeled. Let us consider some notable examples of how negative emotions inspired some artists to capture the attention of the world with their creative work.

2.2.1 You're beautiful (song): james blunt

"You're beautiful" when released in 2005 as a single reached number 1 and 2 on music charts in the UK and Australia, respectively. It reached number 1 in music charts and airplay in Canada and the USA leading to the song-winning Ivor Novello award for airplay in 2006. The song sold 625,000 copies in the UK and over three million copies in the USA [13]. It is the first single to reach number 1 on music charts in 10 major cities in the world, including Spain, Mexico, Canada, the USA, the UK, and The Netherlands. It was the first American Idol song to become the number 1 song on the USA billboard hot 100 [13]. The song received three Grammy nominations in 2007 and won the BMI Internet Award for most plays on BMI-licensed websites in 2007. This song that received global subscriptions and airplay was inspired by a negative emotion experienced by the writer and singer, James Blunt [13]. Blunt confirmed on Oprah Winfrey's show on March 8, 2006 that the inspiration for the song was from a place of misery. He told the audience of how he spotted his ex-girlfriend at the Underground in London with her new boyfriend; this stirred in him an unwanted emotion, which inspired him to write a song that reached number 1 in major countries and sold over 3 million copies in the USA alone in just 2 minutes [13].

2.2.2 Candle in the wind (song): elton John

When Elton John, a UK artist, heard of the death of Princess Diana, his close friend, he went into a devastating depression. Elton John felt he had to pay tribute to his friend through a song, but the time was too short; he, therefore, contacted his writing partner Bernie Taupin, and the words of Candle in the Wind originally performed in 1973 were rewritten to depict the pain of losing his friend Princess Diana [14]. To date, Elton John has performed the song only once at the funeral of Princess Dianna, but when the song "Candle in the Wind" was released as a single after the funeral, it broke records by being number 1 in a large number of countries, which was affirmed by the Guinness Book of Records as the biggest-selling single of all time [14].

So far, we have discussed creativity in terms of tangibility. Often when we talk or think about creativity, what comes to mind is Mona Lisa paintings, iconic buildings, or beautiful songs or poetry, things we can see, touch or hear but what of the process of ideation? How does our emotion relate to or influence our ability to generate new or fresh ideas to solve problems. The answer is creative thinking; it is not very different from what we perceive creativity to be because before one will decide to write lyrics to a song inspired by a particular emotion, the development of the idea is first constructed in the mind before it is written and sung. Researchers at the World Economic Forum suggest that creative thinking is one of the most essential skills needed by

work professionals or skilled workers and future leaders [15]. Creative thinking has been described as nurturing one's imagination to perceive possibilities aimed at developing ideas to solve problems or create something new. The emotions impact creative thinking in similar ways as has been previously discussed. It is instructive to note that, while negative emotions are not desirous at workplaces and positive emotions are perceived to be idle for creative performance at the workplace, this line of thinking could be misleading. If positive emotions necessarily lead to creative performance at the workplace, then all advertised job vacancies would indicate a preference for sanguine personality trait as a key job requirement since it is perceived to spur positive emotions, an assertion shared by Bojanowska and Zalewska [16], who have categorized the sanguine personality trait as a happy temperament. While emotions such as happiness, enthusiasm, and confidence inspire creativity and increase productivity, those same traits could become a source of destruction in the organization. Some employees in expressing happiness or joy go about drinking, playing loud music, chitchatting, and gossiping, which tend to destruct others from working and make the company lose productive time. Negative emotions such as anger and resentment borne out of being denied promotion if controlled can be used as motivation for personal improvement [17]. This presupposes that, that not all emotions whether positive or negative lead to creativity and creative performance, there must be a deliberate attempt at controlling or stirring the emotion toward a creative outcome; to do this, one needs a special skill referred to as emotional intelligence.

2.3 Emotional intelligence

Emotional intelligence is the mindfulness and evaluation of one's own emotions and that of others to control those emotions for purposes of influencing emotional outcomes for greater creative and productive performance [18]. The findings of recent research by Anderson [15] indicate that our ability to use our mind to understand emotions within our space or impact on our environment and control that emotion to the extent of developing new ideas or solving problems creatively is an art of emotional intelligence and application toward the achievement of organizational objectives [19]. Moore [20] posits that people who have a high level of emotional intelligence can manage the relationship in a manner that fosters creativity by showing a high level of emotional constraint and empathy, which correlates with leadership effectiveness, team success, and employee performance [20]. Emotional intelligence provides the opportunity for people to be aware of how emotions influence creativity and performance to harness specific emotional states of the person or employee for developing creative solutions within the organizational or personal goals. This is affirmed in a study conducted on young business professionals [21], where it was established that emotional intelligence improves moods, and persons with emotional intelligence can turn good moods into creativity at the workplace. The findings of this study collaborate with a Yale-led study reported in the *Journal of Creative Behavior*, which explains that leaders who possess emotional intelligence have the tendency of fostering happy moods and creativity in the organization [22]. The Yale study conducted by research scientist Zorana Ivcevic and colleagues at the Yale Center for Emotional Intelligence surveyed close to 15,000 people in the USA to assess the level of emotional intelligence of leaders and the impact on the work of employees [22]. The research, which was conducted in 2017, indicated that 70% of employees whose leaders showed little or no emotional intelligence described their emotions and moods in the work environment in negative terms and showed no signs of being intrinsically

motivated to either work or be involved in any creative work at the workplace [22]. This was in sharp contrast in work environments with emotionally intelligent leaders. Employees with emotionally intelligent leaders appeared to be happy, fulfilled, intrinsically challenged to be more creative and contribute toward the achievement of work goals [22]. Emotional intelligence empowers a leader with the right skill to create a conducive work environment to accommodate varying views, ideas, and to refocus employee emotions to drive creativity and innovation [23]. The leader or organization does not always embrace the drive for creativity at the workplace, which sometimes leads to negative emotions such as disappointment, pain, or betrayal.

A story is told of how Spencer Silver, a scientist at 3M in 1968, set out to create adhesive for aircraft, but the adhesive turned out to be weak, and his creative work was rejected and put aside by the company [24]. Years later, when Art Fry, a chemical engineer in the same company 3M, experienced negative emotions of frustration, disappointment, and pain of losing his place in the choir, he used some of Spencer's adhesive to coat one side of a paper to mark some pages of the hymn book. He realized that after unconsciously pasting and removing the paper with Spencer's adhesive at the same spot in the hymn book, the page of the hymn book was not destroyed. When he realized the potential value of the paper with adhesive, he quickly brought it to the attention of his superiors; surprisingly, he was ordered to stop work. Art Fry, however, ignored the orders of his superiors, bypassed laid down procedures, and continued working on the project using the company's equipment without permission. The company eventually identified the usefulness of Art Fry's creative work, which became known as Post-it and manufactured it [24]. In this story, we realize that the creative performance led to the profitability of the company, but the act of defiance of superior orders and scholars [24] categorize dishonesty in use of the company's asset at the time when the project was a personal one as the dark side of creativity. According to Professor Francesca Gino, of Harvard University, and Professor Dan Ariely, of Duke University, creative thinking makes people justify wrongdoing or dishonesty as long as they aim to or achieve creative performance (e.g., "I am not stealing this; I am just borrowing it; I will return it as soon as I am done") [24]. They posit that this behavior is a slippery slope: once an individual begins to justify or make the excuse for such wrongful behavior, they are likely to engage in the dark side of creativity [24].

2.4 The dark side of emotional creativity

Can a person's emotion lead to bad or dark creativity? There is a current debate as to whether creativity can be considered bad or dark or whether it is the intent of the use of the creative idea or product, which can lead to creativity being categorized as dark. Several research studies, such as [25, 26], argue that creativity does have a dark side if we consider not only the harmful application but the moral or ethical processes of creative ideation or performance as well. The argue that the excitement, passion, joy, or desperation of creating something new or achieving something that can transform a person from an unknown figure to a celebrity or public figure motivate people to use all means, including dishonesty, to attain a creative performance goal [25]. Such people tend to have high moral flexibility (i.e., making excuses to make unethical behavior appropriate) [25] and use it to cure themselves of guilt. If we were to go by this assertion, then most people may have engaged in the dark side of emotional creativity without even knowing. Reflect over the number of times, you were late for an appointment, and out of fear of losing a contract, you conjured and told a very beautiful and believable story to your client. Or the time when someone with amorous

feelings toward you gifted you with something valuable, and when your spouse found out, you told her a story of how you were going to surprise her with it. In all these scenarios, the lie may be original, creative but did not harm anyone; hence, some will say, this is pure ingenuity and there is nothing dark about it since it did not harm anyone. However, persons who believe creativity has a dark side argue that the use of creative thinking to tell lies or deceive someone into acting in a certain way or believing something that does not exist has demonstrated the dark side of creativity.

The argument then arises that, if a notorious criminal uses deceptive but creative means to lure another wanted criminal to aid in police intelligence, will that be considered as purely creative or still darkish? Some scholars [27] assert that some creative performance adjudged as dark creativity should simply be described as creativity and that there is nothing like bad or dark creativity. This is because a creative idea or a creative piece in itself is not bad or dark, but the application of the same is what makes it bad; hence, discussions of the dark side of creativity should be centered around malevolent creativity [27]. Jia et al. [6] explain that often when people talk about creativity, they are referring to benevolent creativity, which has to do with developing or coming up with new, original, and useful ideas or products, but what is often left in the back burner is the malevolent creativity, which involves the application of the new or original idea for harmful purposes. The aspects of change or novelty, which we categorized as creativity, are those that brought improvement into our lives, business, or the world, and creators of such novelty are referred to as creative geniuses [28]. Some notable persons who readily come to mind are Michelangelo, Mozart, and Picasso who are recognized for their wonderful work of arts and Thomas Edisons, Henry Fords, Albert Einsteins, and Marie Curies who are lauded for their groundbreaking discoveries in science which changed the way the world operates [28].

Prof. Susan Krauss Whitbourne in her article titled "Does Creativity Have its Dark Side?" explains that a creative piece may not have an original intent of causing harm, but someone can apply creative thinking to that same creative piece to cause harm [28]; hence, describing the dark side of creativity from the perspective of its malevolent situates the dark side of emotional creativity in proper context. She cites the example of Facebook to describe how developers of the app created a novel product to promote social interaction, but some users use the app for cyberbullying. The app was developed for a good purpose and most people use it for the good purpose of marketing their products or social interaction, but some use it for the evil purpose of cyberbullying and circulating false news. Would such a creative product be said to be darkish just because some people are applying it in a harmful way? Runco [27] posits that in such situations, the act of causing harm should be categorized as malevolent, but the creative piece or the creative thinking behind the harm is simply creativity and not dark. It is, however, clear from most contemporary research, including that of Prof. Susan Krauss Whitbourne, a Professor Emerita of Psychological and Brain Sciences at the University of Massachusetts Amherst, that the description of the dark side of creativity or emotional creativity is about malevolent creativity.

2.4.1 Malevolent creativity

Malevolent creativity refers to creative ideas, creative thinking, creative performance, and creative works aimed at harming someone or with destructive consequences only [6, 28]. Malevolent creativity manifests in many actions such as telling lies, dishonesty, terrorism, spreading false information, theft, bullying, and any form of abuse. Research into factors influencing malevolent creativity indicates

that while social climate, cultural atmosphere, and environment affect a person's malevolent tendencies, emotional manifestations of childhood neglect are a major cause. According to Jia et al. [6], the results of the research indicate that persons who experience childhood neglect or grow in antagonistic family settings are more likely to develop malevolent creativity in their adulthood. The findings also indicated that such individuals have difficulty in emotional recognition and regulation and, hence, have low emotional intelligence [8]. The study also found that such persons are reflective, analytical, and tenacious in their cognitive processes [6, 29], making it possible for them to draw on emotions from their childhood to inspire or motivate them to generate novel and expedient ways to attain their objectives of inflicting pain on people or damaging society as a form of revenge [8]. This finding was consistent with social information processing theory, which suggested persons whose childhood was characterized with destructive behaviors perceive neutral social information differently and interpret them as threatening, hence making them prone to acting aggressively that could induce hostile decisions, making them ready to fight [6, 30]. In all this narrative, emotions come into play. The emotions of loneliness, pain, and anger lead to a desire for revenge. When the desire for revenge meets opportunity or power, malevolent creativity is created to show the dark side of emotional creativity. This reflects the story of Adolf Hitler.

2.4.2 Example of the dark side of emotional creativity: adolf Hitler

New York Times of 1986 reported details of a play by Niklas Raadstrom, a Swedish poet, based on a childhood story of Adolf Hitler written by Alice Miller, which depicted how Adolf Hitler's personality and deeds were influenced by emotional and physical abuse suffered in his childhood [31]. The story recounts how Adolf's father, Alois, constantly beat and humiliated him. Aside from the beatings received, he was trained by his father to hide his pain by forbidding him from crying or showing pain when abused or humiliated [31]. Adolf Hitler's memoir recounts times when he proudly counted the strokes received from his father without shedding a tear and shared it as an achievement with his mother [31]. With his mother grieving over the death of three other children, she never had time to protect Adolf or care for him. He, however, loved his mother because on a few occasions she shielded him from the tyranny of his father out of fear of losing another child. It is mentioned in his memoir how he cherished the few times he slept on the same bed with his mother when his father was away. He often longed for that closeness but did not get much of it. He felt more neglected than belongingness. He had no one to turn to when the pain from the abuse or humiliation was unbearable or when confused, he was lonely, unhappy, and grew in that positive emotionally deficit state [32]. How this person who struggled with his grades in school except drawing and even getting a job later in life managed to scheme his way through the army and later lead Germany and the greater part of Europe baffles many. Hitler who was known as a propaganda genius relied on his oratory skills and capitalized on widespread discontent, political infighting, and economic instability in Germany at the time to develop strong propaganda leading to Hindenburg naming Hitler a chancellor in 1933 and later gaining absolute power. Upon assuming power, his government passed a law, making Germany a one-party state (Nazi Party the only party in Germany). When that objective was achieved, he turned his focus on Europe where he invaded Poland in 1939, which led to the outbreak of World War II. He spread his tentacles, and by 1941, Nazi forces occupied most of Europe and murder over six million Jews. He committed suicide in 1945.

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Hitler was not born evil as most people describe him to be; he was born innocent like any other child. However, his destructive upbringing, which not only led to negative emotions but also encouraged concealment of these emotions, made him deny pain just so he could survive [33]. The emotions of powerlessness felt throughout the years of having to endure pain and denying the truth of pain, shame, and loneliness turned the innocent baby Hitler into a malicious person who equipped himself with the skill of designing schemes to amass power and inflict pain on human beings. Hitler's action was creative as most people could not discern his objectives and was dazzled with the depth of wickedness and contempt for human beings [33]. The emotions of hatred, anger, and revenge inspiring or motivating his actions were so intense; his aggression was merciless making his creative thinking and outcome stand out with far-reaching consequence.

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Section 2

Creativity Learning

Chapter 4

Promoting Curiosity, Creativity and Clarity in Management Education

Christian Walsh

Abstract

In order for management education to move beyond the analytical thinking of the last century to promote creative thinking more appropriate for today's organizations we need to build new courses that allow for organic flexible approaches to building diverse types of knowledge. We need to nurture student curiosity and encourage them to delve deeply into unknown fields. By approaching problems with curious humility they can begin to understand the nuances of tensions and trade-offs that exist at the heart of complex issues. We also need to unleash student creativity and support intelligent generative failure in order to learn. They need to learn the skills of experimentation in order to test ideas in uncertain contexts. We also need to promote clarity of purpose and communication that will enable innovation to be implemented and have positive impact in the world. In this chapter a new process model covering each of these aspects is described along with an illustrative example of how this has been applied in a redesigned MBA course over the last 5 years.

Keywords: curiosity, creativity, clarity, education, innovation, management

1. Introduction

Creativity has been repeatedly identified as an important factor in the growth and development of organizations and society as a whole, yet is a complex and difficult subject to examine and understand [1]. Managers and leaders of modern organizations need to be able to facilitate creativity and innovation in uncertain environments. Taha et al. [2] said, "creativity is seen almost as a prerequisite to manage change and renewal, it is a key skill for leaders and organizations" (p. 1921). It has been said that creativity loves constraints [3] and so at a time when many organizations feel under increasing pressure and constraints seem aplenty, creativity offers one means of relieving some pressure and navigating an uncertain future. Yet creativity alone, generally defined as the generation of novel and useful ideas [4], is not sufficient. This is because novel and useful ideas by themselves do not create and capture value for a business, its stakeholders or society. In order to do this creative ideas need to be implemented in practice and in so doing become innovation [5]. In the words of Robinson [6], noted for his work on creativity in education, "Innovation is applied creativity"

(p. 142). Creativity itself can be viewed as a process [7] and is clearly an essential part of innovation, but it is just one part of a broader process. In order to help managers and leaders get the most out of creativity, particularly in challenging times, we need to do more to help them understand both the process of creativity, but also how this is applied in practice and therefore how it relates to the broader process of innovation.

Most management education, including MBA programmes, still focus on discipline specific knowledge, largely developed through analysis that draws on theories that were created in the relatively stable environments of the last century. Today's managers and leaders face more turbulent environments and so need to develop skills based on synthesis, creativity [8, 9], experimentation [10], and learning from intelligent failure [11–13]. Walsh and Powell [14] said, "solutions to the wicked problems offered in contemporary society require creativity and innovation—aspects that may be difficult to incorporate into the curriculum of a functionally oriented MBA programme" (p. 150). More creative approaches to modern management education are therefore required.

In order to educate managers and leaders to have a better understanding of creativity and innovation we need to first look upstream to what enables creativity. Creativity within organizations is notoriously stifled when restrictive organizational culture does not support, or even suppresses, novel thinking. Such cultures do not encourage questioning the status quo, itself defined as a key factor in encouraging innovation [15]. An inherent assumption that we know what we are doing and we have done this before is ultimately what can spell trouble for organizations when they encounter volatile, uncertain, complex or ambiguous situations (VUCA) [10]. The thinking and approaches that were successful in the past do not necessarily translate to success in the future in such conditions. One of the key attributes or mindsets that enable organizations to better navigate these conditions is curiosity [16]. Having an open and enquiring mind enables people to challenge long held assumptions that come under strain when conditions change. Simply asking why is sometimes seen as challenging authority but is more often a sign of healthy curiosity. Asking such questions enables people to discover what sits beyond the obvious and brings new understanding. Nurturing curiosity in organizations is necessary for enabling more creative and ultimately innovative solutions to wicked problems.

Similarly we also need to better understand and educate managers on how to apply creativity in order to drive innovation. In other words how to implement creative solutions in order to create and capture value. Successful innovation rates continue to remain low and frequently it is this implementation link that is the major barrier [17]. A mindset that helps enable implementation of creative solutions is clarity [16]. Having clarity of purpose and being able to communicate this succinctly makes it much simpler for others to understand the relevance of any innovation for them and therefore decide when to support the change. Again this becomes more relevant in VUCA environments because implementing change in new situations often involves drawing resources from beyond an organization's current asset base. Being able to draw on open approaches to innovation and form mutually beneficial partnerships are often required [18]. As a result designing for implementation should be considered an essential element of the innovation process, rather than something that is carried out afterwards, as with many current innovation process models. Again this is something that is enabled by clarity.

This chapter will fist look into curiosity, creativity and clarity in further detail including their relevance for leaders and managers. It will then bring them together to

describe an overall innovation process based on phases of discovering, understanding, creating, testing, resourcing and implementing (DUCTRI). An illustrative case will then describe how this process has been fruitfully deployed and refined in an MBA course over the past 5 years.

2. Curiosity

> *"Around here, we don't look backwards for very long... We keep moving forward, opening up new doors and doing new things because we're curious... and curiosity keeps leading us down new paths"—Walt Disney.*

Curiosity has been described as being essential for human learning and achievement. As broadly defined by Kashdan et al. [19] curiosity is "the recognition, pursuit, and desire to explore novel, uncertain, complex, and ambiguous events" (p. 130). In order to help leaders and managers get curious about curiosity, recent research suggests there are five distinct types of curiosity [19]. Firstly there is the pleasurable experience of discovering something new and finding it intriguing. This is referred to as joyous exploration. This is where people have a love of learning and are generally fascinated about new things. While this aspect of curiosity is therefore associated with positive emotions, the next is more closely associated with negative emotions. This second type of curiosity is known as deprivation sensitivity. This is the sense of frustration caused by the awareness that there is something unknown that is desired to be known. Here people may be annoyed or anxious until they are able to resolve the information gap. The third aspect of curiosity is stress tolerance. This is the result of first noticing that an event is new in some way and worthy of attention, but then being able to cope with the stress associated with navigating the potential uncertainty. The fourth type of curiosity is the reverse of stress tolerance, where rather than just tolerate this stress people actively seek it. This is referred to as thrill seeking and is where the arousal from a novel situation is not something to be reduced but instead is amplified and what makes the situation desirable. The fifth type of curiosity is social curiosity. This is where we are seek information about other people and enables us to empathize with others. This comes about in two ways. Firstly through direct interactions with others we satisfy overt social curiosity to find out about others. And secondly, by indirect means we can have covert social curiosity which is most often used as a means of building self-esteem by comparison with others.

Research into curiosity in organizational settings has found that increased curiosity in an organization leads to greater levels of creativity and innovation [20–23]. But it also supports better decision making, reduced conflicts and allows more open communication [24]. However, while the benefits are well established, organizational culture still often gets in the way. One study found that while 83% of executives say they encourage curiosity, only 52% of employees agreed [25]. Gino [24] suggests that two key reasons for this is that leaders think allowing employees to follow their curiosity will make the organization harder to manage. And secondly, particularly established managers tend to focus on efficiency improvements rather than exploratory efforts. Similarly Kashdan [26] suggests that to encourage greater curiosity in organizations managers need to encourage rather than supress questions internally, emphasize user observations rather than relying on customer surveys, and actively seek different perspectives when making decisions.

3. Creativity

> *"Making the simple complicated is commonplace; making the complicated simple, awesomely simple, that's creativity"—Charles Mingus.*

In helping leaders and managers think about creativity as a process we can look back to a very early model of creativity which was proposed by G. Wallas [27] which was based on his analysis of the thought processes of physicist Hermann von Helmholtz, mathematician Henri Poincaré, and several other artists, when generating their significant new works. He identified four common phases they each went through and described the psychology of each phase. The first step was described as preparation, where an individual focusses on the problem at hand and builds conscious knowledge based on what currently exists in the field, leveraging curiosity. Secondly he suggested there is an incubation phase during which the problem is internalized and the subconscious works on the issue for some time. This is often the most difficult to allow for in organizational settings where time pressure is ever present. But when seeking creative solutions to wicked problems this is a key reason not to rush the creative process. It takes some time for the subconscious to process and create novel connections. Then there is an intimation or feeling that the solution is near. The third phase is the illumination where the creative solution is forthcoming to the conscious mind. Finally then there is a verification phase where the solution is checked, tested and modified by the conscious. This model of the creative process has stood the test of time and while there has been some debate over the nature of some of the elements remains one of the standards in the psychology of creativity [28].

Another model of creative thinking that is helpful for managers and leaders is based on divergent and convergent thinking. In 1950 in his address as the President of the American Psychological Association, J.P. Guilford decried the lack of studies scientifically examining creativity stating that such neglect was appalling given the importance of creativity to societal wellbeing [29]. He went on to develop a model of intelligence in which he identified divergent production, or the ability to generate multiple options, as a key operation in creative ability [30]. This is then coupled with convergent thinking where we make decisions on a range of options. Basadur et al. [31] proposed a three stage model of the complete creative problem solving process in which each stage consists of a divergent-convergent thinking pair. The three stages are problem finding, problem solving and solution implementation. This inclusion of implementation in the process means by current definitions we would refer to this as innovation. Again in organizational settings there are challenges particularly in encouraging true divergent thinking. Management education has something to answer to here as most subjects and disciplines have been dominated by analysis and theories which help managers narrow their options and make decisions with the information they have, which is classic convergent thinking. Most managers and leaders then have spent much of their careers in convergent thinking modes at the expense of divergent thinking. Management education can learn from arts based education [14] and needs to encourage tools and techniques to promote divergent thinking.

An alternative creativity process that is also helpful for managers and leaders to understand is creative synthesis [32], which can also be referred to as integration or bisociation [33, 34]. Synthesis comes about when the intersection of diverse fields of knowledge come together to create a new amalgamation that is in itself novel and valuable. Particularly in organizations this has significant implications about the value of diversity and the nature of conflict in the creative process. Having diverse

views, skills and experiences in the organization enables greater creativity because it is when these different planes of knowledge can be bought together is where more creative solutions can result. This is particularly true for wicked problems where if a group all has similar perspectives on a problem they will tend to approach the problem in the same way, and so all get stuck at the same point. By having diverse perspectives involved it often means problems can be approached from multiple different angles providing different ways around obstructions and more creative solutions are uncovered as a result. But managing diverse views can mean dealing with conflict. Creative conflict should be seen as a healthy part of the process and organizations that manage this well ensure that ideas are regularly challenged but avoid it becoming personal [35]. When seeking synthesis, opposing views should be bought together to create unique shared understanding. Again organizational leaders and managers have often been trained out of using synthesis as opposed to analysis. In his influential critique of the formulaic approach to strategic planning and analysis in large organizations H. Mintzberg [36] stated that, "Strategic thinking, in contrast, is about synthesis. It involves intuition and creativity" (p. 108).

In terms of organizational creativity many researchers have been focussed on the apparent tensions between aspects of organizations that may hinder employee creativity, such as structure, direction and predictability, with those that may enhance it such as challenge, autonomy and experimentation [4, 37]. However this notion of structure and creativity being polar opposites is itself being challenged by viewing organizational processes and practices themselves as being dynamic factors that are in a constant state of change over time. Organizational structures and routines that both constrain and enable action are in themselves being created, enhanced or undermined by people's actions within the organization [7].

Design thinking is a term that has been broadly used to describe a designerly approach to creativity and innovation and is seen as describing a user centric innovation process with phases of inspiration, ideation and implementation [38]. Design thinking has become increasingly popular in industry as a means of addressing complex problems and draws explicitly on many creativity processes. In particular having conscious phases of divergent and convergent thinking are often depicted as a part of the process, including the UK Design council's well used double diamond [39]. However, contrasting the double diamond to the three stage model of a "complete creative problem solving process", discussed earlier [31] highlights that the double diamond and many design thinking process do not pay particular attention to the implementation phase. This is a surprising omission due to the fact that implementation is often one of the most challenging parts of the innovation process [17]. Arguably then many design thinking processes could be described as organizational creativity processes rather than full innovation.

4. Clarity

"Mystification is simple; clarity is the hardest thing of all"—Julian Barnes.

Clarity can be thought of in several ways and each have relevance to implementing creative solutions in organizations. Firstly there is clarity of purpose. Dobni et al. [40] state, "no company can escape the fact that present management principles are becoming a less reliable guide to the future. Clarity is essential" (p. 20). An organization or even individual needs to be able to describe exactly why they do what they do.

Increasingly organizations are being called on to define their purpose and articulate their strategy and impact of their operations. When it comes to implementing creative solutions then, clear alignment with purpose is a significant factor in determining the successful adoption of any new change. This is true for both internal and external stakeholders when trying to build support and gather resources, particularly social capital. If others cannot clearly see how a new initiative supports the stated purpose then they are naturally less likely to engage or support it. If however it has clear alignment with the purpose and this is well communicated then gathering support is much more likely. This also assumes that an organization or individual in question has a clearly defined purpose. If not then often a new initiative is a way of exploring and better defining what this should be. A key tool to help in this endeavor is the use of double loop learning [41]. So often both organizations, and the individuals within them, are tied up in execution of their plans, correcting for any errors or deviance from the plan, they forget to step back and check if this is even the right plan to be executing. Discipline specific knowledge helps us become more efficient in doing things right, building skills in solving specific problems faster and improving processes to eliminate waste. But sometimes this focus on doing things right means that we forget to take time to step back and check if we are doing the right things. This double loop learning means having clarity about why we are doing these things and if necessary challenging the inherent assumptions in place.

Another aspect of clarity is communicating the vision for where the solution will take us which is needed to help overcome resistance to change. As described by C. Heath and D. Heath [42], "Clarity dissolves resistance" (p. 72). In order to affect change there needs to be clear direction that people's rational thinking can see and support. They suggest this comes through showing positive examples of change, as opposed to our natural tendency to focusing on correcting the downside. Alongside this is the need to paint a clear picture of the future state so people can see where this change is leading. There also needs to be a clearly communicated expectation of what specific behavior is required. They refer to this as scripting the critical moves. Resistance to change is often a result of either decision paralysis or decision exhaustion. This may be counterintuitive when generally we think of providing as much choice as possible is beneficial but research has proven that too much choice can lead to people actually opting out of any decision [43]. Alongside these means of appealing to the rational aspects of change they also highlight the need to motivate the emotional drivers for change along with shaping the environment to nudge behavior in the intended direction [44].

5. The DUCTRI model

In response to the need for tools, theories and methods to help people with creative problem solving in uncertain environments design thinking has been widely adopted in industry, and has slowly made its way into many management higher education programmes. Yet many of the existing models that are in use, both in industry and existing management education, do not incorporate the complete creative problem solving process as defined by Basadur [31] and described earlier. The three phases, each with divergent-convergent thinking, should include problem finding, problem solving and solution implementation. While most design process models do a very good job on the first two areas they generally do not include much if any detail on the

final phase. In fact some explicitly stop after the first two phases, for example the UK design council's double diamond. Given implementation is where so many initiatives fail [17] this is a significant shortcoming. These three phases have some broad alignment with desirability, feasibility and viability that are proposed as needing to each be considered in designing solutions [45]. As with implementation, the viability aspects are often not a significant focus of most design thinking models.

This became apparent when the author was asked to take over a new executive MBA design thinking course which had run for a single semester in 2015. The author ran the course for the first time in 2016 using one of the typical design thinking models of the day. The student feedback from these 2 years was broadly positive about the concepts, tools and methods as used in the course but there was a common question being asked that, yes it's good in theory, but how do we implement this in our organization? This led to reexamining the tools and models that were fundamental to the course and alongside ongoing research into the mindsets innovators in industry use [16], a large gap was identified with respect to lack of focus on implementation. The author was also not happy with some of the wordy descriptions for the phases that some models employed which needed simplifying. He also felt that the models needed to highlight the mindsets that support each phase in the process, namely curiosity, creativity and clarity as described above. As a result the DUCTRI (duck-tree) model was created, shown below in **Figure 1**, in 2017 and was used for the MBA class that year. It has been used it as the basis of the course each year with minor refinements in the 5 years since. It has also been used for several consulting projects with industry, and has subsequently been adopted as the core framework for an undergraduate innovation course.

Student feedback is now overwhelmingly positive about this course, the DUCTRI process, and the direct applicability to industry situations. The course was originally an

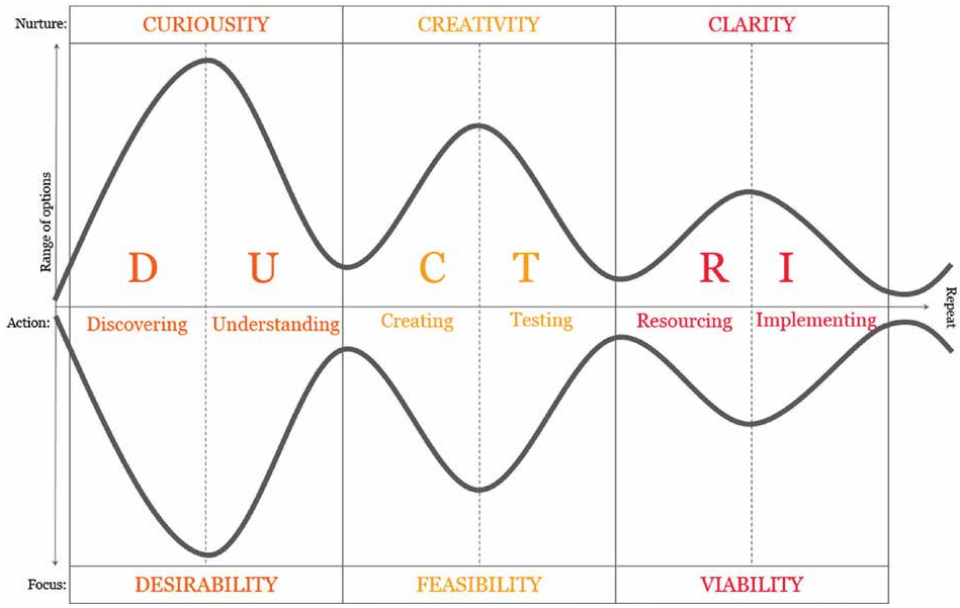

Figure 1.
The DUCTRI model of creative problem solving.

elective but has now become a compulsory course in the MBA structure. Example comments from anonymous student surveys conducted after the 2021 course completed:

> *"Focusing on the DUCTRI model got me thinking outside the square and looking at things from a less bias (sic) approach."*
>
> *"I was not aware of this method. I have realised its value and how I can use and already am using the tools and methods in my work. I feel this course has grown me in my role considerably."*
>
> *"Loved the Design Thinking model that anchored the course learning."*
>
> *"Going through the DUCTRI process was really useful."*

Given that a design based approach to creative problem solving should have a bias for action [45], the DUCTRI model uses gerunds, the noun forms of verbs, to describe the actions that should be being undertaken in each main phase. It also overlays the primary mindsets that should be nurtured in each phase to enable these actions, namely curiosity, creativity and clarity. These also align with the focus in each phase in terms of desirability, feasibility and viability. The model retains the pairs of divergent and convergent modes of thinking as the process unfolds which creates more options and then makes decisions on these to narrow the focus in each cycle. Repeat is mentioned at the end because while a clean linear process can be explained on paper in execution it is rarely so clear cut and loop backs are to be expected and some phases will inevitably need to be repeated, if not the whole process.

The first phase of the process is where we are discovering as much as we can about the problem, who is affected, their world, the background and context of the situation. In this phase curiosity should be encouraged and tools such as empathetic interviews, ethnography, talking with extreme users, analogous empathy, focus groups, card sorts and drawing with users can all be valuable in discovering as much as possible about what is happening. This relies on divergent thinking to explore widely.

The second phase is then understanding what is really going on, making sense of the volume of data from the discovering phase and generating insights into the issues at hand. Again curiosity is the driver and tools such as affinity mapping, empathy maps, developing persona, journey maps, reframing, two-by-two matrices, and defining jobs to be done, can all be useful to help generate insights. This phase engages convergent thinking to ultimately come down to a small number of point of view statements and guiding principles which should be able to capture the new understanding of the core problem.

The third phase is creating where creativity should be unleashed and divergent thinking is employed to generate a large number of options for how the problem could be tackled. How might we statements provide the springboard for tools such as nominal group technique brainstorming, lateral thinking, question storming, five whys, walking for creativity, mashups or working in reverse.

The fourth phase is testing where a sub-set of the range of potential solutions are actively tested to generate further insight and converge on the most feasible solutions. This phase still utilizes creativity where prototyping is used with experimental techniques such as A/B tests, storyboards, wizard of Oz prototypes, role plays and dark horse models may be used.

The fifth phase is resourcing which is a divergent phase because by engaging with open innovation [18] the range of options available for gathering resources, including

economic, social, cultural and symbolic capital are significant. Such approaches include crowd sourcing, crowd funding, strategic partnerships, prizes or competitions, and engaging with incubators. Tools such as business model canvas [46] and pre-mortems [47] should be used to promote clarity and define required resources including fit with existing business models and overall viability.

Finally implementing is a convergent phase where change management considerations should be designed into the solution to enable successful implementation to take place. Again this requires clarity. Tools and models such as the switch framework [42] with the components required to direct the analytic rider, motivate the emotional elephant and shape the path, including nudge theory [44] and behavioral insights [48], help with this phase.

As with any theory, tool or model it is important to acknowledge its limitations. The DUCTRI process is well suited to complex or chaotic problems where cause and effect relationships are unknown, difficult to untangle or have complex interrelationships. The process does take time and effort particularly in the early stages to try and get to the deeper understanding of these causes. So in situations where the cause and effect relationships are well understood then this may be an inefficient process to solve those types of problems.

5.1 An illustrative case

In order to encourage curiosity and diversity in class projects the author employs a method called the project marketplace [49] where all students pitch a problem they are passionate about to the whole class prior to forming project teams. The class then all vote on the problems they are most interested in helping solve and groups form around the most interesting problems. During this process in the 2021 MBA class, one student who works in diabetes health pitched a specific problem from her experience that many people when diagnosed with diabetes suffer from avoidable complications due to treatment inertia. Simply put, they delay treatment of the condition and often suffer irreversible damage to their health because of this delay. A number of her classmates were also curious about this problem and so a group of four students with diverse backgrounds including education, marketing, emergency services and health, formed around the problem.

They started by discovering as much as they could about this issue. They engaged in empathetic interviews and spoke with healthcare professionals, diabetics, members of the public and a close contact who had a chronic health condition but not diabetes. They delved into exiting research and data on diagnosis and treatment rates. In total they carried out 51 interviews and gathered 297 individual statements, problems, opportunities or pieces of data.

From their broad and deep discovering work they started to build a greater understanding of the core issues behind the problem. In the understanding phase they created a persona, “Alex”, to help define the characteristics of the human at the center of their problem. They used affinity mapping to collate the swathes of data into 20 overarching themes covering issues such as “Prognosis”, “Why me?” and “Motivation.” They created 12 guiding principles that any solution must try and cover, such as “Reduce stigma”, “Demonstrate the seriousness”, “Link in my support network.” They also developed a new point of view statement based on their new understanding of the core issue, “Alex needs a way to understand what is happening now, and is likely to happen in the future because there is damage being done to their body that could minimized.”

To engage their creativity and start creating lots of potential solutions, the group generated an opportunity statement, "How might we enable Alex to live a full and healthy life with Type 2 Diabetes?" They use nominal group technique to generate ideas individually and then collectively. They also employed question storming and created 39 potential solutions. These ranged from the weird and wonderful; such as a "naughty food taser" and "diabetes dog"; to technology based solutions, such as "a support app" and "diabetes smartwatch"; to various support services, such as "call center" and "personal assistant."

To narrow down their range of possible solutions and begin testing some of the ideas the group used a two-by-two selection matrix to organize the ideas according to likely effort and likely impact. They also compared the most promising ideas against their earlier guiding principles to ensure there was alignment. From this process they selected two ideas to prototype and test with their user groups. The first being a new "Live well with diabetes" app. This would be a place for the user to record, measure and share their treatment related information and habits. The group created a sketched wireframe using a freely available template to show the possible user screens with the options available to a user accessing it on a smartphone and how they might flow from one aspect of the app to another. They tested this by putting it in front of a small range of some of the participants from the discovering phase research. They conducted one iteration to add in some ideas from the first round of testing and engaged in a second round of tests. In doing so they received further feedback and ultimately came to the valuable insight that:

> *"The patients identified as likely to use the app solution were not the ones who most needed help and guidance. Effectively we had targeted those patients already concerned about doing the right thing. This would not solve the problem we had set out to solve."*

The second idea the group decided to prototype and test was coined "Glucose Guardians." This would be a free to the user, telecare health coach service where the user is checked on regularly by a trained guardian. A guardian could help with goal setting, motivational and emotional support, help remove any other barriers for example connecting with transport or financial support services. They would not be a replacement for the primary medical care which would remain with existing healthcare professionals. The group created an infographic as a mock pamphlet for the service and tested the concept with a range of participants from the earlier discovering phase. This met with very positive reactions and highlighted issues such as having good cultural connections between guardians and users which would be invaluable. The team leader who had initially proposed the problem was able to take the prototype to a national health conference and gain additional feedback from a broad base of healthcare professionals, who were also very supportive of the concept. Based on this testing the group progressed with the "Glucose Guardians" concept.

In the resourcing phase the group needed to identify with clarity how the service could be funded and also how it might leverage existing social capital of other organizations already active in diabetes health. They uncovered complications related to the different funding models of different regional health authorities which meant that in some regions they may be able to access funding for initiatives such as this, but this was not possible everywhere. They identified how the role of the guardian would be trained and staffed. They also identified how referrals from healthcare professionals would work. They build two business models with different resourcing options. One

where as a stand-alone service they would need to attract some funding, and proposed a small pilot requiring only three guardians to be funded. A second business model was also created where the service would fit within the existing national support organization for diabetes and be largely staffed by volunteers from that organization's network.

In the implementing phase the group needed to consider how the service would be adopted in practice. They employed the switch framework [42] to identify aspects of clearly communicating and directing the rational mind of the users by having very clear and simple outlines and infographics showing clearly what the service would and would not do. They also tried to motivate the emotions of the users by having relatable coaches that would reduce the barriers to engagement. They also tried to shape the environment to nudge the behavior in the positive direction by making sure the service was connected with existing health professionals so they would be able to refer users directly to the service.

The group were passionate about the problem and so devoted significant effort into this project and were able to achieve a great amount in the relatively short 12 weeks of the course, only a portion of which was available for the project. Subsequent to the course finishing the leader of the group reports that the concept has progressed further into implementing but has evolved into a different format, integrating with another new health coaching service that was created mainly for other long term conditions.

6. Conclusion

In helping managers and leaders understand and manage the process of innovation in VUCA conditions we need to empower them and their organizations with the tools, techniques and mind-sets needed to solve the complex problems they face. They first need to have an appreciation and desire to engage in problems with curiosity. They then need to be able to unleash creativity in themselves and those around them. Finally, they need to be able to find and communicate with clarity on the solutions that they implement. The DUCTRI model described here was designed to give structure to a process of innovation that has proven to be successful in not only generating creative solutions that deal with the core problems in the world, but also designing them to be implemented and therefore being able to have an impact. It has proven to be a successful means of helping leaders and managers from a wide range of disciplines bring effective innovation to their organizations. The author is hopeful this encourages other management educators to adopt and adapt this process as necessary.

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Conflict of interest

None.

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Chapter 5

Developing Creative and Meaningful Learning in the Curriculum

Um Albaneen Jamali

Abstract

Creativity as an important skill has attracted increasing attention. The attempt was to provide a framework, which is not costly nor time-consuming while is applicable to all subjects. To do so, it highlights the characteristics of meaningful learning and explains the relevant creativity thinking skills, which should be developed according to each characteristic of meaningful learning. The chapter then provides a summary of a research study carried out in 2021 by the author in this regard. It discusses the results and suggests implications for policymakers and educators while provides recommendations for future researchers in the field.

Keywords: creativity, meaningful learning, fluency, flexibility, elaboration

1. Introduction

Creativity as a vital, 21-century skill has attracted increasing attention in recent years [1]. It is now highlighted as a predictor of growth in various fields of science, technology, engineering, art, and math (STEAM) [2, 3]. Moreover, creativity predicts leadership development, lifelong accomplishment, and technology advancement [4]. Thus, educators are examining different ways to foster creativity as to prepare their students for the future. The current chapter starts by defining creativity using the CAT's Cradle model, then, proposes the meaningful and creative model of learning (MC model), by discussing ways in which meaningful learning could develop creativity. It, then, explores the present study, which examines the MC model and suggests future potential implications.

2. Creativity

Broadly speaking, creativity denotes producing something novel and useful [3]. Various definitions and models have been associated with creativity. Differing variations, however, do not mean confusion nor contradiction, rather, refer to how creativity was elaborated and discussed in detail in different contexts [3]. The current chapter explores creativity according to the CAT's Cradle [5]. The model argued three

factors for flourishing creativity in terms of creative climate, creative attitudes, and creative thinking. These factors have been applied in educational contexts [6].

2.1 Creative climate

It refers to the environment of a home, a classroom, a school, or a culture. Kim argued that creative climate goes beyond physical settings to include psychological aspects [7]. A creative climate in a classroom, for example, includes both physical support like time and resources, in addition to psychological supports, such as trust and collaboration. In this regard, educators call for creativity-developing behaviors of teachers, such as focusing on solving, for example, math problems in different ways or appreciating unusual ideas [8]. Such a creative climate allows students to freely discuss their opinions, make mistakes and offer novel solutions [9]. Creative climate paves the way for individuals to display and develop their creative attitudes and creative thinking.

2.2 Creative attitude

It denotes personal qualities within individuals. Researchers refer to a range of personality traits, such as openness, that are crucial for fostering creative behaviors [9]. Kim's concept of creative attitudes, however, is broader than creative personalities, as it constitutes inherent and learned personal characteristics [5]. It comes from within individuals and includes a wide range of personal attributes, such as curiosity, passion, courage, persistence, and humor [6]. As individuals develop and display their creative attitudes in a creative climate, they will be able to develop creative thinking.

2.3 Creative thinking

According to the CAT's Cradle, creative thinking requires three patterns of convergent, divergent, and emergent thinking [6]. Divergent thinking denotes a loose pattern of thinking and results in generating novel and original ideas [8]. Convergent thinking refers to a method of thinking and results in assessing the usefulness of the generated ideas. Emergent thinking describes deep thinking, which uses novel and useful ideas, and translates them to creative products. Thus, creative thinking requires cooperation among these three patterns. Furthermore, adopting the three patterns of thinking requires enhancing a range of thinking skills [10]. Divergent thinkers demonstrate skills of fluency (i.e., producing many ideas), flexibility (i.e., generating diverse ideas), and originality (i.e., producing unusual ideas). Convergent thinkers analyze ideas, and emergent thinkers indicate skills of abstract mindset (i.e., considering beyond the obvious) and elaboration (i.e., adding details). Creative thinking patterns and relevant skills are presented in **Table 1**.

The creative climate was traditionally referred to as a classroom in a school. Nowadays, we can argue that a creative climate could be even a room, a kitchen, or a corner down the stairs. Corona pandemic taught us that attending to physical aspects may not be as imperative as ensuring psychological support provided in such contexts. The current chapter focuses on creative climate referring to teachers' and parents' behavior to foster creativity. It also examines such climate in relation to creative thinking skills due to its direct applicability for both educators and learners.

	Creative thinking skills	Description
Divergent thinking	Fluency (generating many ideas)	Fluency—The number of ideas generated
	Originality (generating unusual ideas)	Originality—The number of unique ideas generated
	Flexibility (having another perspective or using another sense)	• Unusual visualization—Looking with another angle
		• Internal visualization—Conceptualizing the invisible
		• Colorfulness of imagery—Using the five senses
		• Movement or action—Using body movement
Emergent thinking	Abstract mindset (enjoying the complex and ambiguous)	Abstractness of titles—Thinking beyond what is seen
	Persistence and elaboration (working on details or describing with imagination)	• Elaboration—The degree of detail and persistence
		• Storytelling articulateness—The skill to tell a story
		• Expressiveness of titles—The skill to be expressive
		• Richness of imagery—The skill to visualize
	Integration (unconventional and connecting between the seemingly irrelevant)	• Extending or breaking boundaries—Nonconforming
		• Synthesis of lines or circles—Reorganizing
		• Synthesis of incomplete figures—Connecting the different
Convergent thinking	Logical	Analytical/evaluative/logical thinking—Part of intelligence

Table 1.
Creative thinking patterns and relevant skills [7].

A proliferation of research studies has investigated teachers' behaviors and provided abundant instructions and programs [10–12]. However, these studies are either too narrow in the sense that the specified and detailed instructions are not applicable to most subject areas or too costly in terms of time and resources. Nowadays, considering the pressured environment of schools, where teachers are pressurized with credibility and assessments; providing a flexible guideline is vital to develop creativity. One of the most systematic models that offered such a framework is the model of meaningful learning. It was first argued by psychologist Ausubel in 1968 [13]. It was further developed by Howland et al. [14]. According to them, creative learning cannot occur unless meaningful learning takes place. Similarly, researchers argued that creativity is an advanced level of meaningful learning [15]. However, while the researchers repeatedly mentioned the link between meaningful learning and creativity no systematic theory as to explain the nature of such link was argued. The current chapter is an attempt to do so. Providing such an explanation may well serve to teachers and parents in their attempts to develop creativity. Psychologists and educators argued a number of characteristics for meaningful learning [14], which are discussed in detail in this chapter. Each characteristic results in developing certain creative thinking skills, which were emphasized accordingly. Furthermore, although the attempt was to highlight the characteristics in order of difficulties, there is, certainly, no "one

size fits all"! Teachers and parents may well tailor them to suit their subject areas. Similarly, some students may develop creative thinking skills faster than their counterparts do. Indeed, providing such students with encouragement and motivation results in further fostering and deepening their creative thinking skills. The chapter concludes with a summary of research conducted in this regard, providing implications for educators and parents.

3. Meaningful learning

Howland and colleagues argued five characteristics for meaningful learning [14]. According to them, learning is meaningful if it is constructive, active, intentional, cooperative, and authentic. Each of these characteristics and its related creative thinking skills. The MC model of meaningful and creative learning proposed in this chapter is shown in **Figure 1**. According to this model, learning is creative and meaningful when the five characteristics of meaningful learning result in developing creative thinking skills. Constructive learning results in fostering fluency and flexibility. Active learning results in developing flexibility, while intentional learning fosters originality. Cooperative learning develops fluency, flexibility, and elaboration, while authentic learning fosters fluency, flexibility, elaboration, and originality. The MC model of learning is discussed in detail.

3.1 Constructive

According to this model, meaningful learning should be constructive. This view of knowledge development aligns with constructivists' theories of learning [16, 17].

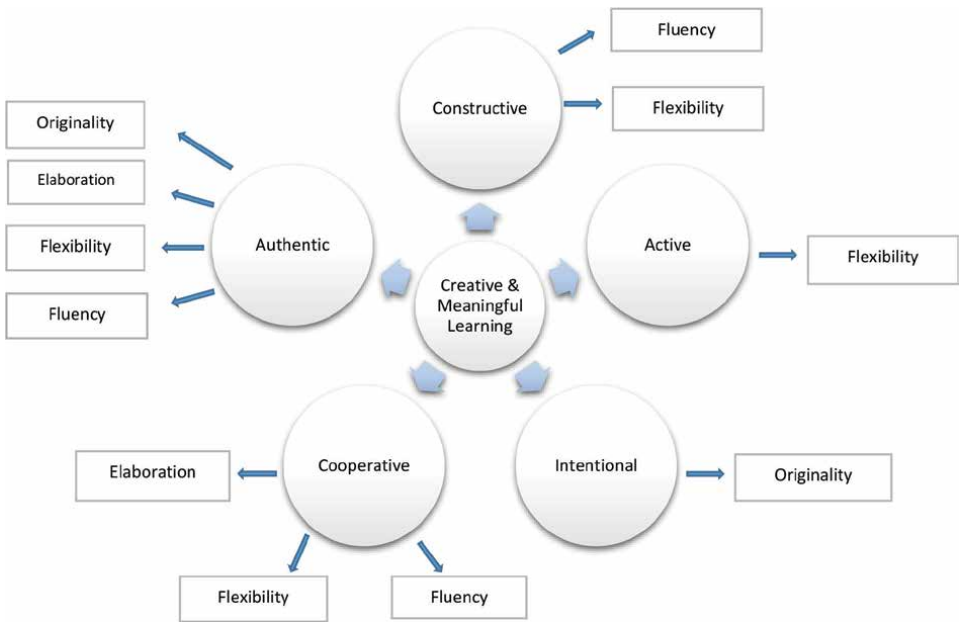

Figure 1.
The MC model of creative and meaningful learning. Applying five broad characteristics of meaningful learning results in each characteristic developing certain creative thinking skills.

Constructive activities invite learners to reflect on their thoughts and information. When a learner starts to reflect s/he will be able to incorporate the new knowledge and understanding with his/her previous prior knowledge. With engaging in reflection and teachers' and parents' support, their previous mental models become more and more complex. This results in creative meaning-making and generating new knowledge [18]. A handful of activities can be used to foster constructive learning. KWL charts (i.e., What I know? What I want to know? And what I learned?) are one of the well-known activities that help students to organize their thoughts before, during, and after a lesson while indicating its effectiveness in fostering creativity [19].

The creative thinking skills that will be developed during constructive learning are fluency and flexibility. Learners recall as many ideas as they know regarding their previous knowledge (e.g., What I know?). Afterward, as they want to incorporate the new knowledge with their prior information, they will develop the creative thinking of flexibility. They search for new and different ways of interpreting old knowledge while finding various ways of incorporating the old one with the new knowledge [20]. In simple words, they want a fluent mind to present them with a flow of ideas from before (fluency) and a flexible mind to be able to represent different ways and different thoughts of how old understanding can be interpreted and incorporated with new knowledge. As a result, their previous schema and mental model become more complex, and, hence, constructive understanding will occur.

Some activities that can be used in this regard are, for example, mind maps that provide learners with the opportunity to develop as many ideas as possible. Other

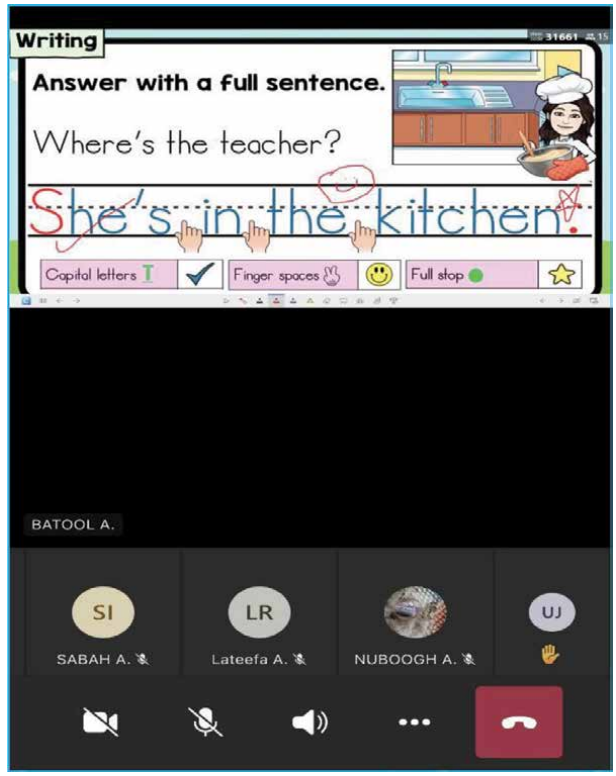

Figure 2.
Constructive learning activity through students' commenting.

activities such as open discussions, commenting, liking, or disliking their classmates' responses also provide learners with opportunities for reflection. It helps them to consider various ways of interpreting and incorporating their old knowledge with their new knowledge. Such activities could be as simple as young students' commenting by happy face or star, as presented in **Figure 2**.

3.2 Active

The second feature of meaningful learning is being active. Active learning denotes activities involving students in doing and thinking about what they are doing [21]. Active learning has a positive influence on learners' creativity as it builds new knowledge and develops new skills [22, 23]. It begins as learners start to interact with their surroundings. Some examples of activities in this respect involve learning new game skills or dealing with a new device. Researchers indicated the important role of active learning in fostering creativity among students [22, 24–26]. The creative learning skill that will develop through active learning is flexibility, which denotes producing different ideas. The flexible mind uses different ways to approach new knowledge and new skills. Games, including online educational games and robotics, for instance, are very effective in developing children's creative skills of flexibility. Furthermore, smart device applications regarding digital stories are very useful for those students who demand lots of active learning, where they can write their own scenario and produce it. Developing the creative skill of flexibility becomes evident as they build different characters, who become involved in different events and produce story morals.

3.3 Intentional

All that we do is toward achieving a goal. Basic goals may be as simple as making someone happy. More complicated goals may involve deciding to invest in stock exchanges or enter a new profession. As learning becomes goal-oriented and intentional, learners start to develop self-regulated strategies, such as time management; self-discipline strategies, such as organization, or may develop twenty-first century skills, such as leadership [27, 28]. In this stage, I suggest for teachers and parents to provide their learners with opportunities to be involved in local or worldwide events and contests. Researchers indicated that students' learning goal orientation was significantly associated with their creativity [25].

When learners intend to participate in challenging events, they start to develop ideas that are unique and original [29]. As a result, intentional learning helps learners to develop creative thinking skills of originality. Some examples of intentional activities may include publishing digital postcards regarding "Earth Day" and "Children's Day" and raising social awareness or participating in various contests.

3.4 Cooperative

The fourth characteristic of meaningful learning is to be cooperative. As the old saying states, "team work makes the dream work!" Cooperative learning results in individual and collective knowledge building. In cooperative learning, students communicate together by sharing their thoughts and listening to each other's perspectives. They work together to accomplish the task. A number of creative thinking skills will develop through cooperative learning. A flow of ideas will produce as team members

start sharing thoughts (fluency) [30]. Various ideas will develop as they listen and discuss the task (flexibility) [31] and as members began to add ideas and details to their thoughts, they develop the creative thinking skill of elaboration. Similarly, researchers demonstrated that the more information being shared, the more nonoverlapping knowledge emerges from students within the group. Therefore, the process of knowledge sharing and collective adding of information can leverage students' creative skills of elaboration [25, 28].

3.5 Authentic

Authentic activities enable gifted learners to bring their knowledge and skills into life [32]. As they start to establish the new knowledge through constructive and active learning and master it through intentional and cooperative learning; they will be ready to generalize or apply their learning into new contexts. Authentic learning activities, hence, enable students to deepen their understanding. Authentic learning allows learners to absorb new knowledge. Furthermore, it strengthens the links between what is learned and what they can transfer to future contexts. Subsequently, it helps them to solve future problems in which this present authentic learning may be applicable [33, 34]. Researchers emphasized the development of creative learning when it was contributed to students' life and well-being [26].

The skill that develops during authentic learning is creative problem solving [33, 34], which involves a combination of creative thinking skills of fluency, flexibility, originality, and elaboration. When facing a problem, learners use a flow of ideas (fluency), provide various solutions (flexibility) to come up with original and unique ideas (originality), refine the final solution by adding details (elaboration), and finally solve the problem. This could not be achieved without providing meaningful learning, which is constructive, active, intentional, cooperative, and authentic.

The current chapter reports on a research study, which examined the development of learning as part of continual professional development in Bahraini primary schools. The study was carried out in a primary school when the researcher provided teachers with training workshops on creative and meaningful learning and monitored the result on students' creativity. The study hypothesis denoted that applying characteristics of meaningful learning of constructive, active, cooperative, intentional, and authentic learning, positively affect developing creative thinking skills of flexibility, fluency, elaboration, and originality.

4. Methods

4.1 Sample and design

A mixed method was used for the purpose of the current study. The quantitative method consisted of a control experimental and pre-posttest design. The qualitative approach included observation and interview. The researcher observed students' task performance and conducted semi-structured interviews asking students to elaborate on their tasks' performance.

A random sample of 60 female students aged 9–12 participated in the study (n = 60). They were, mostly, from middle socioeconomic status and attended a primary girls school in an inner area of Bani Jamra. They were randomly assigned into two groups of treatment and controlled groups.

4.2 Procedures

A series of two workshops on integrating meaningful and creative learning in classrooms were executed for 30 members of the teaching staff. Sixty follow-up sessions' observations on two periods were carried out. Students' creativity was measured using Frank Williams [35] Creativity Assessment Package (CAP) prior to and after their teachers took part in the training.

Furthermore, during class observations, the students' performance on class activities were observed and 30 follow-up semi-structured interviews of 30-minutes long were conducted. Students were asked to elaborate on their tasks' performance. The quantitative data was selected to provide an overall picture of the impact of applying meaningful learning on students' creative thinking skills, the qualitative data was sought to further investigate the possible impact of each characteristic of meaningful learning on the development of creative thinking skills.

4.3 Data analysis

A pre and posttest design was selected for the purpose of this study. The quantitative data source included CAP tests that students completed on a pre-post basis. Respondents were asked to complete 12 drawings, using a simple line as a stimulus provided. The test measured changes in students' creativity skills of fluency, flexibility, originality, and elaboration. The results indicated in pre and post CAP were analyzed using the *t*-test with repeated measures. It was conducted to compare the pre-post scores on overall CAP results, besides subscales of creative thinking skills of flexibility, fluency, originality, and elaboration.

The qualitative data source included observations of students' performed class activities, where researchers explored their creative thinking skills of flexibility, fluency, originality, and elaboration based on their class activities' performance. Students' interview transcripts were also used to inform the observation. Mixed methods ensured triangulation. Cronbach's alpha was used to rate reliability in the test; alpha was 0.78, which was in the acceptable range.

5. Results

The findings from both quantitative and qualitative data yielded interesting results. The participants achieved higher scores on creative thinking skills following teachers' training interventions in the treatment group, when compared to the students' scores in the controlled group, and these changes were significantly different. The paired samples *t*-test comparing creativity posttest scores in the treatment and controlled groups demonstrated significant gains at posttest, $t(29) = 2.157$, and $p = 0.040$ ($p < 0.05$) in favor of students' scores in the treatment group. Student scores after teachers' training program ($M = 45.666$, SD = 8.482) showed an increase of on average 6.533 points compared to their counterparts in the controlled group ($M = 39.133$, SD = 8.105). These findings supported the study hypothesis denoted that applying characteristics of meaningful learning of constructive, active, cooperative, intentional, and authentic learning, positively affect developing creative thinking skills of flexibility, fluency, elaboration, and originality. It also provided support for the MC model of creative and meaningful learning, where each characteristic of meaningful learning (i.e., constructive, active, intentional, cooperative, and

Group	*N*	Mean	SD	(*t*)	Significance (*p*)
Controlled	30	39.1333	8.10526	2.157	.040
Treatment	30	45.6667	8.48247		
Controlled	30	10.3333	1.39728	2.483	.019
Treatment	30	11.5333	1.24595		
Controlled	30	6.0000	1.36277	2.808	.009
Treatment	30	7.3333	1.23443		
Controlled	30	2.1333	1.30201	0.442	.662
Treatment	30	2.4667	4.48277		
Controlled	30	19.4000	5.42218	2.716	.011
Treatment	30	24.3333	2.61498		

Table 2.
The results of the t-test with repeated measures comparing students' posttest scores on subscales of creativity in the treatment and controlled group.

authentic) was suggested to result in developing creative thinking skills of fluency, flexibility, elaboration, and originality. The results of the *t*-test with repeated measures comparing students' posttest scores on subscales of creativity in the treatment and controlled group is indicated in **Table 2**. The study findings regarding these creative thinking skills shall now be discussed in detail.

5.1 Flexibility

The *t*-test comparing flexibility posttest scores in both treatment and controlled groups indicated significant gains at the posttest, $t(29) = 2.808$, and $p = 0.009$ ($p < 0.05$) in favor of the students' scores in the treatment group. Flexibility gains were the most significant among other creative thinking skills as the p value of 0.009 was indicated. This may be due to the argument put forward by the author as presented in the MS model, most characteristics of meaningful learning resulted in the development of flexibility. Similarly, students' performance on various activities and their interview subtracts supported the above findings. For instance, following the session with a focus on active learning, a student explained how she/he built and programmed a robot to do different missions (i.e., flexibility) of watering, moving, and providing data regarding the soil moisture and temperature. Similar results were found following sessions focusing on constructive, cooperative, and authentic learning. These findings supported the study hypothesis that the above-mentioned characteristics of meaningful learning resulted in developing creative thinking skills of flexibility. The findings were in harmony with previously mentioned studies [23, 30, 31].

5.2 Fluency and elaboration

Similarly, the p values regarding other subskills of creativity in terms of fluency and elaboration indicated the following gains of 0.019 and 0.011, respectively, which were statistically meaningful. Students' performance on cooperative tasks indicated the development of creative skills of elaboration and fluency. For example, student participants were able to create a cap, which consisted of 18 components and performed four activities using artificial intelligence. The findings supported the study

hypothesis as cooperative and authentic activities resulted in developing fluency and elaboration. The findings were in line with previously mentioned studies [25, 28, 30].

5.3 Originality

In contrary to findings regarding fluency, flexibility, and elaboration, there was no significant increase concerning the subscale of originality, $t(29) = 0.442$, $p = 0.662$. This was despite students in the treatment group ($M = 2.466$, SD = 0.482) attending higher scores than students in the controlled group ($M = 2.133$, SD = 1.302), as presented in **Figure 3**. These findings contradicted research findings in which intentional and goal-oriented activities demonstrated to develop originality [25, 29, 30].

The results from the qualitative method, however, indicated fostering originality skills among some students. For instance, a group of students created a smart mask using a combination of robotic sensors and herbal medication, namely, Organa plants from the school garden. Such a unique and original idea of combining tradition and technology was awarded the first prize in the Kingdom of Bahrain's science fair. The students further mentioned that they decided to think of unusual ideas following the session in which the teacher encouraged them to perform a goal-oriented activity while introducing the science fair. I would take the view that intentional activities were effective in developing originality at least among some students. These findings partially supported research studies [25, 29, 30], that demonstrated the impact of goal-oriented activities on developing originality and unique ideas.

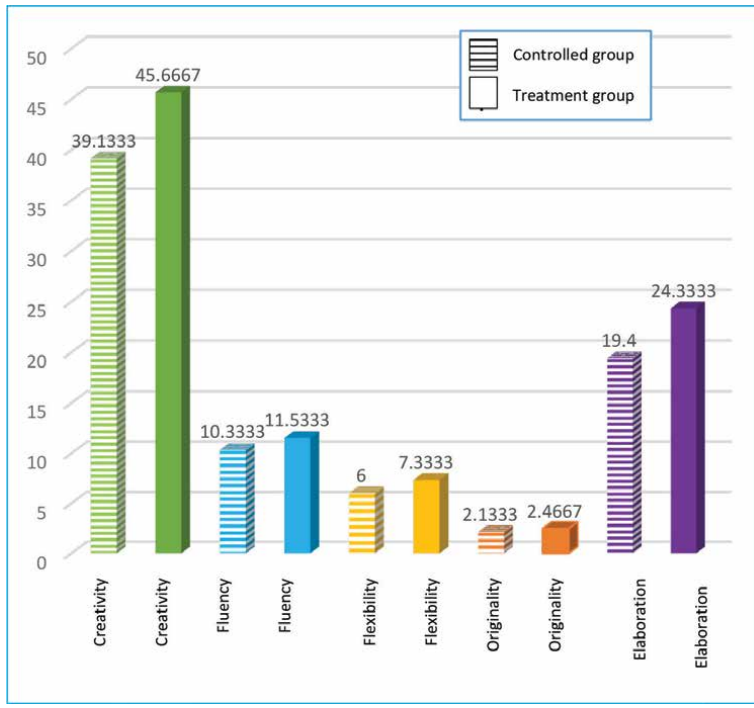

Figure 3.
Mean of students' posttest scores on subscales of creativity in the treatment and controlled group.

6. Discussion

The findings from the current study provided insight into creativity and meaningful learning through introducing the MC model of meaningful and creative learning. It investigated the impact of applying five characteristics of meaningful learning, namely, constructive, active, intentional, cooperative, and authentic learning on developing creative thinking skills of fluency, flexibility, elaboration, and originality. The post-test scores of participants in the treatment group indicated significant differences in creative thinking skills compared to the posttest scores of students in the control group who received no training intervention. The findings from qualitative data of task observation and students' interviews further supported the study's result. The findings suggested that teachers' incorporating creative and meaningful learning had a positive impact on developing students' creativity.

The results were consistent with earlier research studies [22, 24, 26, 28, 30], which indicated positive impacts of meaningful learning on fostering creativity. Furthermore, the findings in the present study demonstrated significant gains in a wide range of creative thinking skills of fluency, flexibility, and elaboration compared to previous studies. I would like to argue that the gains indicated in the present study could be due to the study sample, the length of intervention, and the research setting. The study was carried out in students' familiar settings and learning was delivered by their teachers and not by stranger researchers. Considering the participants' young age, a familiar instructor and a familiar setting might have been effective in developing creativity.

Furthermore, the teacher training intervention provided in this study was a detailed instructive program, which was closely supervised by the researcher. The aim was to avoid vague and general instruction guidelines, being executed in one intensive workshop. In the present study, teachers attended the workshops according to a timeline, which ensured their mastering of the skills. Teachers were supervised and follow-up meetings were conducted. In addition, the study lasted for a prolonged period of 15 weeks. The aim was to avoid pressure on both teachers and students. This might have had a positive effect on developing creative thinking skills.

On the other hand, the present study had some limitations. The study used a random sample of female students from middle socioeconomic backgrounds. Conducting research with larger and randomized samples consisting of both genders, and from different socioeconomic backgrounds may yield more valid findings in future studies.

Moreover, the current study applied quantitative and qualitative approaches. Adopting other mixed methods of data collection, such as case study, may provide further information regarding how meaningful learning enhances creativity in children.

In addition, the classroom context of the present study did not provide a controlled laboratory setting. However, the setting in the present study might have been more advantageous in encouraging teachers to consider incorporating various features of meaningful and creative learning in curricula in their classroom contexts.

7. Conclusions

In summary, the chapter highlighted the MC model of meaningful and creative learning. The current study provided useful insights into the impact of meaningful

learning and its five characteristics on developing creative thinking skills among Bahraini students. As an experienced specialist in creative learning, I was overwhelmed by the impact of a humble teacher training intervention on developing a wide range of creative thinking skills of flexibility, fluency, elaboration, and originality among the students. As a result of the present study, policymakers and educators may consider various implications. Policymakers may consider providing training opportunities in creativity as part of continual professional development programs; while funding large-scale and longitudinal studies in the field. School leaders and teachers may consider incorporating meaningful and creative learning in curricula. The present study demonstrated an easy, doable, and inexpensive attempt to foster creativity. Further attempts are, indeed, required to further enhance means of developing meaningful and creative learning for both teachers and students in the future.

Conflict of interest

The authors declare no conflict of interest.

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Chapter 6

Perspective Chapter: Teaching Intuition and Creativity - An Interdisciplinary and Playful Approach

Marianna Fornasiero, Federico Malucelli and Isabella Sateriale

Abstract

The students attending the Italian technical and vocational high schools have often a critical behavior towards the classes of Mathematics and Italian. They usually believe that these disciplines are sterile and marginal with respect to their main interests that rely on subjects characterizing their professional choice. We made some experiments intended to wake up the interest and reactivate the lost creativity in these two disciplines. We report on an interdisciplinary experience in the first-year class of a technical high school where we introduced a series of games in the classes of Mathematics and Italian, with the intent of stimulating creativity and empowering the students. In Maths, we applied the puzzle-based learning technique. In Italian, we used the creative writing technique. Despite the limited time devoted to this experience, the outcomes have been extremely positive.

Keywords: creative writing, creativity in mathematics, divergent thinking, gaming

1. Introduction

From the very first days of high school attendance, especially in Technical Institutes or Vocational Institutes, many students often assume adverse attitudes to deal with Mathematics and Italian. This results in hostile behavior and lack of interest, sometimes originating from low self-esteem or negative experiences in the early school years. These attitudes are an obstacle to good performance and successful inclusion in the school curriculum from the very beginning. There are many misconceptions in the minds of students. Perhaps due to previous negative experiences or an uninspiring social context, On the one hand in mathematics, most of the students consider the discipline dry and boring. They associate it to mechanical aspects of the mere algebraic calculation, neglecting instead the creative potential. On the other hand, in Italian, many students seem convinced that they do not know how to write, they are very concerned about the form rather than the content, and often, in front of the requests of the teacher, they take a passive attitude, almost giving up.

In this chapter, we want to illustrate an interdisciplinary project carried out in a first-class of a Technical Institute. The objectives of the project were mainly to

overcome the misconceptions mentioned before and to highlight the creative and intuitive component of the two subjects by stimulating students to curiosity and study [1, 2].

According to psychologist Max Wertheimer [3], the key objective of school activity is to foster so-called "productive thinking" in students, i.e., to orient students to solve new and unusual problems in order to stimulate their intuition. Our aim was just this: to propose activities that can bring out the students' intuition in solving problems, the so-called insight of Köhler [4, 5], that is, to activate those cognitive mechanisms, those mental jumps that allow to solve situations never faced before or to face known problems in an original, more immediate and brilliant way.

In other words, we wanted to enhance and put in the foreground the productive aspect of thought, refraining from mechanically applying formulas, grammatical rules, or procedures that passively reproduce already known knowledge and would make the discipline devoid of real meaning.

As other objectives, functional to the main one, we set out to strengthen the observational and abstraction skills as well as to foster the critical thinking of the students. In addition, we tried to awaken divergent thinking to build new knowledge from the acquired experiences [6]. All these skills are often dormant in the students, now belonging to the digital generation, more and more accustomed to the passive use of electronic communication tools and little predisposed to direct interaction with the objects of the real world. Observation, the use of materials and objects, and their manipulation has been the main tool to trigger the process of intuition and creation. A concept supported many times by Emma Castelnuovo, which remains always relevant, is that "one thing that is very missing in school today is the hand-brain relationship" [7].

However, a positive aspect of the new generations of so-called "digital natives" is that learning does not develop in a sequential way, but rather in a reticular way, i.e., following different directions at the same time. From this point of view, we are faced with students who are more predisposed to deal with interdisciplinary topics and to conceive knowledge as a "unitary whole". They are naturally disposed towards carrying out tasks in groups or online, being able to deal with connections between multiple disciplines and knowledge [8]. These are very important skills at the base of social learning as intended in [9]. In this perspective, our experiment aimed to create links, similarities, and communion of methodologies between different disciplinary areas, the humanities-literary and the scientific-mathematical, trying to guide students towards the concept that both are linked by the common denominator of creativity and intuition.

The experience proposes a fruitful interaction between the two disciplines of mathematics and Italian, linked by the common thread of potential creativity. This is an essential aspect in learning the contents and customizing the tools of the two subjects. For this reason, we were inspired by the technique of puzzle-based learning and creative writing, leveraging on the playful component of the activities, using as much as possible materials taken from everyday life, and proposing to the student's role-playing games or engaging questions solvable through teamwork, according to the methodology of cooperative learning.

The center of the learning process becomes the student, with his characteristics and his specificities. The passive transmission of content is replaced by the proposal to the student of authentic and contextualized problems ("authentic and situated learning"). The student, together with her mates, is stimulated to find the solution and formalize it, activating a metacognitive process that also leads her to reflect on how

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she arrived at the final result and to have a greater awareness of her own learning process. These are the key competencies of "Learning to learn", "Mathematical competence", "Communication in the mother tongue" specified in the Recommendation of the European Parliament and of the Council of the EU, 2006 [10].

Students are presented with "complex, open-ended problems", i.e., situations that are challenging for the student, contain a dimension of challenge in relation to the knowledge and experience possessed, solicit the activation of resources, and lend themselves to different modes of solution [11, 12].

Even though we dedicated only a few hours to this experience, the effects were tangible both at a motivational level, affecting the students' self-esteem, and at an objective level, as could be verified in the school parallel tests carried out at the end of the school year in the two disciplines.

In the following we will briefly survey the concepts of puzzle-based learning and creative writing (Section 2), then we will present the details of the activities carried out in class in Mathematics and Italian (Section 3). A brief report on the results achieved will conclude the chapter.

2. Learning by playing

One of the lacking aspects in most school curricula, at any level, is the development of problem-solving skills, whether in mathematics or arising from other contexts. Generally, schools instruct students on how to apply so-called "rules", whether mathematical or grammatical or how to solve exercises by applying formulas or predefined schemes. In this way, students have difficulty framing problems, extracting relevant information, developing critical thinking, and proposing solutions [13]. It is well known [14, 15] that this mode of learning has the effect of killing students' creativity and interest, and in most cases induces them to resort to learning by heart instead of reasoning.

The techniques that we adopted to awake the reasoning skills and the creativity of the students are mainly puzzle-based learning and creative writing. Both techniques are very playful and engaging since the beginning.

2.1 Puzzle-based learning

Puzzle-based learning [16] is a learning approach that is intended to develop reasoning skills, perseverance, and motivation in dealing with problems. That is, it intends to build the fundamental foundations of what problem-solving is. This is done not from real problems, but rather by taking cues from games that do not require any special contextual knowledge and that have the sole intent of being engaging and challenging [17].

In this context, the curricular teacher and the external expert become guides and facilitators of knowledge within a community of learners [18] which is the classroom. Each student becomes the main player of a learning process where she is an active builder of her own knowledge, acting in cooperation with peers, according to the theories of collaborative learning and guided discovery of Vygotskij [19, 20].

In practice, the role of the teacher is not to "teach" how to solve problems, but rather to propose stimulating games for all students, to follow their reasoning, to arrive together with them at the solution [21]. The teacher must be ready to accept methods of solving problems other than the one she has thought of, or tried to solve

together with the student's problems posed by them. In short, the fundamental purpose is not the solution of problems, but the effort that is made to achieve it. The teacher must therefore be ready to get involved and not be uncomfortable in the face of possible setbacks. Adopting a sporting similarity, the teacher takes on, during puzzle-based learning, the role of the coach, whose motivational skills must be preponderant over the merely technical ones.

The assessment phase is also strikingly different from the usual context. After the first few games, the enthusiasm shown by the students in arriving at a solution on their own goes far beyond a good grade. Therefore, more than rewarding the result achieved, the effort to reach it is to be encouraged even if it was not successful [22].

2.2 Creative writing

Creative writing is a way to approach the world of literature and to acquire greater critical awareness. It is closely linked to the idea of "invention", so it does not have universally valid rules, but rather has "techniques". The invention is a very important moment that must be guided and trained. The literature on creative writing is particularly rich [23]. However, we took advantage of the presence of the local writer Luigi dal Cin, who has also a long record of collaborations with schools at all levels. According to Luigi dal Cin [24], many writers agree that invention springs from five mental attitudes:

Inspiration: the first mental attitude is the most important and is developed mainly through the "fantastic pair" (the juxtaposition of two concepts, characters, situations, very different from each other).

Proliferation: linking different situations and characters, even contradictory ones, to the first idea.

Selection: select characters and situations.

Preservation: do not forget anything that was initially discarded.

Re-crossing: resume the plot of the story and try to develop it even with what was initially discarded.

It is curious to note that, although with different terminology and in a context very distant from the creation of a story, we find similar techniques in the design of heuristic algorithms for solving mathematical problems: Genetic algorithms, Simulated Annealing, Neural Networks, Tabu Search, Evolutionary algorithms, etc. [25].

Creative writing techniques also go beyond those mentioned above, however, given the purpose of the experience, it was deemed appropriate to focus on some of the simplest and of immediate impact on the students.

3. The experience in class

The flow of our experience is summarized in **Figure 1**, where the connections between mathematics and Italian are pointed out.

3.1 Mathematics

Starting from the assumption that the mathematics that is taught in school is, among all disciplines, the one that students find more and more difficult to assimilate in its concepts and in its many applications, the hours dedicated to this project appeared instead as a sort of "game of the mind" captivating and pleasantly full of

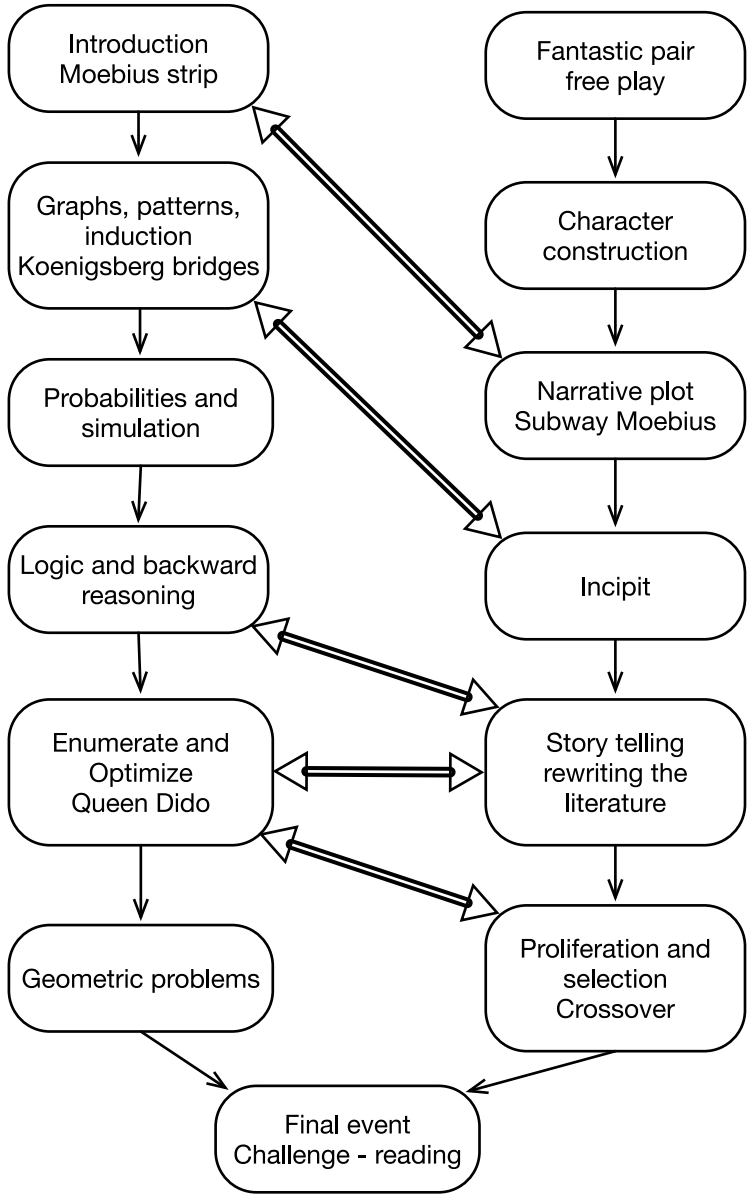

Figure 1.
Connections between activities.

surprises [26]. The students immediately showed interest and enthusiasm in addressing the proposed questions, showing curiosity and willingness to collaborate. The lessons were held according to the mode of cooperative learning, through pair/group activities: students, placed at the center of the learning process, were guided and trained in problem-solving by the external expert teacher who stimulated in them the desire to experiment with new strategies and new methods. According to Bruner's theories [27] developed about fifty years ago, but still very relevant, the concept of discovery learning can be a suitable way to foster in students' minds a way of thinking

independently. The student is actively involved in identifying the key ideas of the discipline, which are not presented in a "pre-packaged" way by the teacher: the student, during a research-action path, defines hypotheses, makes predictions, has intuitions, investigates the nature of what she is studying, comes to new results independently, through one or more paths, according to progressive discoveries [28].

We report briefly on the experiences made during the ten hours of this project, listing the activities and their purpose.

3.1.1 Meeting 1: let us break the ice

The most critical aspect of the designed activities is to immediately get students into the mindset of puzzle-based learning and cooperative learning by taking an active role. We tried to address this issue with a very engaging physical puzzle. The kids were organized into groups of three and a volunteer was identified in each who was not afraid to dishevel. The volunteer wore a T-shirt and her hands were tied with a rope that left about twenty inches of play. The challenge was to take the shirt off and slip it back on so that when it was pulled back on, it would be inside out with the label on the outside and back. The task of the volunteer's assistants was to help him in the movements that are restricted by the rope and suggest the actions to be taken to get to the solution. The teacher can only help observe what happens, in case some group gets stuck.

3.1.2 Meeting 2: let us use our hands and learn to observe

As Emma Castelnuovo argues, knowledge begins with the use of the senses. The purpose of the second meeting is to stimulate the spirit of observation and subsequent abstraction. This can be done through the use of simple materials. For us, it was paper ribbons about twenty centimeters long and three wide, glue and scissors [29]. Taking a cue from the T-shirt game, where we played with the "inside" and the "outside," we invited students to create a simplified physical model of the T-shirt by building a ring with a paper ribbon. We then invited them with a ribbon of the same size to build a different T-shirt model, where it was not possible to distinguish the "inside" from the "outside". The students came up with the well-known Moebius ring. The property of having a unique surface has been verified by drawing a longitudinal line with a pencil in the closed ribbon. We then prompted them to observe the properties of the ring they had obtained by cutting the ring with scissors along the traced line, or by cutting it longitudinally, remaining one cm from the edge. The manual activity and the use of colors stimulated the imagination of the students. As the activity unfolded, one of the students uttered a phrase that gave the measure of how well the message on the creativity potentials had been understood: "This isn't math: it's modern art!". The activities with the Moebius strip were also recalled during the creative writing meetings where some stories have been created starting from the mathematical properties.

To reiterate the importance of the spirit of observation and the use of information, we proposed a simple question: in three identical boxes we put chocolates with the same external appearance, but with different tastes (type A and type B). In one box we put chocolates of type A, in another one type B, and in the third one a mixture of the two types, moreover a label was added to each box (A, B, A/B), but it was said that the labels were all wrong. The question was to determine how many chocolates needed to be tasted in order to correctly attribute the labels to the boxes.

It has not been easy to find chocolates that were right for us. We went to an artisan chocolate shop whose saleswoman, faced with our bizarre request, was so intrigued that she wanted to try to solve the game as well.

3.1.3 Meeting 3: model building with graphs, recognition of regularities, and the idea of induction

The third meeting was dedicated to the introduction of graphs as a tool for mathematical representation. We started with the story of Euler and the bridges of Königsberg, starting milestone of Graph Theory. We discovered together planar graphs and how to represent geographic maps by means of graphs, then the problem of coloring maps and graphs. We also explored the same coloring problems when the graph is arranged on a Moebius ring made with transparent paper. We finally tried to count the number of arcs of a complete graph, using induction.

3.1.4 Meeting 4: probability and simulation

The concept of probability is usually very abstract, but if it is associated with the game, it becomes much more engaging. We have studied a sort of puzzle related to the probability that recalls a television quiz. In the game, there are 3 boxes available: one contains a prize, while the other 2 are empty. The contestant chooses one of the three boxes without opening it. Then the host opens one of the remaining two boxes that he knows do not contain the prize and asks the contestant if she wants to change her choice. The question is, putting aside superstitious factors, which choice maximizes the probability of finding the prize? The intuitive answer (the probability that the prize is in one of the left two packages is identical) is wrong. It is difficult to convince us of this using reasoning while using simulation it is obvious. We then divided the groups of kids into two teams simulating the game: the groups on one team kept the choice unchanged, and the other team always changed it, repeating the experiment 20 times each. Putting the results together gave a good estimate of the actual probability of the two choices.

3.1.5 Meeting 5: logic and combinatorics: goat-cabbage-wolf, zombie

Logical/combinatorial reasoning questions are among the best known, however, it is worthwhile to dwell on the topic to go beyond intuition and develop more rigorous reasoning to support what has been intuited. We started with the classic question of the goat, the cabbage, and the wolf to ferry, resorting to drama. We then generalized the game to the problem of having to get three zombies and three humans to cross a river in a boat carrying at most three people. However, the humans can never be outnumbered either in the boat or on the banks of the river otherwise they succumb. Finally, we solved and logically analyzed the following tautology using three volunteers. Matteo looks at Agata and Agata looks at Alberto. Matteo is engaged and Alberto is not, while it is not known if Agata is. Is anyone engaged looking at anyone not engaged?

3.1.6 Meeting 6: reasoning backward

The most common approach in problem-solving is to advance the reasoning forward to reach the solution after a series of steps. However, when reasoning gets stuck

someone may get discouraged and quit. If we adopt the point of view of a detective facing a crime scene, it is more productive to reason backward from the final result. Many questions are more addressable if explored backward, think for example of the mazes in puzzle newspapers, or economics problems where a company sets goals and asks how to achieve them. Therefore, we studied together some questions such as the following one. A colony of algae begins to populate the surface of a lake. Each day the area covered by the algae doubles and is completely covered by day 10. On which day is the surface of the lake half covered? Finding the answer by reasoning forward from day 1 is complicated, it would involve making assumptions about the initial coverage of the lake and proceeding by trial and error, much simpler instead is to start from day 10 and go backward.

3.1.7 Meeting 7: we enumerate and eliminate

The proposed problem-solving approach is based on a simple principle: enumerate the solutions by eliminating the impossible ones, what remains is the solution. This simple principle soon clashes with the size of the problems to be solved, which could grow exponentially with the number of alternatives to be considered. It is therefore necessary to combine enumeration with the use of logic to recognize as soon as possible the unfeasible combinations. One of the girls proposed the so-called Einstein's puzzle[1] that in principle requires the enumeration of 5^3 combinations, something impossible to do manually, and for this reason, it discouraged everyone in the class. Thus proposed a series of questions of increasing difficulty inviting groups to tackle them using the enumeration technique. At the end of this path, we have faced Einstein's question together and we have been able to complete it in a short time.

3.1.8 Meeting 8: optimizing

Optimization problems are simple enough to grasp, after all, optimization is inherent in human nature, and in nature more generally. Despite optimization concepts are usually introduced at the university level, there are successful examples of optimization experiences in school. Emma Castelnuovo introduced the geometric interpretation of Linear Programming in her textbooks. Malucelli and Fantinati [30] illustrates an optimization experience in an elementary school. Experiences of optimization problems tackled in medium schools and in high schools are surveyed in [31].

We started with the example of the oldest documented optimization problem: the founding of Carthage, i.e., the problem of enclosing in a fixed perimeter the maximum possible area. We pointed out that the question in optimization problems is not to find one possible solution, but among all possible solutions to identify that maximizing or minimizing a given objective. We have therefore addressed some simple optimization problems. Starting from the isoperimetric problem of queen Dido. A second one considers a scheduling problem. Four people must cross a dangerous bridge at nighttime, and to do so they need a flashlight. The bridge holds at most the weight of two people and there is only one flashlight available. The people have different crossing speeds: 1, 2, 5, and 10 minutes respectively, and when two people cross the bridge, having to hold the flashlight they must do so at the minimum of their two speeds. Which crossing sequence guarantees the minimum time to get all the people from one

[1] https://web.stanford.edu/laurik/fsmbook/examples/Einstein%27sPuzzle.html [Accessed 2021-10-25].

side to the other? The sequences are obviously infinite, but one can exclude all those with redundant crossings. By adapting the enumeration techniques to the optimization case, we reached the solution.

Another problem addressed was the following. The town of Comacchio[2] is built on 13 islands. A sudden cataclysm destroys all the bridges and the mayor must decide which ones to rebuild so that from any island it is possible to reach any other island using paths that involve the crossing of even more than one bridge. The cost of rebuilding each bridge is given and the mayor obviously wants to minimize the overall expense. We invited students to reason using a graph model and each group came up with their own algorithm comparing the solutions obtained.

3.1.9 Meeting 9: geometric problems

Geometric problems have the great advantage that they can be represented graphically and also constructed physically. Therefore, they are very concrete and can also be manipulated easily. We have dealt with various problems of the arrangement of lines and points on the plane. One question posed by one of the students was to find a way to cover with three consecutive segments 9 points arranged on the plane on 3 rows and three columns. Or arrange 10 points and 5 lines on a plane so that each point falls on the intersection of exactly two lines. Then we moved on to consider the problem of covering with dominoes an 8x8 chessboard from which we eliminated the opposite corners. Finally, we considered together with a personal way of proving the Pythagorean theorem.

3.1.10 Meeting 10: the final challenge

Instead of concluding the experience with a conventional test, we wanted to propose to the students, organized in groups of two or three, a small competition with prizes. We prepared about ten questions of various difficulties, each associated with a score. The final ranking considered the overall score totaled by the groups. The purpose of the challenge was not to see who had managed to better acquire the concepts, but rather to increase the self-esteem of the boys and girls. Indeed they were faced with the evidence that all the proposed questions were within their reach, and that before embarking on this path they would not even have tried to solve them.

3.2 Italian

The outcome of the entry texts made at the beginning of the year evidenced that the class had some difficulty in dealing with written texts. In particular, the main problems were arising from choosing and following an outline. In addition, many students had not acquired any method of writing. Therefore, during our experiment, we tried to increase first of all the self-esteem of the students. Then we focused on stimulating interest in writing, in the narrative plot and its development, leaving the issues on the form only to a subsequent moment. The specific objectives on which the work in class was developed were aimed at fostering creative capacity and skills in writing a narrative text. To do this, different types of creative writing techniques have been practiced, such as the “fantastic pair”, various role-plays, the description

[2] https://en.wikipedia.org/wiki/Comacchio [Accessed 2021-10-25].

through the five senses, the dramatization of parts of the text. The students then had fun playing with classic texts of literature by rewriting some parts previously read and explained in class by the teacher.

This type of less classical and more playful approach has led the class to develop first the pleasure of reading, and then the curiosity in writing and the development of a narrative plot that is almost never predictable. The writing games were often developed in small groups. During the curricular hours of Italian, the teacher has therefore tried to implement in class the experiences of creative writing structured on the model of the "Grammar of Fantasy" by Rodari [32]. Therefore, we worked on the creation of a narrative text by putting into practice various creative writing techniques suggested by the author, ranging from the creation of a fantastic pair to fantastic hypotheses. We also tried to stimulate the student's imagination and strengthen their self-esteem, trying above all to enhance the error as a very important moment of creation. It was explained to the students that error should not be demonized, but should be seen as a fundamental step in creation. Therefore, as an important and sometimes inevitable moment in order to arrive at the correct solution or dynamic of the action.

We carried out the work in different ways. Generally, the activity opened with a brainstorming session to focus on the important issues on which we decided, from time to time, to work. The various ideas were then developed through group work, in which the creative writing techniques introduced by the teacher were put into practice. The students had fun, from time to time, to produce different types of texts following the proposed methods and inventing new ones. Always motivated by the thought that creativity comes through manual skills in writing and that one cannot write well only with theoretical knowledge: practice is of utmost importance to develop a personal style. Following the advice of the local writer Luigi Dal Cin, the lessons were articulated as follows.

3.2.1 Meeting 1: free play with the fantastic pair

The students, in pairs, carried out the creative writing exercise, trying to let interact with very different characters (e.g.: the teacher and Tarzan) and to develop the story that was taking shape.

3.2.2 Meeting 2: construction of characters and landscape

Students were invited to build fantastic or invented characters starting from careful observation of reality and what happens every day. The students described people, events, real places that struck them and that have remained in their memory. One student, for example, imagined and described the figure of a traveler and the landscape:

> *"… man is like a star that lives by its own light for millions of years, showing its splendor to all, but remaining far away."*
> *"… the landscape outside had changed in a very short time from a thick fog to a blue sky, it seemed to be among the stars, it was surreal and mysterious."*
> *"… the mountains filled with white like an hourglass."*

3.2.3 Meeting 3: "a subway called Moebius"

In order to create a link between the work of mathematics and that of Italian, an entire activity has been dedicated to the Moebius ring. The meeting began with the

short video Wind and Mr. Ug[3], in which a story is constructed that exploits the properties of the Moebius strip. We then moved on to reading and commenting on the science fiction short story "A subway named Moebius" by A. J. Deutsch[4]. The story examines the concept of "node" from a mathematical point of view. After reading, we tried to stimulate the class on the main themes proposed by the story and on the relationship with the shape of the Moebius strip. Subsequently, various exercises were proposed, extracted from the manual in use, on the objective and subjective description of places and characters of everyday life.

3.2.4 Meeting 4: construction of a narrative plot

We proceeded to construct a story that starts from a series of data planned in advance (for example historical period, setting, role of the main character, ...). The students, divided into small groups, had fun making the characters interact, some planned in advance, others created according to the plot that was developing. They came to realize that it is important to start writing even when you do not have full knowledge of the overall plot.

3.2.5 Meeting 5: the importance of the incipit

The class analyzed several incipits of famous short stories or novels of Italian and foreign literature: for example, The Betrothed, by Alessandro Manzoni, science fiction stories, etc. The students were invited to express their opinion on what they considered to be the most interesting incipit and to motivate their preference and then to develop different incipits, experimenting with narrative styles and literary genres.

3.2.6 Meeting 6: storytelling in the first or third person

Several short stories were analyzed in class. The class was then asked to develop creative writing stories in the first and third person. We tried to make the students understand that the narrator is chosen according to the effect that we want to achieve in the reader. In fact, first-person narration is emotionally stronger and more intense at the cost, however, of a certain subjectivity, while third-person narration is more objective but less empathetic.

3.2.7 Meeting 7: the rewriting of literature texts

The students were invited, at first, to analyze some important texts of Italian literature (The Betrothed in particular) and then to rewrite parts of the stories or novels by changing the setting and introducing invented characters and situations.

3.2.8 Meeting 8: proliferation and selection

The stories developed in the first two meetings were resumed and rewritten, according to the criterion of proliferation and selection of settings, situations, and characters in the light of the techniques learned.

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[3] https://www.youtube.com/watch?v=4mdEsouIXGM&t=8s [Accessed 2021-10-25].

[4] https://www.fadedpage.com/showbook.php?pid=20210556 [Accessed 2021-10-25].

3.2.9 Meeting 9: crossover

The plot of the initial story was resumed, developing, setting, and characters also trying to include what was initially discarded.

3.2.10 Meeting 10: reading and evaluation

The different groups were invited to present their work to the class, taking advantage of multimedia presentations that summarized the plot of the different stories, accompanied by images. The presentations also included the sentences that the author and the readers liked the most. The subsequent evaluation was therefore based not only on the written production, but we tried to give an overall assessment of the work done, keeping in mind also the relational aspect.

4. Achievements and conclusions

At the end of the experience, the satisfaction questionnaire has been administered to the students. The outcome is summarized in **Table 1**.

The full satisfaction and enthusiasm in having participated in the experience have emerged also from the free comments. For example the comments of question (1) have been: the project was helpful "because this way you compare what we are doing in class also with a university teacher, and you can hear his opinions", projects like this "help you understand things better", "because it is interesting how he explained mathematics in a different way making the lesson less heavy but useful", "because, with projects like this, you learn to use logic" (motivation repeated several times).

This testifies that the perception by the students about their personal skills in the disciplines of Italian and mathematics during the experience is considerably high compared to the perception they have during standard curricular lessons.

In addition, in the parallel test of mathematics that involved all the first classes of the Institute, concluding and summarizing the ministerial program carried out during

Question	Very positive	Mild	Very negative
	(%)	(%)	(%)
(1) Would you be interested in continuing the project the following year?	95	5	0
(2) From a mathematical point of view, do you think projects like this are important in curricular time?	89	11	0
(3) Through the proposed activities, has your interest in mathematics increased?	16	52	22
(4) Do you think the project was important for the development of your logical-solving skills?	84	16	0
(5) Have you encountered particular difficulties in solving the proposed questions?	0	16	84
(6) If you had to self-evaluate your work during the project, what would be your opinion?	16	84	0

Table 1.
Percentage answers to the satisfaction questionnaire.

the school year, students have reported the following results: 20% scored between 6 and 7 over 10, 70% scored between 7.5 and 9, 10% scored higher, placing themselves in the range of excellence of the school. Note how the average score for the institute is between 6 and 7, on a scale ranging from 0 to 10. Moreover, the fact that none of the students were rated insufficient, shows that the interdisciplinary course of creativity and intuition was also useful as an activity to reinforce self-esteem, to make up for deficiencies, and to strengthen the logical-solving skills of students who initially had a negative rating.

In Italian, the criticalities highlighted by the entry test have dissolved. The result of the parallel tests at the end of the year was very positive: the average score was between 8 and 9 and only one student was slightly insufficient. It should be noted that in the other classes of the institute the incidence of insufficient evaluations was greater than 50%. A special note must be done considering the students with special needs present in the class. The proposed activities have been revealed to be very inclusive. The two students have been constantly engaged and participated with great satisfaction and with excellent results.

In conclusion, although the experience was limited to one class and only 20 curricular hours, we can say that the enhancement of creative and "manual" aspects proposed in the project has given encouraging results. Indeed the subsequent year, in the same class a second advanced edition has been proposed, as described in [33, 34] maintaining the same playful approach. Moreover, the same activities have been proposed to the new first-year classes in the following years.

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Section 3

Creativity on Science and Arts

Chapter 7

Perspective Chapter: Creative Mapping and Mapping Creativity

Stanley D. Brunn

Abstract

Creative efforts showing places and human/environmental features are integral to understanding our evolution of knowledge. Throughout human history, the construction of maps for personal, commercial or political control has been instrumental in displaying food production, faith landscapes, human migration, transportation networks, environmental conditions, human welfare and much more. The visible products about environmental settings and human well-being from prehistoric artists, explorers, cartographers and geographers to those using satellites, GIS and social media reflect rich imaginations about the place and environmental knowledge. Historical creative efforts are addressed as well as ongoing geographic searches and mapping to improve our understanding of the planet's human and environmental features. Creative curiosities about places local, planetary and extra-planetary will forever be part of human histories.

Keywords: prehistory, Europeanization, hyperlinks, geohumanities, imagination, planetary knowledge gaps, unknowns

Geographers on Afric-maps.

With savage pictures filled their gaps.

And o'er uninhabitable downs.

Placed elephants for want of towns.

—Jonathan Swift.

Geographers find maps exude emotion.

About a place or environmental location.

Far less inspiring are the worlds of apps.

Replete with many uninspiring gaps.

—Stanley Brunn.

1. Introduction

All maps are creative efforts as they are designed, prepared and produced by humans, whether children in elementary grades or adults using super technologies. Maps are also information products that contain material the designer or the client, whether a scholarly community, corporation or state, wishes to display. Behind those constructions are many questions about the map designer her/himself, why the map was constructed, the person or organization funding the production and the desired uses of the final product. These why, for whom, and so what questions are foundational in looking at any map considered, constructed and used. Because of the individual, state and corporate incentives behind map constructions, it needs to be recognized that maps themselves represent some creativity. Two or three individuals constructing a map of a region or showing the same specific feature can produce a different map in size and content as well as colors, scales, legends and title. Those variations themselves represent creative efforts on the part of the designer and producer for the intended audience.

What is important to recognize in any map construction is the creative skills and talents the cartographer brings to the task and the final product. Mapmakers or cartographers can be grouped into several categories, including those that have keen imaginations and talents and those that are simply using an existing map or

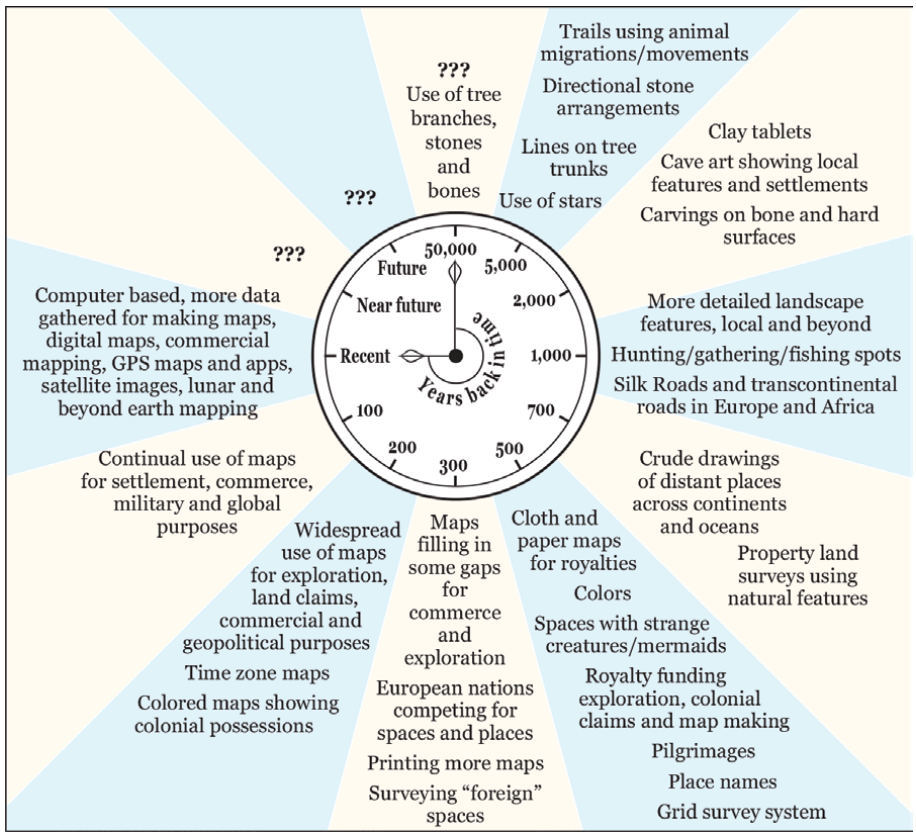

Figure 1.
Evolution of creative mapping: From sticks and stones to GPS maps and apps.

constructing one with only some slight variation in content or projection. There are all kinds of cartographers along this continuum. Those variations in talents were displayed in early cartographers drawing lines on the earth's surface or sketches on cave walls or stone or wood. The early cartographers displayed much creativity in mapping features and colors depicting distances, directions and images of human livelihood and environmental settings. We observe these distinguishing features on maps showing the layout of a village, a favorite hunting ground or fishing spot, sacred landscapes and distant places of enemies. Some early developments in the evolution of human cartography are depicted in **Figure 1.**

2. Early cartographers

Our history of early cartographers has many "gaps," including who they actually were. Perhaps they were a woman or man who exhibited to peers some spatial, esthetic and creative "wherewithal" about places nearby or distant and also displayed those talents in designing tools and weapons, clothing, musical instruments and even reading the stars to predict regular and irregular events. Or they may have been someone with a physical disability who enjoyed listening to stories of someone who eagerly ventured into known and unknown places. Or they may have been those who led hunting and gathering sojourns for daily livelihood or persons of power and leadership who led expeditions into little-known places or military leaders who returned from exploits and provided knowledge that they sought to display on some flat surface. Whoever they were and whatever their purposes were, the earliest cartographers were, like today, both creative in thinking spatially and also seeking how to represent what they observed and learned to satisfy members of some tribe or clan or to advance some commercial or state-powered ambitions.

In describing any creative earth-surface map, it is important to consider and value the early cartographers' ingenuity and ability to depict "place and environment" content in some framework for others to learn from, build on and enjoy. One can look at the construction and evolution of maps and map-making for a very small local forested or grassland area or a coastline or riverine settlement as ongoing efforts to know more about "what is where," but also how to present that knowledge to others for whatever purposes. That use might be to locate safe places to live, good places to fish, hunt and grow crops, places for secure settlements and places to expand and depict place knowledge beyond what the cartographer and/or geographer already knew. Even a cursory examination of early map knowledge in Southern Africa, the Middle East and the Mediterranean displayed on various surfaces (stone, clay, wood, cave walls, etc.) reveals that in the span of several millennia more information was gained about distant places, peoples, landscapes and environments. This accretion of knowledge was gained by those exploring new places and moving into new home spaces and environments, all increasing in an ever-expanding place-knowledge base.

3. European cartographers

Ever so slowly did that accumulated geographic knowledge about human histories begin to appear on more maps. In short, cartographers were beginning to "fill in" some of the "knowledge gaps," some that had persisted and now were "filled" some with the river, a mountain, wildlife or secure place for human settlement.

These increased "place knowledges" appeared on maps produced by states who sent military, commercial and religious expeditions into unknown territories and then returned with new place knowledge. That information the states themselves valued to display political and commercial power and a desire to claim territory for their own prestige and control [1]. In short, maps became not just a source of "surface or flat-earth" information about new places, but official evidence to assert some control and claim over "their" new spaces. Maps as official creative "instruments of power" were used to make claims about places and environments of which they often had little prior knowledge, all efforts to ensure themselves and others that they did not invade their "new spaces of control." During the Ages of Exploration and Discovery, especially beyond Europe and the Middle East, they were constantly competing for extra-territorial efforts to not only gain more knowledge about new and distant places but also to produce detailed and colorful maps that clearly showed state sovereignty. These maps not only depicted their exploratory efforts but also showed their claims over previously unmapped and distant places. These innovative and imaginative colonial expansion maps of "cartographic imperialism" showed possessions, some place name features related to state explorations along coasts, mouths of rivers and distinct physical features such as mountains, deserts and also settlements [2]. Many unmapped indigenous-named features were renamed.

Creative cartography was in full swing during Europe's exploration and discovery history [3]. Maps were among the best ways to show that those in power had firsthand knowledge and control about places for human settlement. And they could display that knowledge on maps (not many until printing presses) for their own constituents. More maps gradually appeared in public places to show military and corporate power and control but also in education settings. These were detailed maps of some regions, such as Europe or eastern North America, but also crudely drawn world maps of the continental interiors of Australia, Africa, Latin America and Asia. Surely, these early world maps were inaccurate by contemporary standards, but they were very important in establishing claims by early European countries funding exploratory voyages and later settlements. These early world maps also were Eurocentric; that is, Europe was in the middle. What was at the "map edges" considered less important? The words "Near, Middle and Far" were used in European labeling of the worlds beyond. This subtle labeling of regions is a legacy that remains to this day with millions associating Europe as "the Center of the world." Consider the contemporary use of the "Middle East" instead of Southwest Asia and "Far East" instead of East Asia. And do not forget where 0-degree longitude exists—in Greenwich, England. Europe was the center of early world map construction and Eurocentric views remain important in world visual news reporting.

Cartographers over the centuries sought to "fill in the gaps," especially gaps in maps of continents. That task has always been a major one for those studying all places on Planet Earth. The first world maps of Africa, North and South America and Asia, as well as oceans, displayed much emptiness. The answer for the Earth-bound cartographer was simple; there was next to nothing known about "what was where." The absence of any knowledge base from a discovery team meant that something "had" to be placed in those blank spaces. Not surprisingly, the cartographer himself (most were men) placed huge whales in oceans, mermaids along shorelines, and imaginary mountains and deserts "somewhere." Strange and huge wildlife creatures (snakes, elephants, etc.) or some strange-looking people were also inserted in places where place knowledge was absent. It was both a terrae and an aquae incognitae.

Increasing human settlement and migration from Europe and evolving cartography gradually filled in many of these gaps with specific information from explorations

into continental interiors, along coastlines, into mountains and also contacts with indigenous peoples. Creativity blossomed with more place names and political boundaries showing territorial claims in lands and landscapes known and unknown, and with Europeans superimposing their own "knowledge base" over any existing indigenous geographical naming. The "Europeanization" of the world did not exist to the same degree in interior Africa, Southwest Asia and Central Asia as it did at local scales in Europe. The European claims and boundaries on maps were often defined by major features such as rivers or mountains. Connecting coordinates by strait lines defined boundaries of territories and colonies in Africa, North and South America and Australia. Place names defining European control and settlement eventually were common in initial and subsequent settlements around much of the world. Not knowing "what was there" or "who was there" was not that important. What was important in a state's raison d'être was establishing a claim before another colonial power and constructing and displaying maps that showed power and control. The Berlin Conference in 1884–1885 of European powers became the defining point in colonial boundary drawing in Africa, the impacts which remain to this day. Maps were used for political, commercial and military purposes as we have observed in boundary and territorial conflicts over land spaces in the past five centuries. These two-dimensional maps still serve as places of conflict, power and control, even in a cyber world.

The creativity behind European mapping efforts of Earth's space extended far beyond their initial uses by the state. Behind those early state-funded explorations into distant places, by Europeans especially, were those in cooperation with the commercial sector. Their goals were to find sources of additional revenue for settlement, wealth and power. These enterprises not only added to their own power, domain and influence but also stimulated competition with other states for prized non-European territorial spaces distant from Europe. These were not simply to find sources for more tropical fruits or valuable minerals but as spaces to spread their culture (political, religious, heritage). Supporting these European efforts were African slaves they brought to the Western Hemisphere in large numbers and European diasporas emerging in South and Southeast Asia, Australia and the Pacific. Each new group of Europeans brought Europeans in contact with existing indigenous populations. The objective was to establish European cultural and political systems. Those explorations were evident in European place names on maps and also in renaming existing indigenous places on European settled landscapes. Again, power was evident in the construction and display of information on a state map. Colonial maps of continents were constructed in English, French, Spanish, German, Dutch, Portuguese and Italian. Continental maps were also creative in using a variety of colors to effectively show spaces and places that are "mine, not yours." The colorful mosaic of political spaces existed into the 1960s and 1970s on world maps showing European colonies in Africa, Asia, the Caribbean and the Pacific. Cartographers employed by governments and companies making maps for school or home use were kept busy constructing maps that reflected name changes associated with independence, but also peaceful and violent transitions resulting from conflicting border claims.

4. A gradual global awakening

Describing and discussing state maps and mapmaking processes and patterns into much of the first half of the last century was much different than the last half [4, 5]. Political maps were often standard in projections, content, topics, symbols and legends.

World political maps showing national boundaries were common as were those showing colonies and results of conflicts. Most changes were about territories and land boundaries. Very few changes were about oceans as they were basically empty spaces with a little depiction of valuable natural resources for minerals and fishing or conflicting boundary claims and areas of regional military conflict except in Europe, Asia and the Pacific. For those in the geography community, maps in textbooks were basic reference maps that showed the names of countries, location of major cities and major physical features such as rivers, mountains, deserts and climates, vegetation types and soil categories. In economic subjects, again the topics were fairly standard: major agricultural regions, mining sites and industrial centers and population numbers and densities. In what today one would call the Global South countries, maps of incomes were usually per capita GNP, which showed wide gaps between the "developed and underdeveloped regions" (these were the labels used). Even a casual examination of research articles and elementary, high school and university textbooks published before 1960 revealed more uniformity than creativity in content. Geography classes using maps at that time were focused on description more than interpretation and were more concerned about what might be called "standardized reference materials" about basic content than any alternative projections or topics or themes that might be termed thought-breaking and creative. Also, of note is that Africa was usually the last world region discussed in world regional texts. Australia was considered before Africa. Oceans, covering three-quarters of the planet, were ignored.

During the late 1950s and early 1960s, former European colonies became independent and adopted new names; they were also the sites of conflicts, some serious, in African, Asian and Caribbean regions. Accompanying these changes were changes in the human face of the world, beginning with some new terminology and topics previously unstudied or understudied. These included maps of rich and poor countries or developed and underdeveloped countries or developed and less developed countries. The labeling of regions changed. New topics such as "economic developments in former colonies" were addressed as were "intra-national and inter-regional conflicts," and "emerging resource-rich regions producing oil, iron and other minerals for the developed worlds." Economic aid for literacy programs, disease outbreaks, new state infrastructure and urban development presented challenges to those preparing maps for the private sector, for states, for schools at all levels, and for a public that was slowly experiencing the end of colonialism and the beginnings of globalization.

Other changes in the cartographic realm were also occurring at this time. Among the changes where how Antarctica was being viewed. The Treaty of Antarctica in 1959 resulted in the carving up of the spaces for scientific study by nation-states. Soon thereafter additional maps showed the expansion of territorial coastal waters accompanying United Nations Law of the Sea negotiations in 1982. These negotiations were related to offshore fishing and oil and gas exploration, the carving up of sea spaces such as the North Sea, measuring pollution levels and defining areas of water conflict. Maps were increasingly being used to show the spread of diseases and tourism sites and cruise ship networks for emerging tourist economies. Three additional groups that emerged as major producers and users of maps for their own constituents were the corporate and environmental sectors and the United Nations. An integral part of the increased globalization efforts of many small and large corporations was to use maps showing the location of consumers or markets as well as potential investments in agriculture, industrial development and especially energy economies. Advertising informed many consumers about the locations, new countries and their pronunciation, profitable investments and new markets. Environmental and conversation

organizations with international contributors expressed global concerns about shrinking natural habitats for endangered wildlife, pollution levels, global warming impacts and human welfare. All used maps to inform their supporters about the need for increased planetary awareness. The United Nations during the 1960s and 1970s was becoming heavily involved in a wide variety of human welfare and human conditions, especially related to issues about refugees, poverty, literacy, political conflicts (especially Southeast Asia), gender disparity and the spread of diseases. All these efforts contributed to a slow global awakening of places heretofore unknown to many residents of the planet.

Many of this human development and planetary awareness efforts included creative maps, not only by cartographers but also by those with training in the arts and photography, computer graphics and the visual humanities. They collectively demonstrated the importance of an emerging "popular cartography" that went beyond the construction of maps primarily for state purposes. Popular journals like the *National Geographic Magazine* were beginning to publish articles that addressed global and planetary issues along with photos and maps of places, ecosystems and the human condition that had seldom appeared to global visual audiences previously. Visual learning with photography and maps was on the rise. The interest and popularity in these topics generated more research on these topics as well as special television programs, global tourism, international NGOs with caring missions and United Nations efforts to improve human/environmental worlds. Maps were integral to many of these initiatives.

Those awakening efforts continued into the 1970s and 1980s with increased calls for a greater understanding of what was happening in many world regions as well as new topics and approaches to traditional topics [1, 6–11]. "Globalization" emerged as a term that replaced "international relations" in many academic, governmental and nongovernmental circles and discourses. Trade was no longer only a topic of interest between rich and poor nations. Health, gender variations, education and welfare programs were depicting concerns for human and humane conditions: massive rural-urban migration, rampant population growth in rural and urban areas and loans for a variety of human development initiatives. These were at the forefront of world regional and global planning. These topics began to be addressed in scholarly journals of the social sciences and what today we call the environmental sciences. Maps were being included in these presentations to show "what was happening where." The emergence of new states on the world political map, the appearance of new topics about human welfare and the beginning of environmental awareness were associated with an awakening of scholarly and policy worlds about topics that had long been silent.

5. From human to humane geography

While global awareness about the planet's environmental future was emerging, simultaneously there were calls for more attention about the planet's human family. The social sciences were concerned about population numbers and growth, gender inequality, economic livelihood in different sectors and nongovernmental organizations. These scholarly communities realized that greater detail included mapping topics about the human condition that were ignored. The actual "causes" for this greater interest in the human condition can likely be traced to several sources, one being the increased awareness in "visual earth" worlds from satellite imagery and greater global media coverage about "what is happening where" on the planet. This increased

visualization was occurring at the same time there was greater interest in many global worlds, especially in the "global rich" world and efforts to study and improve human/environment worlds. Already much of the world was experiencing some degree of social unrest about the "norm" in social values and political worlds. Protests, parades, legal challenges as well as race, gender and class divisions were fueling both mild and serious challenges to existing bureaucracies whether in the commercial, secular or political sectors.

Examples of these challenges were on full visual display for national, regional and global audiences around the world in television reporting, magazine content (more than words) and then on personal computer screens. They were transborder, international and cross-cultural accounts about "a visual planetary livelihood," not restricted mostly to the daily lives of those in the rich and developed worlds. The challenges for those in the geography and cartography communities were twofold: one, to learn more about their root causes and impacts; and two, to present and inform/educate public institutions and organizations about these social, political and environmental changes that were occurring almost "everywhere." Corporate, scholarly and political communities began to look seriously at issues about the causes of poverty, racial and gender discrimination, exploitation, crime, class warfare and welfare, health conditions, disease outbreaks, public spending on education and food distribution, environmental quality and justice, mental/cognitive maps and the many kinds of conflict (economic, religious, cultural) that were emerging and visible on the planet. It was not enough for social scientists to just explore and discuss these issues in a non-spatial context. All these issues exist in spaces, places and regions. The "where" feature needed to be examined not only as an issue but also to explore "why" or root causes. These challenges presented many "firsts" to those looking at the above topics, that is, to look beyond the concept or terminology to address mapping where these conditions and problems were occurring and to whom. Mapping was considered an integral part of addressing serious political, economic and social solutions and presenting humane solutions. These issues presented challenges for scholarly and policy communities in their own scholarly discipline, but also in informing a wider public. They were not just a concern for those in an Australian or Italian suburb or a port city in Southeast Asia or a coastal West Africa village, but everywhere on the planet. Human geography itself was changing not only in content, that is, what it studied, but how it presented and represented materials to global visual communities. Creativity was called for in presenting, informing and bettering the human and environmental worlds.

Accompanying these changes in the social and behavioral sciences were also changes between the sciences and the humanities. The worlds of those studying language, art, film, music and literature are often thought of as being separate and distinct fields different from those in the social and policy sciences. But they really are not completely separate scholarly fields of exploration and it is time to explore some common intersections between these two broad categories. There have been small, but increasing visible and influential, scholarly communities in the social sciences that are exploring some common grounds with those in the humanities and vice-versa. One example is the professional journal *Geohumanities.* Authors explore the intersections between music and culture, film and social conditions, language and the state, minorities in advertising, gender and city planning and architecture, diseases and environmental therapy, and landscapes of art and social/political protest. Many pioneering scholars in the social sciences see the visual and performing arts as ways to better understand the human condition. The same also applies to those in the arts,

film, and drama who observe many common linkages when it comes to looking at morality and the arts, the politics of caring, politics and museum displays, political protests and parades, censorship and politics, racial and gender discrimination in public education, television or internet policies, and politics as being a major influence in religion, sports and daily life. The recognition of overlapping spheres of interest and policy formation are stimulating some creative efforts by exploring some common grounds [12, 13].

Not to be eliminated from this discussion is how computers and computer technologies have changed not only the ways maps are made, but also the content of maps themselves. The very notion of having computer-designed maps radically changed the ways they were prepared and produced as well as their use in instruction, public policy, the corporate sector and for personal use. Creativity was and is much at work in the cartographic projections that were used, the designs themselves, the topics or themes mapped and their implementation for multiple purposes in the classroom, for scientific analysis and public policy and to prepare datasets on new topics. The technologies ushered in completely "new ways" of looking at "old topics" and "new ways" of exploring "new topics" at personal, community, national and global scales. The entire field of cartography in the 1980s and 1990s changed—the way maps were prepared, designed, reproduced and used [14–16]. Entire new subfields emerged including popular cartography, citizen cartography, critical cartography, medical cartography, behavioral cartography and digital mapping that brought new perspectives looking at traditional cultural, historical, political and environmental topics [17, 18]. Many of these innovations were considered radical as they included topics not considered previously. All fields and subfields of geography were affected by these innovations in designs, production and use. They include climate change and weather forecasting, natural disaster preparedness and impacts, electoral and redistricting geography, gender, race and justice issues, health care planning and the diffusion of diseases, children's and tourists' perceptions of landscapes, time/space logistics in human mobilities, language and religious diversity, and fluctuations in demographic change and ad hoc market economies. Complementing these emerging and creative cartographies of the earth's surface are maps using GIS systems, satellites and social media technologies. All continue to inspire new and different ways of not only studying a topic or a place but also mapping it [19–21]. The creators of these and other ongoing mapping innovations include a broad mix of interdisciplinary and international scholars who seek to know more about the importance of constructing, informing and educating both traditional and new map users.

6. Challenges in creativity and cartography

There are two realities in our thinking about geography and cartography intersections today. One is that we now have more than enough maps about every place and landscape so there is no reason for anymore. However, that geographic arrogance needs to be countered with some humility that tells us that we neither know much about some places nor we have maps of some important topics. Geographic knowledge depicted on maps, whether on traditional early twenty-first-century maps of places, landscapes and regions, is very uneven. If we consider the world's nearly 200 states, there are many more maps about some states and regions than others. The unevenness is in many cases reflected in a rich versus a poor world, with a few rich countries having many more maps than most poor countries. To fill or narrow these "gaps," we will

need new maps that portray existing and familiar features about countries and cities, such as economies, cultures, population growth, racial and gender inequities as well as transport arteries, tourism attractions, elections results and health care. The second reality is that something is happening to the "mapping worlds" today. A case might be made that with increased globalization, however that is defined in a transdisciplinary, cultural or political context, there is less need for maps. The argument continues that the names of places in the news about the world's economies or cultures or politics are becoming more familiar to the ear and where they are on a map is not important or necessary. Advocates of this position might argue that time is more important than distance, that is, how long it takes to contact or get to a place in person or by some machine technology is more important than if it is north or south of the equator or an interior or landlocked country. These same individuals support the thinking that in a "mapless" world one does not need a map to travel from X to Y. The GPS aficionado would declare that having such a device in a personal car or on a plane or your wrist is all you need to get from a point of origin to a destination. The travel time is important and direction and distance and what is "in between" are not. Paper and folded maps, which were once important, are considered almost antique documents for those traveling from Point A to Point B. Users of such maps care about what is "in between" points; their car dashboard map or social media map is more like a toy or gimmick than an instrument that evokes curiosity about a place or landscape feature. A cyber map is like a blank piece of paper with a few points connected.

For those who think that we know much, or too much, about the planet, they need more than a dose of humility to reflect on the unevenness of our planetary knowledge. This vast unevenness in knowledge and maps is reflected in places and subjects we know much about, places we know little or very little about, and places where we have almost no knowledge or maps. The terrae incognitae on the planet exists not only in polar and tropical worlds, but also in sparsely populated areas on all continents, including Antarctica. The map knowledge about places within the United States, France, Italy, and Japan is just as uneven as our map knowledge about Brazil, China, India, Indonesia, Nigeria, Mexico, Peru or the Democratic Republic of the Congo. The "silences" are rampant when it comes to mapping knowledge about major and minor cities, ethnic heritages, languages, religions, livelihoods, migrations and archeological finds. If we placed a grid of equal-sized cells over a world map and entered in each cell the amount of knowledge we have today, the result would be another map of vast unevenness not only on continents but also within countries and cities. That same map would also include squares over the world's oceans and seas where there is vast unevenness in place/environment knowledge. In short, the geographic knowledge about what is below the surface is next to nothing in most places. There is some knowledge about potential mineral deposits or valuable fishing grounds or territorial sea conflict or major transport routes or origins of violent weather, but there are many places and regions with few or any maps of what is below the surface. The aquae incognitae are one of the major regions or places on the map that beg for more place knowledge about subsurface landforms, migrating fish, buried mineral deposits, environmental pollution levels, potential tourism sites and perhaps even human habitation.

A cursory examination of present-day maps and map knowledge about places and environments has many striking similarities to those earliest human sketches on cave walls, rocks, wood and clay. They were using both their knowledge and their imaginations to depict "what was where." Those creative-guiding impulses led them to prepare graphical and cartographical messages for their own knowledge and use and also

for succeeding generations. Cartographers today using twenty-first-century cameras and satellites, whether women or men, amateurs or professionals, display some of the same artistic skills and curiosity levels as the ancient cartographers to map and remap familiar and unfamiliar places on Planet Earth and beyond.

7. Creative mapping is alive and well

Maps are essential efforts that aid our understanding about the importance of places, landscapes, regions, spaces, networks, surfaces and boundaries in many disciplines and fields of study. They are not, nor should they be considered, only the interest and concern of geographers or cartographers. Rather "umbrella" views of these concepts include displaying or picturing them graphically in some ways to those in many fields. Even a "surface" or casual thinking about earth places, spaces, surfaces, landscapes and boundaries will acknowledge that these are, or can be, a focus of those studying biology, geology, astronomy, architecture, health care, law, religion, languages and economies. Some study the earth's surface and features, others below the surface and others what is above the earth's surface. All these, to one degree or another, can use these geographical concepts and perspectives to explore the place or an environment concept in studying colonial, military or economic history, human rights and welfare, environmental issues and topics in biology, psychology, geology, society, politics, oceanography, astronomy and other fields. Maps in one way or other represent an important perspective or way to look at human relations and environments at all scales and between the social, natural and physical sciences and the sciences and humanities. Too often geographers may think that maps are the "singular" domain of those in geography. That is a rather narrow way of looking at the worlds around us, as places, locations, networks, surfaces and landscapes are all at the heart of studying many topics in many disciplines.

Recognizing the stark reality that there are thousands and millions of maps that can be constructed and hundreds of atlases that might be compiled at local and universe levels, we focus the discussion now on earth-maps that are familiar to many in an everyday world. This is the scale that geographers study and prepare maps, that is, places where people live and have lived, work, play, worship and interact. Other disciplines use spatial perspectives at other scales, including microbiology, geology, meteorology, oceanography, archaeology, law, physics and astronomy, all of which study and map many of the same concepts geographers use in seeking better visual knowledge levels to understand above and below the earth's surface.

In the following paragraphs, I present and discuss some examples of innovative maps that will help us better understand the earth's inhabitants and environments. In each example, a salient point is that "there is much more we do not know about a place or landscape or region than we do know." In the contemporary high-tech world using huge databases, unimaginable even three decades ago, there are ongoing efforts to examine the nature of these databases and to map distinguishing features about a place or a region or a landscape. Many advanced technologies use GIS or Geographic Information Systems. These utilize massive databases looking at weather and climate, disaster preparedness and impacts, global warming, land-use changes, population shifts, human welfare (rich and poor) gaps, elections, shifts in cultural, and political and religious preferences. Many innovative computer programs were written to map key features of some human or environmental feature or event. The collection and availability of these interdisciplinary and international databases have stimulated

geographers to explore the existing status of some phenomenon or a set of related phenomena at local, city, national and international scales. GIS techniques and models today are used in a wide variety of fields and disciplines seeking both to visually present the existence and appearance of some feature or using those maps and related graphics to consider new ways to understand interrelated, or previously considered unrelated, phenomena.

Another computer-driven innovation in the past several decades has been the emergence of search engines which provide massive datasets that can be used for popular use or scholarly research. Yahoo and Google were pioneers in these explorations; Amazon, Wikipedia, Facebook, Twitter and YouTube are also rich sources of information. The Google enterprises include massive generic databases about many topics and themes as well as data about regions, countries and cities. A second database called Google Scholar includes citations for articles, chapters, books and other materials, including maps, that appear in scholarly literature bases. Two additional valuable features of the Google databases are that the entries or hyperlinks are available in languages other than English and that the hyperlinks are ranked according to some industry-defined formula. That ranking is neither based on the most recent year an item was published, nor the number of citations, but probably some combination about the ranking of the journal. For example, one can examine the top 10 or 50 entries in the Google Scholar database to identify major recent research findings on a topic. In Google searches, one enters, for example, the name of a country and feature, such as, Baltic States + climate change; South Africa + COVID 19 vaccination rate; China + minorities, or the Mediterranean Sea + maps of water pollution. Entering these terms in the Google Search box will yield the number of hyperlinks available. The number of hyperlinks, as well as the rankings, constantly change and will vary depending on the language used in the search. The Google search engines provide the inquisitive scholar with contemporary and historical source materials and are the most important sources scholars use. In this context, they are more valuable than using current materials in college, university or national library collections or looking at the contents of a few major journals.

In undertaking this research using Google Scholar entries, I had little idea what would emerge from collecting the data as well as how best to map the results [22, 23]. The maps, as is noted below, contain some patterns and features that were unexpected. They clearly demonstrate that the knowledge base of a topic or of countries or cities is very uneven and that those differences raise questions about the best way to map the results for research either about a single topic such as Pacific Islands + missionaries or a region such as South America or North Africa.

The database was used to examine "how much do we know about a given country." The raw Scholar hyperlink data are from an English language search conducted in late November 2021 where the name of the country was entered into the Google Scholar search box. There were vast differences, as one would expect, from those states at the very top and those at the very bottom. **Figure 2** is compiled from these data. The Tokyo metro area has a population (39 million) almost equal to that of Canada, Poland or Afghanistan or the combined populations of Kazakhstan and Zambia or Syria and Guatemala.

Another perspective is gained by examining maps showing the vast differences in the absolute number of Scholar hyperlinks for the 198 countries. The countries with the most Scholar hyperlinks were the United States (6 million), Switzerland (5.8 million) and India (5.7 million) and the fewest were Eritrea, St. Vincent and Grenadines, Bahrain and Tuvalu, each with less than 75,000 hyperlinks. Because of the vast

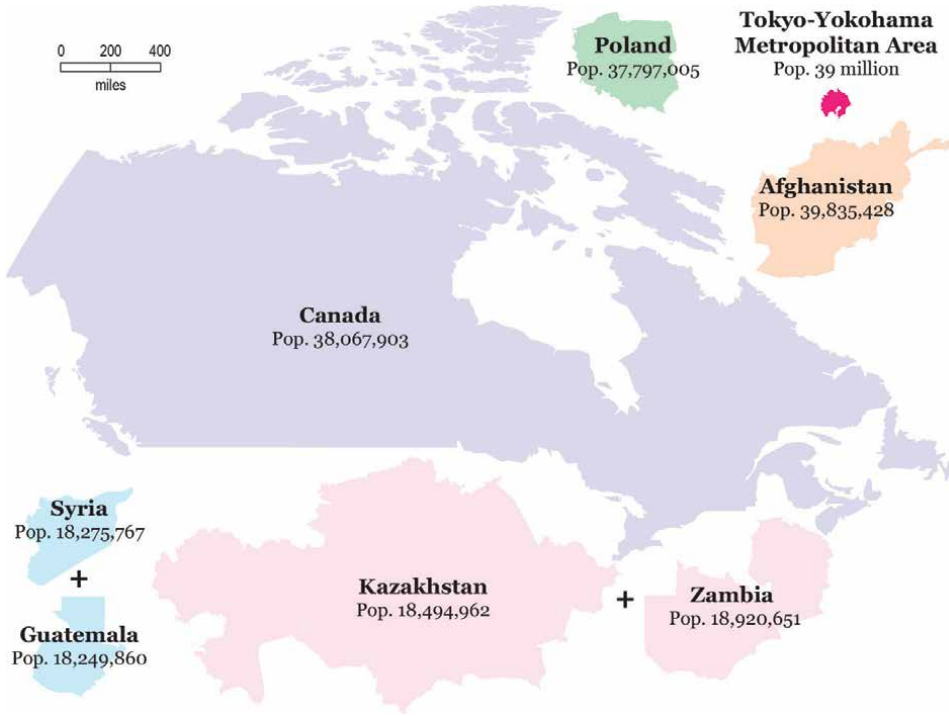

Figure 2.
Maps of comparable population. Each area has about 39 million residents, which is about the same as the total population of the following 53 countries combined (listed from smallest to largest population): Vatican, Nauru, Tuvalu, Palau, San Marino, Monaco, St. Kitts & Nevis, Marshall Islands, Cayman Islands, Andorra, Antigua & Barbados, Seychelles, Tonga, St. Vincent & Grenadines, Grenada, Micronesia, Kiribati, St. Lucia, Samoa, Sao Tome & Principe, Barbados, Vanuatu, Iceland, Bahamas, Belize, Brunei, Malta, Cape Verde, Suriname, Western Sahara, Montenegro, Luxembourg, Solomon Islands, Bhutan, Guyana, Comoros Islands, Fiji, Dijbouti, Eswatini, Cyprus, East Timor, Mauritius, Equatorial Guinea, Estonia, Trinidad & Tobago, Bahrain, Latvia, Guinea-Bissau, Slovenia, North Macedonia, Lesotho, Botswana and Gambia.

differences, the data were ranked into quintiles (**Figure 3**): 1–39 (the most), 40–79, 80–119, 120–159 and 160–198 (the fewest hyperlinks). A similar procedure was used when examining the number of maps about each country in the Scholar database. The United States (4.3 million) had the most followed by the People's Republic of China (3.5 million), Germany (3.5 million), France (3.4 million) and Japan (3.2 million). At the other end of the spectrum these countries had fewer than 10,000 Scholar hyperlinks each: Ukraine, Nauru, Micronesia, Belarus, Bahrain, Tuvalu and St. Kitts. The bottom map also shows the vast unevenness in the number of maps in the database.

Figure 4 shows the vast differences in the number of hyperlinks among the world's capitals. In most countries, the capital city is the largest city, has the most hyperlinks and is most important culturally, commercially and politically. Exceptions are New York City (vs Washington, DC), Toronto (vs Ottawa, Canada), Sydney (vs Canberra, Australia), Cape Town (vs Pretoria, South Africa), Lagos (vs Abuja, Nigeria), Mumbai (vs New Delhi, India), Auckland (vs Wellington, New Zealand), Jerusalem (vs Tel Aviv, Israel) and Istanbul (vs Ankara, Turkey). The data were gathered by entering (in English) the name of the capital city and the country into a Google search (such as, Paris, France; Lima, Peru; Port Moresby, Papua New Guinea; Bratislava, Slovakia). There are very significant differences between those cities in Zone 1

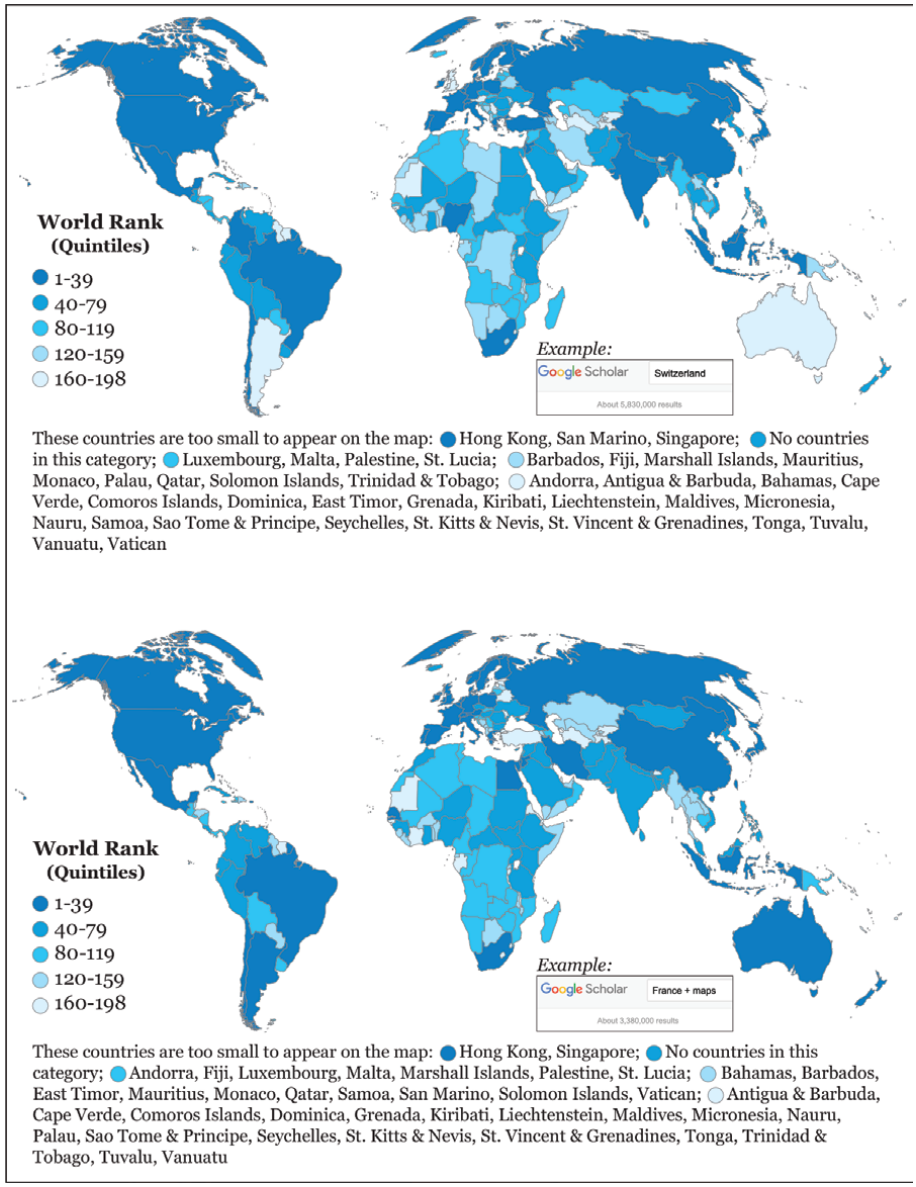

Figure 3.
The knowledge base of countries (top) and country maps (bottom) according to number of Google Scholar hyperlinks.

(the most hyperlinks) and Zone 6 (the least). Regional differences again are stark, with much more knowledge in the database for European than for African (orange type) and some Asian (black type) countries. Examples of capitals with less than 50,000 hyperlinks were: Monrovia, Liberia; Minsk, Belarus; Vatican City and Libreville, Gabon. The pie graph clearly shows that six cities in Zone 1 have one-quarter of the hyperlinks of all world capitals.

The data also revealed vast differences in the number of maps about capital cities. Some capital cities have many maps and others very few. Paris, London and Berlin have over 1 million map hyperlinks; Cairo, Egypt and Ankara, Turkey somewhere in

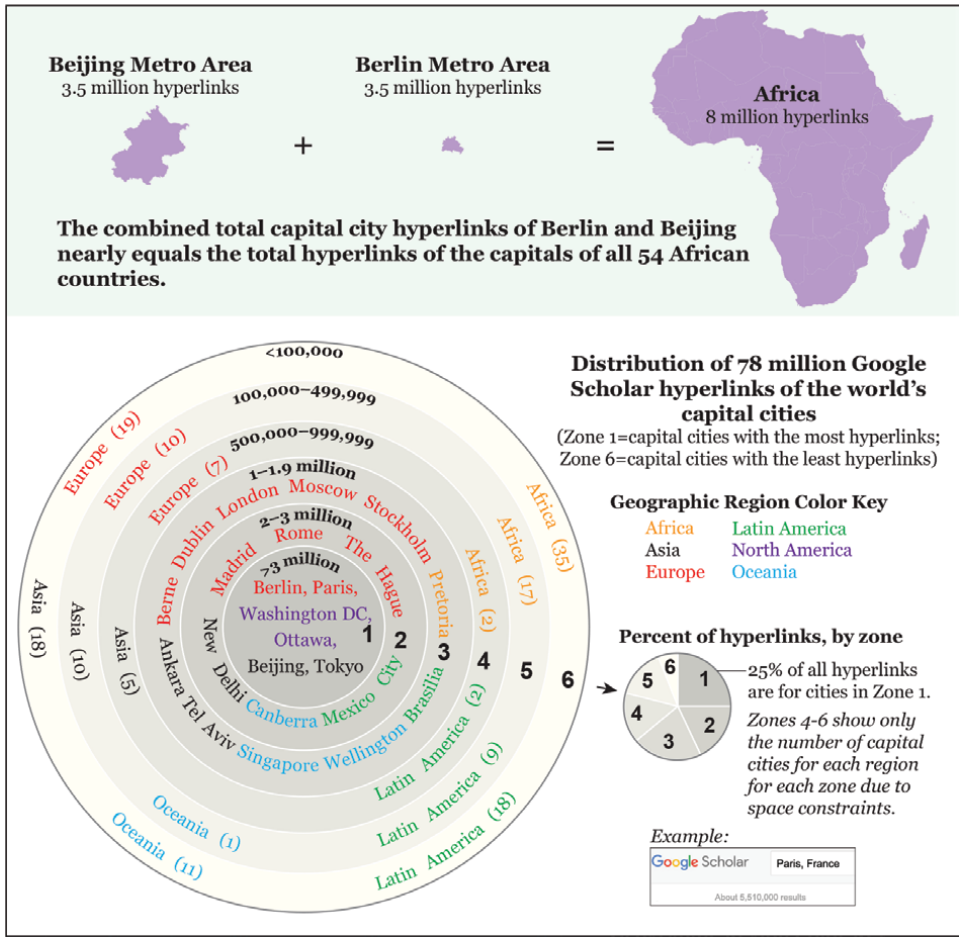

Figure 4.
The number of Google Scholar hyperlinks shows a large variation in available information about the capital cities of 198 countries.

the middle (99,000 and 62,000 respectively) and Monrovia, Liberia; Georgetown, Guyana; and Asmara, Eritrea had fewer than 10,000 each. The top of the figure shows that the combined Scholar hyperlinks of Beijing and Berlin approximate those of all 54 African capitals combined.

The third set of maps explores the vast differences in the amount of information about major water features, specifically oceans, seas, rivers, bays and straits (**Figures 5** and **6**). There are some major "knowledge gaps" in the scholarly literature about these features. For some seas and rivers, there were many studies, for others very few. Compare the North Sea and Persian Gulf (#1 and #20 on **Figure 5**) or the Congo and Mekong Rivers (#9 and #12 on **Figure 6**). A strong case that can be made from looking at global and regional patterns is that we are truly witnessing aquae incognitae. Additional research could be undertaken at below surface physical features, climate change patterns and natural disasters, fishing and mining economies, and coastal and island tourist destinations.

"Explorations into the unknown or little known" are extended to the eight world maps in **Figure 7**. Each world map is empty except for ??? which indicates that it

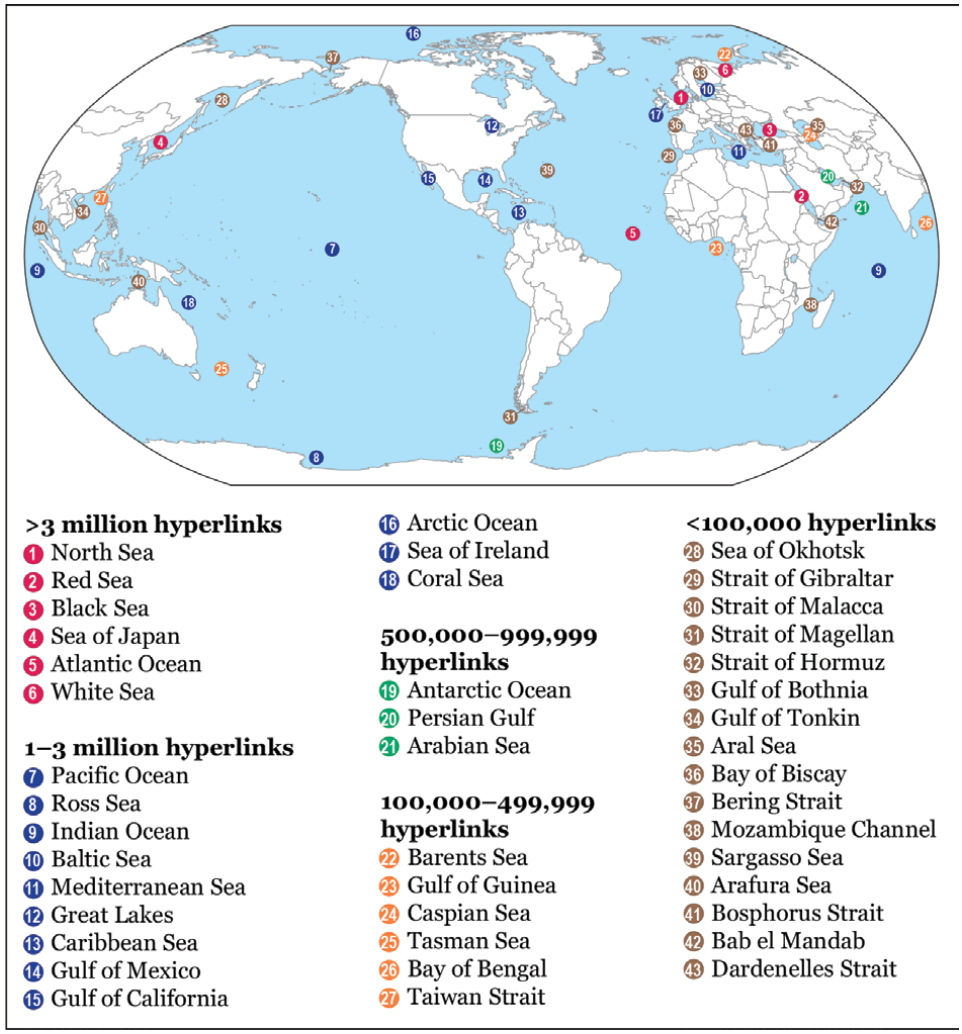

Figure 5.
Knowledge base of planetary water features.

would be useful to study the topic in the title. These include developing a database to explore social media networks, users and content; in what countries and especially what world regions scholars are studying global warming; what countries are the leaders and laggards in LGBT issues about rights, discrimination and empowerment; what networks of successful programs are addressing seasonal as well as deep poverty and illiteracy in Africa, Asia, Latin America and what role the UN, EU and faith communities are playing in these efforts; where the most successful national sustainability projects are when it comes to green energy projects, promoting biodiversity and innovative conservation and agricultural practices to reduce global warming; and what steps are most successful in preparing for natural disasters and reducing human and environmental impacts. These representative maps are meant to stimulate scholars in the social and natural sciences and the humanities to explore pioneering research in rural and urban areas in their own countries and major world regions.

River Rank by Length	Rank by Hyperlinks	Rank by Maps	River Rank by Length	Rank by Hyperlinks	Rank by Maps
1 Nile	6	6	11 Lena	12	13
2 Amazon	4	3	12 Mekong	11	11
3 Yangtze	7	4	13 Mackenzie	10	8
4 Mississippi	2	2	14 Niger	9	9
5 Yenisey	18	18	15 Brahmaputra	14	12
6 Yellow	1	1	16 Murray-Darling	16	16
7 Ob-Irtysh	20	20	17 Tocantins	17	17
8 Río de la Plata	3	10	18 Volga	13	15
9 Congo	5	7	19 Indus	8	5
10 Amur	15	14	20 Euphrates	19	19

Figure 6.
Knowledge base of the 20 longest rivers.

The final map is a "blank" map (**Figure 8**). It is meant to stimulate the reader to consider tackling a topic important at any scale. The map could be a village, a city neighborhood, a large or small city, a coastal or inland tourist destination, a political capital or a university city, a country or group of countries, a region of a continent or a continent. It could also be related to features about humans including migration routes, children's and women's rights, networks and patterns of those barely surviving, border crossing points, crime rates, health/disease conditions, unemployment rates, etc. In an environmental context, it could be placed annually experiencing tsunamis or hurricanes or occasional earthquakes or a river basin, an ecozone or storm track region. All of these places and landscapes have features that could be mapped but seldom are. The list of sites could be expanded to include places of spouse, child and elderly abuse, child labor, human trafficking routes, historical and contemporary slavery networks, dispersal or clusters of undocumented refugees, white collar criminals, adults unvaccinated against COVID-19, community quilting projects, unregistered voters, foreign investments and ownership of countries and cities, geographical references in religious and secular music, variations in the books ordered for local libraries in a large city versus small city, elderly populations not covered by medical programs, geographical roots (home towns) of those in diplomatic corps and

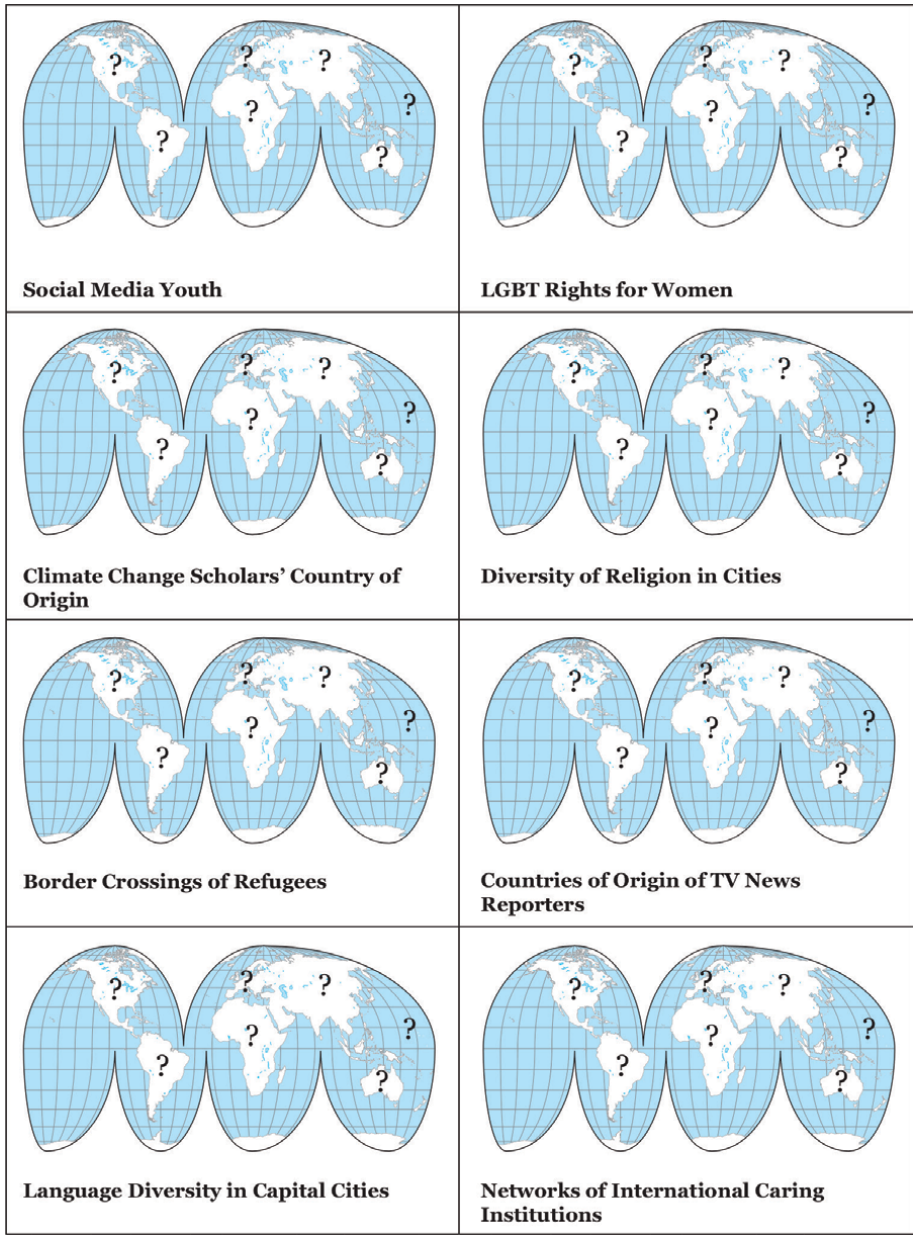

Figure 7.
Exploration into cartographies of the unknown.

faith communities, the densities of foreign language translators and services, social class neighborhoods, time-space patterns of the disabled, news from little known places (Africa, rural areas in the Global South), underemployed, college dropouts, networks of volunteers and criminals, the daily travels of mobile health workers and volunteer lawyers for indigenous peoples, devolution patterns in global tourism due to COVID-19, fashion industry and sports communities' responses to COVID-19, song lyrics in COVID-19 music, mapping morality in COVID-19 times, immobility during COVID-19 times, changes in bird migrations with climate change, and many more

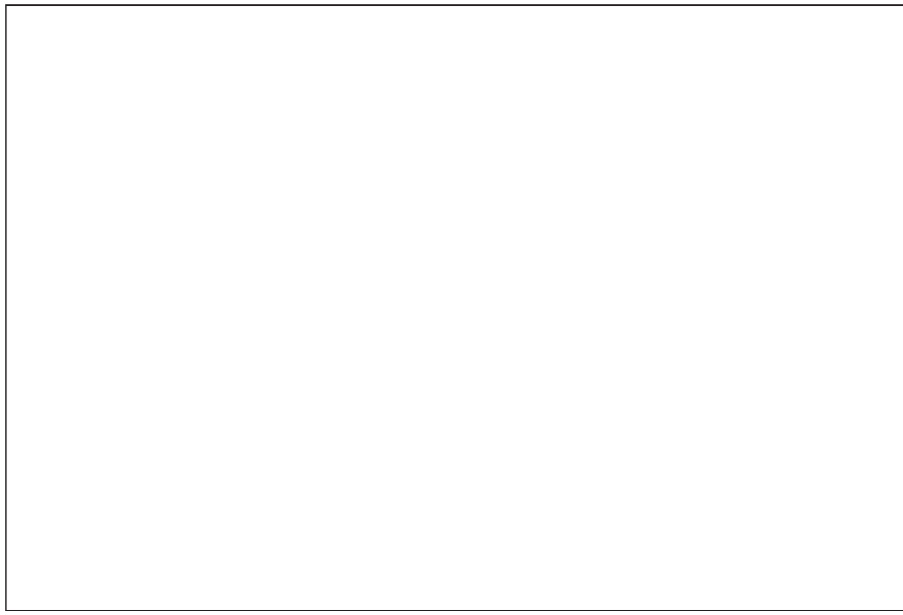

Figure 8.
Invisible, silent and unknown geographies.

topics. The world is literally full of unexplored silent and invisible spaces awaiting the attention of geographers at all scales.

8. Going forward with inspiration

Humans throughout history and across continents have always been inspired to communicate with others in various ways. These inspirations have come from words and phrases in narratives and music and individual and community efforts bringing empowerment and human progress. Expressions about emotions, togetherness, heritage and communication have also come through "the visual." These can be in sketches, drawings, paintings, monuments and photographs. Maps are part of this visual repertoire as they are human constructions that reflect the efforts, insights, expectations and imaginations of the creator, whether that be an individual depicting some topic or pattern in some original way with the use of colors and designs or an innovative computer programmer empowering the elderly with disabilities or a group effort tackling some controversial environmental problem. What is paramount in promoting ongoing creative mapping as well as mapping creativity is incorporating both a "longitude and latitude thinking" about places, locations, surfaces, networks, boundaries and environments. These efforts emerge when thinking about the subject matter outside the traditional "boxes" or "frameworks" of geographic thought and human experience. These include exploring the perspectives that come from exploring art, music, drama, and words as much as networks, communities, big data sets, bridges and systems. Throughout human history, both amateur and professional cartographers have displayed creative talents in mapping what they see, experience and value around them. From the earliest cartographers using sticks and stones to present-day digital, social media and satellites, the interest, appeal and use of maps

continue to inform, value and display the creative worlds surrounding everyone and every place local, planetary and universal. In these efforts, there are no ends.

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Chapter 8

Creativity in Science and Art

Franc Solina

Abstract

This article compares creative work in science and the arts based on the author's own experience. In the field of science, the author works in the field of computer vision and is most interested in modelling 3D shapes from depth images. He started to collaborate with new-media artists almost three decades ago to produce interactive art installations that used also computer vision technology. Gradually, he developed also his own art installations. Ten years ago, he took up sculpting in wood and stone using the direct carving method. He has sought to enrich his sculptures in a virtual dimension by means of video projection. The scientist/artist describes how his experience in computer vision modelling 3D shapes has influenced his sculptures and compares how creativity is expressed in both fields. Although there is usually a wide gap between science and art, creative activity in both fields has surprisingly many common features.

Keywords: computer vision, sculpture, creativity, 3D models, superquadrics

1. Introduction

Creativity is difficult to define, as the evolution of the concept of creativity throughout history since antiquity shows. The word creativity is derived from the Latin word *creare*, meaning to make or create [1]. The meaning of the word 'create' has increasingly shifted throughout history from the idea of simply doing something to the idea of creating, where it is important to first have a new idea and then try to bring that idea to life [2]. As to what the original source of creativity is, there are of course different interpretations. After all, the Christian tradition says that God created our world and that this is an expression of God's will. Today, creativity is usually interpreted as the ability to perceive the physical world or the world of ideas around you in completely new ways, to discover previously hidden patterns and to combine them into new solutions. For this reason, we speak of creativity primarily in the arts and sciences, for the work of artists and scientists is said to be characterised primarily by new works of art or new scientific knowledge.

Nevertheless, in the Renaissance, creativity in art and in science was closely related. Many people, not least Leonardo Da Vinci [3], combined scientific and artistic approaches in their work. However, the further development of science increasingly encouraged the specialisation and division of individual scientific disciplines, not to mention the disintegration of science and art. Various studies have reinforced this division, for example, studies of the differences between the right and left halves of the human brain [4]. It is thought that the right side of the brain is primarily responsible for emotions, intuition and thus creativity, while the left side supports more

analytical skills such as learning, memorising and processing information. Based on the individual differences between the right and left hemispheres of the brain, a person should therefore be more gifted in either the arts or sciences or in a more holistic or analytical view of the world. This dichotomy was put forward by C.P. Snow in his public discussion *The Two Cultures* [5] and has even been reflected in academic disputes between different fields (humanities or social sciences versus natural sciences or engineering) in the so-called Sokal affair [6] in which natural scientists accused social scientists of violating scientific principles.

However, contemporary creativity research, especially that of Mihaly Csikszentmihalyi [7], reveals common psychological processes that occur during creative activity. The psychological state of a person working creatively is characterised by optimal attention and involvement in the process, a state described by the word flow [7]. In order to enter a flow state, the individual can be supported by a suitable environment, music and discussion of the planned work and goal, which have been explored within art therapy [8, 9]. A suitable environment is important to the creative process so that the individual can remain in the creative process for as long as possible, not be distracted and be fully engaged and immersed in the creative process.

The principle of *mise-en-place* [10], which originated in the culinary arts, is often used to prepare a suitable working environment. For the preparation of a dish, which usually requires a process that must not be interrupted, it is desirable to have all the ingredients and utensils ready—on the table in front of you—before you start cooking. This principle, of course, applies in many other areas of work, not just the kitchen. We do not want to interrupt our concentration and focus on the creative process by looking for tools or components we need in the middle of the work.

The modern rapid development, especially of information technology or computer science, requires many developers and sophisticated users to have a thorough knowledge of the technological side, which in practice means at least knowledge of programming as well as creative use of this technology. In fact, the technology is evolving so fast that one cannot expect that the necessary knowledge to use this technology can be formed into specific tools that potential users can use without a deeper understanding of the technology. Therefore, only those who know how to develop the technology can understand how to use it creatively in other, sometimes entirely new ways. A typical example is computer game developers, the vast majority of whom are programmers by profession. For this reason, 20 years ago, interdisciplinary study programmes emerged around the world that combine both technological knowledge in a particular field and the creative use of that knowledge, often to create artistic products. This is the case, for example, in the field of new media art. One of the first degree programmes of this kind was the *Digital Media Design* [11] programme at the University of Pennsylvania in Philadelphia, which consists of about half computer science and engineering courses and half art courses. In Slovenia, the *Video and New Media* degree programme comes closest to this. At this study programme at the Academy of Fine Arts and Design in Ljubljana [12], I have a secondary teaching appointment.

2. My research experience

I want to write about creativity in science and art from the perspective of my own experience. My main profession is computer scientist. After graduating from the University of Ljubljana in electrical engineering, I earned a Ph.D. in computer science

[13] at the University of Pennsylvania in the United States. I did my Ph.D. in the GRASP Lab, where I specialised in computer interpretation of images or videos—a research area we call computer vision. This means that we use various computer methods to figure out what or what kind of objects are in an image, what shape they are, where they are in physical space, to try to determine their identity, recognise people, etc. Already during my Ph.D. studies, I was mainly concerned with three-dimensional interpretation of image information and started to use a special kind of geometric models, namely superquadrics [14]. Superquadrics are a generalisation of Lamé curves in three dimensions. They were introduced into computer graphics by Barr [15] and into computer vision by Pentland [16] to model rectangular and curved shapes. In my Ph.D. thesis [17], I developed a method for their reconstruction from depth images.

One of the advantages of superquadrics is that we can use just one equation to describe a wide variety of basic geometric objects, e.g. spheres, cubes, cylinders, etc.:

$$\left(\left(\frac{x}{a_1}\right)^{\frac{2}{\epsilon_2}} + \left(\frac{y}{a_2}\right)^{\frac{2}{\epsilon_2}}\right)^{\frac{\epsilon_2}{\epsilon_1}} + \left(\frac{z}{a_3}\right)^{\frac{2}{\epsilon_1}} = 1. \tag{1}$$

Eq. (1) is the implicit superquadric equation in object space. The size parameters (a_1, a_2, a_3) represent the size of the superquadric along the axes x_o, y_o and z_o of the object centred coordinate system, while the shape parameters (e_1, e_2) represent the roundness of the vertical and horizontal edges.

With superquadrics, we want to model the shape of an object in a kind of holistic and abstracted way, without the irrelevant details that might otherwise be important for identifying the object. **Figure 1** shows stone sarcophagi whose shape was first

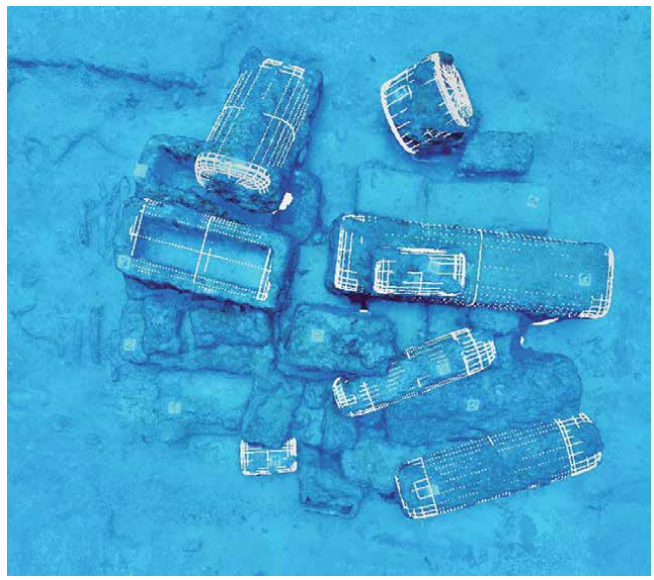

Figure 1.
Sarcophagi on the remains of a sunken Roman ship off the island of Brač in the Adriatic Sea, modelled with superquadrics [18]. The 3D point cloud was acquired using multi-image photogrammetry by a diver with a handheld camera. Modelling 3D point clouds with more compact, part-based geometric models is a current challenge not only in archaeology and heritage science, but also in robotics.

captured underwater using multi-image photogrammetry, and the resulting 3D point cloud was then modelled using superquadrics [18]. With new and improved means of acquiring 3D data, 3D documentation of individual artefacts and entire environments is becoming increasingly important in heritage science. However, large 3D point clouds suitable for display and presentation must be segmented and modelled with appropriate geometric models to allow further analysis and understanding of the imaged scene.

My original method of superquadric recovery was based on iterative least squares minimisation of a fitting function that was too slow for a real-time application. Nevertheless, the method has been used in many very different applications, and my publications on superquadrics reached almost 2000 citations on Google Scholar. Interestingly, after a hiatus of almost 20 years when our lab stopped intensive work on superquadrics reconstruction and segmentation [14], we are working on it again as we try to speed up superquadrics reconstruction and segmentation by using deep neural networks [19].

3. My artistic experience

I started teaching at the University of Ljubljana in 1988, and when the World Wide Web came along, I realised that it could be a good tool for presenting visual art, which I always liked very much. In 1995, together with my students, I built the Slovenian Virtual Gallery, a virtual space with paintings by famous Slovenian painters that could be explored by clicking in the direction of the desired movement or on the paintings themselves [20]. This first-generation virtual gallery was a success and received the highest rating—four stars in the Magellan Internet Guide, based on the depth, ease of exploration and Net appeal. At the same time, in 1995, my colleague Ken Goldberg of GRASP Lab, who was at the time at the University of Southern California, developed the influential art installation *Telegarden*, where users could instruct an industrial robot over the Internet to plant seeds and tend plants in a circular garden around the robot [21]. Goldberg's successful combination of a scientific and artistic career was a source of inspiration for me. Through the Slovenian Virtual Gallery project, I started collaborating with Srečo Dragan, the first Slovenian video artist and professor at the Academy of Fine Arts and Design in Ljubljana. Over the years, we have produced many interactive art installations involving both computer science students and art students [20, 22].

Under Dragan's influence, I soon began to create my own art installations. My most successful installation, inspired by Andy Warhol's portraits of famous people, was the interactive installation *15 seconds of fame* [23], which was first exhibited in 2002. The installation uses automatic face detection to create pop art portraits from randomly selected faces of gallery visitors standing in front of it, which are displayed on the computer monitor for 15 seconds. The installation was created before the era of selfies even began, but it has already satisfied people's need for self-discovery and self-assertion.

Ten years ago, in 2012, I started sculpting in stone and wood rather accidentally and out of a need to do more with my hands than just type and sit behind a computer screen. Perhaps my experience with 3D documentation of physical objects in the context of heritage science also had some influence on my desire to touch and feel real objects. After a few workshops under the guidance of academic sculptors Alenka Vidrgar and Dragica Čadež Lapajne, I began to work independently. My sculptural

work so far was recently presented in my solo exhibition, which took place in DLUL Gallery in Ljubljana in autumn 2020 [24].

Like computer programming, sculpting requires concentration and thought, especially in direct carving, the technique I primarily use. While computer programming and research allow for easy experimentation and lots of trial and error, it's impossible to glue a stone back together once it's chipped. But my computer vision research has given me an experience that makes me see the objects around me mostly volumetrically—I can easily imagine how I would model them with superquadric blocks. Interestingly, superquadrics or superellipses were already used in furniture design and architecture by the Danish mathematician, designer, writer and poet Piet Hein [25]. Piet Hein designed a large public square *Sergels Torg* in Stockholm, Sweden, in the 1960s in the shape of a superellipse (**Figure 2**).

I make my sculptures from regular blocks of stone, but more often from irregular rocks or large pebbles. In my sculptures, I often look for abstract and pure geometric forms that remind me of superquadrics, like the sculptures in **Figures 3** and **4**.

In the block of Carrara marble in **Figure 3**, I have made a large and shallow indentation in the form of an ellipse. Inside the depression is a round hole that goes all the way through the block of marble. Both subtractions of material could be modelled as superquadrics. The title of the sculpture is *Big Eye*.

I found the rock for the *Taschenleerer/pocket emptier* in the Lesno Brdo quarry (**Figure 4**). I noticed the distinctly dark, almost black colour of the rock, because black limestone is not typical for the Lesno Brdo quarry. In short, when I have a rock in front of me, I try to find the abstract form hidden within it that would require the least amount of material removal. I can describe this process as a kind of discovery and

Figure 2.
The superellipse-shaped fountain in the middle of Sergels Torg, Stockholm, Sweden [26]. Original photographer: Anders Bengtsson; CC BY-SA 2.0 via Wikimedia Commons [27].

Figure 3.
The sculpture titled big eye was created from the slab of Carrara marble on the top. The finished sculpture on the bottom has an elliptic indentation and a round hole, both examples of superquadrics.

exploration of the possibilities that a particular piece of material offers. The original rock from which the *Taschenleerer* was made already had a depression in the centre (**Figure 4**). I highlighted this indentation in the sculpture and rounded the overall shape into a strikingly symmetrical form. The overall shape could be modelled with a superquadric (**Figure 4**).

I have also finished the stone differently. The outer surface is polished to bring out the texture of the stone, and the vertical side of the concave central part of the sculpture is chiselled with a tooth chisel.

I usually find a suitable name for my sculptures only after I have finished them, or during the work, when the final form has already taken shape in my mind. I was not

Figure 4.
The sculpture entitled Taschenleerer was created from the rock seen on the top. The outer shell of Taschenleerer is in the shape of a superquadric (bottom).

Figure 5.
TOP: The virtually augmented sculptures sun and galaxy from the light fountain series. A Kinect depth sensor and video projector are mounted above each sculpture. The projected light dots move as water drops across the sculptural surface. BOTTOM: The virtual water drops merge on the Gallaxy sculpture to form a spiral gutter, eventually flowing into the hole in the Centre. The short lines of light are the result of the longer exposure of the moving points of light.

familiar with the German word *Taschenleerer* before—pocket emptier in English, but there are also synonyms in Italian (svuotatasche) and French (vide-poche). I found the German word *Taschenleerer* interesting, a bit puzzling, but it was very descriptive for my sculpture, because the indentation in the middle can also be used to put away the small stuff we usually carry in our pockets. Lidija Golc, who wrote about my sculpture exhibition [28], with the help of Fran [2] defined the appropriate Slovenian term for T*aschenleerer*, which did not exist until then—i.e. žepni praznilnik.

I am trying to combine my knowledge of computer science with sculpture. I am investigating how a sculpture can be enriched with virtual content [29]. In the past, artists have often placed stone sculptures in a watery environment— either with standing water in which the sculpture was reflected or with flowing water in the form of various fountains that introduced a dynamic element. For the *Light Fountain* sculpture series—I have done two sculptures in this series so far, *Sun* and *Galaxy*—I used the Kinect depth sensor to capture the 3D shape of the sculpture. This 3D shape information can then be used to calculate how the raindrops falling on the sculpture should move. Since these are only virtual water drops, they are represented by points of light projected onto the sculpture via video projection. These points of light actually behave like water drops as they slide across the surface of the sculpture in the direction of maximum slope (**Figure 5**).

The installation is also interactive, as the Kinect sensor continuously captures the 3D shape. When someone touches the sculpture, the 3D shape changes and the light dots move across the new 3D configuration. Hand movements can easily trigger a 'splash' of the projected light dots. In the video [30, 31], one can observe the virtual dynamic enrichment of the sculptures. In the sculpture *Sun*, the drops falling evenly over the entire surface combine to form deepening rays of sunlight and then flow over the edge of the sculpture. In the sculpture *Galaxy*, the drops coalesce into a spiral and eventually flow off through the vortex in the centre of the spiral. This is an example of spatial augmented reality (SAR) achieved by video projection onto real physical objects. However, one must have appropriate 3D models of these objects to achieve this effect. Such augmented reality can be observed from any direction and by several people at the same time without any special equipment.

4. Discussion

Creativity as a human phenomenon has also become the focus of scientific research in recent decades, with the aim of better understanding it and possibly promoting it through imitation of observed circumstances and identified conditions. The first major scientific study of creativity was begun at Stanford University in 1959, involving a large group of the most distinguished contemporary architects [32]. Stanford remains a centre for the study of creativity, and as part of the Hasso Plattner Institute of Design (Stanford d.school), workshops are held for students and faculty members on how to apply design thinking to scientific and scholarly research and to learn about creativity [33].

Several schemes or stages for creativity have been proposed, such as:

1. preparation (e.g. investigation in all directions),

2. incubation (i.e. unconscious processing),

3. illumination (e.g. flash of insight),

4. verification (e.g. a conscious and deliberate effort in the way of testing the validity of the idea).

However, pioneering psychologist Mihaly Csikszentmihalyi [34] has suggested an underappreciated but crucial aspect of the creative mindset: a predisposition to psychological androgyny. Indeed, based on interviews with 91 highly creative people from a variety of fields, Csikszentmihalyi has found that female artists and scientists tend to be much more assertive and self-confident, and that the men in the same sample are more preoccupied with their families and their sensitivity to subtle aspects of the environment that other men tend to dismiss as unimportant.

The second phase of the above scheme, incubation, usually requires some release from other obligations—in other words, leisure. Pieper [35], a mid-twentieth century German philosopher, already claimed that leisure is the basis for culture and creativity. Margared Mead [36], the famous anthropologist, noted that activities that can be freely pursued by people who make their living from another source are degraded and corrupted when pursued for gain. Workaholism, a trend and a malaise of modern developed societies, does not leave enough free time to devote to creative activities. However, the latest negative trend affecting more people is addiction to media and social networking, especially mobile phones. An addicted person tends to spend all available free time surfing the Internet, social networking sites, playing computer games, etc. and cannot engage in creative activities. Therefore, the call for regular, weekly unplugging and abstinence from screens is in vogue to gain more time, creativity and connection [37].

5. Conclusion

So, based on my own experiences, what similarities do I see between creativity in computer science and creativity in art?

Stage 1 (preparation) in academic research consists mainly of reading research articles, attending conferences and talking to other researchers. For making sculpture, this means visiting galleries and exhibitions of other sculptors, but nowadays it also means searching websites about sculpture and sculptors. It can also consist of collecting or selecting material for sculpture.

In winter, I often look for river stones in the hopfields around our country house in the Savinja valley. In prehistory, the Savinja River changed its riverbed several times, leaving quite large and well-rounded stones in the ground, which come from the Smrekovec Mountains, the only place in Slovenia with extinct volcanic activity. Andesite, an extrusive volcanic rock, and its variants such as basalt and rhyolite are typical of Smrekovec (see e.g. **Figure 6**).

Stage 2 (incubation) need not be all idleness. I often find that switching what I do, for example, from academic writing and research to sculpture, is very beneficial from a creative standpoint. In my computer vision research, this stage often involves thinking about how to combine known methods and techniques to find solutions to new problems or applications. In sculpting, I try to imagine possible abstract and regular 3D shapes hidden in mostly irregularly shaped stones.

Stage 3 (illumination) usually means that a particular configuration of methods finally 'clicks' and seems perfect for a solution in a new problem area. In sculpting, a

Figure 6.
Foot of the Giant, 2017, 38 × 16 × 11 cm, Oligocene volcanic—effusive rock, andesite, with white phenocrysts of Na-Ca plagoclase and rare black hornblende within green chloritised glassy to microcrystalline groundmass with traces of fluid lava flow, formed during the time of effusive activity of the Smrekovec volcanism.

particular shape finally emerges in the stone under consideration and wants to be explored further.

Stage 4 (verification) in research means that the solutions envisioned must be implemented, tested and reported. As in research, the planned implementation in sculpture, especially when using the direct carving approach, requires constant adjustments and changes necessitated by the actual shape of the material and its structure. The final stage in sculpting also requires documentation by photographing the finished sculpture. Sometimes the intermediate results are also of interest. Finally, one hopes to exhibit the sculptures or find a permanent outdoor location for large-scale works. This often requires the procurement of suitable bases for the finished sculptures, wooden bases for indoor display and stone bases for outdoor use.

Despite many similarities, there are also some differences between creativity in science and in the visual arts. Although there are many advantages to knowing important people in your field of research, the evaluation criteria for published research papers are really quite objective. The means of reaching a wider audience, such as conferences and scientific journals, are basically open and democratic. However, a large circle of enthusiastic followers is even more important in the arts, as objective criteria for evaluating art are much harder to define. Opportunities to show and exhibit one's own art are therefore rarer.

Creative work in either field requires, at least in my experience, concentrated, largely individual effort. In programming and academic writing, we like to isolate ourselves from the rest of the environment. For example, when programmers are not alone in a room, they often put on headphones to isolate themselves. A sculptor working on stone wears a mask and noise reduction ear muffs to isolate himself from dust and noise. This also isolates him from his surroundings, making conversation impossible.

It is important that the scientist/artist be able to put himself in a state of enthusiasm, for that is how he becomes most productive. In both areas, however, regular communication with the immediate and wider professional environment is necessary. If only to ensure that we are on the right track.

Note

Franc Solina is the author of all photographs in this chapter, except where indicated otherwise.

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Section 4

Creativity Tendencies

Chapter 9

Perspective Chapter: The Importance of Supporting Creativity Development as the Main Skill of the Twenty-First Century

Iryna Simkova, Kateryna Tuliakova, Oksana Serheieva and Oksana Pastushenko

Abstract

This chapter calls into question the ways of creativity development as the main skill of the twenty-first century. Attention is paid to the analysis of key notions and concepts of creativity. This chapter discusses how to enhance creative thinking skills during training in higher institutions. The study presents the results gained from the literature overview. The examples of assignments aimed at creative thinking skills development during training are given. The paper investigates approaches to the construction of tasks to develop creative thinking and criteria for creativity assessment. An analysis has allowed highlighting the positive experience of different experts researched creativity, which can be implemented in future training in Ukrainian higher educational institutions. The findings of this study support the idea that heuristic tasks, creative projects, mind maps, and case study are significant assignments in the enhancement of creativity development that can be supported in the educational process and everyday life.

Keywords: creativity development, creative thinking, creativity assessment, heuristic tasks, twenty-first century skills

1. Introduction

Modern society is involved in the processes of globalization and increased industrial competition. Individuals must respond quickly to changes, apply nonstandard solutions, and generate new original ideas. Society needs unusual solutions to familiar problems, new approaches to solving broadly known and investigated problems, as well as new ways of behaving in typical situations. Most professions in the modern world need highly developed creative skills. In the cutting-edge socioeconomic system, experts have always seen creative thinking in various forms. It is associated with

scientific discoveries, entrepreneurship, technical inventions, the creation of works of art, and relations with people or public administration.

In the history of creative thinking development, the focus has always been on the mechanisms of its development, its interdisciplinary nature, and the desire of a person to understand his/her abilities with the respect to creative thinking. It is considered at the philosophical, pedagogical, psychological, and other research levels. The past decade has seen a renewed importance in creative thinking development, its special features, and ideas of designing a comfortable environment to enhance creativity. It can happen due to several factors. The first one is that creativity is assigned the role of an instrument in solving diverse and constantly growing interdisciplinary problem-based tasks; the second one is that creativity performs an important function in the process of forming maturity thinking of an individual.

Based on the survey conducted with the World Economic Forum (WEF) [1] that represents more than 7.7 million employees worldwide, creativity and innovation are considered by employers as rising in prominence. Nevertheless, the global recession and the COVID-19 pandemic-induced lockdowns in 2020 have brought an uncertain outlook for the labor market and updated the list of the top skills with such skills as resilience, stress tolerance, and flexibility, the education field must be ready that by 2025, there will be an increasing demand for skills related to creativity and innovation.

As far as many hypotheses regarding creative thinking development appear to be debatable, current solutions have been seen in strengthening the education systems ready for future challenges with designing training programs that could build a solid foundation to optimize global talent and assist in the development of new abilities in the twenty-first century.

The perspective chapter takes a new look at the issues of creative thinking development. With this in mind, we tried to consider the concept of creativity as a phenomenon, approaches to the construction of tasks to develop creative thinking, criteria for creativity assessment as well as products of creative activity, and how creativity development can be supported in the educational process and everyday life.

2. Creativity as an important skill for future

The term "creativity" has been applied to the overall structure of the personality, his/her uniqueness, and individuality; therefore, it has a significant impact on all stages of educational trajectories of personal development. In the literature, creativity often refers to the creative abilities of a person, which are manifested in creative thinking and feelings, communication, and individual types of activity [2]. It can be used to characterize the personality in general, as well as his/her aspects, products of his/her activity, as well as the process of his/her creative thinking. Creativity is sometimes equated with essential and relatively an independent factor of giftedness. It is hardly reflected in tests to define the level of intellectual development and academic success. In contrast, creativity is more receptive than critical thinking about new ideas. A complex approach to the upbringing of a creative personality covers a wide range of issues related to originality, initiative, and complex problem-solving.

According to Freedman [3], creativity is the indissoluble unity of the ideological, worldview, internal and artistic, it is an essential condition for the personality of a growing individual, versatility, and harmony of his/her development.

At the present stage of social development, a person needs to develop in order to possess in-demand skills needed by the employers. Highly developed creative skills

allow a person to continue active learning, be more flexible and easily adapt to changing conditions and requirements, work with innovations, and improve the environment.

Demirkan and Hasirci [4] identify three main elements of creativity: (1) competence (availability of a knowledge base, experience, skills); (2) cognition (using creative thinking methods, ingenuity, flexibility, perseverance); and (3) motivation (internal and external). Internal motivation deals with a personal interest in solving a problem, a persistent desire to apply knowledge and self-actualize. Extrinsic motivation is connected with promotion and material interest.

De Bono [5] developed a holistic program for the development of creative thinking and highlighted the following basic principles: (1) determination of the conditions for solving the problem, necessary and sufficient to achieve the goal, (2) wish to abandon previous experience in solving similar problems, (3) possession of the ability to notice multifunctional, universal things, (4) interdisciplinary nature (ability to connect the most different, even opposite ideas from the most diverse areas of knowledge and the use of the resulting associations to solve problems, and (5) enhancement of the ability to understand the dominant idea in a given field of knowledge.

Figure 1 depicts the unity of components that from our point of view influences the development of creative thinking, such as logic and cognition, positivity, harmony, and productivity, joy, and professional development. The implementation of these components simultaneously helps students to enhance a wide range of abilities, as for instance, ability to think logically, the ability to overcome stereotypes, the ability to find logical connections between phenomena, objects, facts, etc.

Botella et al. [6] suggest that the development of a person who can act creatively involves the development of a fundamentally new culture of thinking, its essence is the development of human intelligence using off-pattern learning technologies. In this situation, the emphasis is on the generation of knowledge rather than on the organization and processing of the knowledge.

Corrazza [7] outlines creativity as the ability of students to generate new knowledge through a technologically controlled expansion and transformation of the vision of reality as a future that can be able systematically organized based on the present; thus, creativity is a construction ability in the mode of the thinking process organization. On this point, creativity differs from innovation, as the generation of new knowledge through the use of existing abilities, connections, relations that are interconnected. Creativity presupposes the design of such features based on the already existed skills and abilities (aptitudes, relations). Kant in Ref. [8] believes creativity is a controlled productive imagination that is characterized by spontaneous actions.

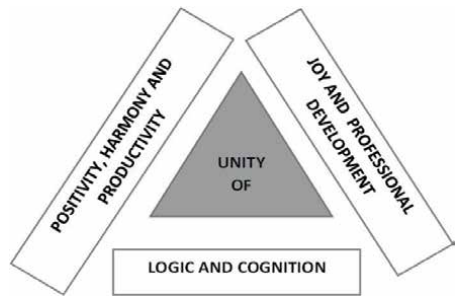

Figure 1.
The unity that influences the development of creative thinking skills.

Barron and Harrington [9] suggest that creativity presupposes the necessary variety of knowledge, and the initial mental order is a potential collection of all possible orders. Amabile [10] focuses on the idea that the scenario of creative thinking is approximative to the model of mental experimentation, to balance "on the edge of chaos" between the real and the possible.

These ideas have to be taken into consideration by teachers and trainers during the development of the assignments aimed at enhancement of the creative thinking skills.

2.1 Approaches to the construction of tasks to develop creative thinking

While researching the problem of students' creativity development, experts note that it greatly contributes to the development of the individuality of personality. Creative tasks are described as an original solution to a problem that gradually becomes more complex, where the data and requirements are presented to the student, and he/she must find a solution to the problem using the techniques of creative activity and innovative ways of thinking. Thus, Runco considers creative tasks as the tasks that require the student to be resourceful, when the student finds his/her original solution, applies it, or makes use of certain techniques to create innovative solutions steadily [11].

In general terms, creative tasks can be defined as a system in which many forgetive assignments are ordered and interconnected, built based on a hierarchy of creative methods, and aimed at developing the creative thinking of students in the educational process. According to its structure, the system of creative tasks includes target, content, activity, and effective components [12].

Originality or authenticity relates to understanding and accepting a person's identity in order to maximize his/her talents. The development of creativity starts with the awareness of individual authenticity and acceptance of a person's identity as unique originality. Knowledge about technologies, different approaches, methods of development, and strategies of creative thinking perfectly fit into this background.

The content of the creative tasks system includes thematic groups of tasks that are aimed at cognition, creation, the transformation of various objects, phenomena, situations performed by students. The construction of such thematic groups is based on setting students' own goals, using certain methods, performing some functions that ultimately are aimed at developing students' creative thinking skills.

The creative tasks system may include a regulatory component that relates to the reflexive actions of students in the process of their study; in this case, the creative tasks system can change in accordance with additional information about the implementation of elaborated decisions, which is gained as a result of the process of implementation, which necessitates control and regulation of their actions.

The activities in the creative tasks system are represented with the forms of organizing procedures (group, individual, or collective work), optional activities.

The past decades have seen a renewed importance in the development of approaches, methods, and techniques dedicated to the support of creativity. Many researchers, scientists, and scholars proposed various ideas for creativity development (Delphi Method, Synectic Method, SCAMPER Method, etc.) that were implemented in practice due to their specific features.

Table 1 presents a short overview of the highly demanded approaches, methods, and techniques proposed and implemented by different scientists from 1926 to 2006. All those approaches, methods, and techniques are aimed at supporting the creative potential of individuals. An increasing number of studies have found that the main

№	Author name	Approaches and methods	Specific features
1	Edward De Bono (1973)	Holistic approach and Six Thinking Hats Method	It aims the development of creative thinking based on the methods from an understanding of how the mind works as a self-organising pattern recognition system.
2	Graham Wallace (1926)	Creative Problem Solving Approach	It outlines the theory that the creative process includes four stages: preparation, incubation, insight, and examination.
3	Bob Eberle (1971, 1997)	SCAMPER Method (Abbreviation for Substitute, Combine, Adapt, Modify, Put, Eliminate, Reverse)	The SCAMPER approach aims at the modification of the object or problem in question. It includes questions that guide individuals in thinking about the problematic pathways that new ideas usually come up with. In the process of obtaining answers, their various properties are studied, new ideas arise, new opportunities for the development or improvement of the object are revealed.
4	Tony Buzan (2006)	Mind Mapping Approach	It is based on the concept of radiant thinking that led to the formation of the technique of mind mapping. It stimulates creativity due to establishing relationships among ideas and developing individuals' memory and learning potential.
5	Fritz Zwicky (1966-1969)	Morphological Box Method	The essence of the method is to build a matrix (table, box), which lists all the constituent elements of the research object and indicates all possible options for the implementation of these elements. By varying all known options for implementing the elements of the object, you can get the most unexpected new solutions.
6	William Gordon (1969)	The Synectic Method	The idea of synectics is to unite individual creators into a single group for joint formulation and solution of specific creative problems. The method is based on the use of unconscious mechanisms that are manifested in a person's thinking at the time of creative activity.
7	Olaf Helmer and Theodore Jay Gordon (1964)	The Delphi Method	The emergence of Delphi is associated with an objectively urgent need to improve the methods of group decision-making. Before the advent of Delphi, the most common way of agreeing with different positions and reaching a common opinion was the traditional meeting.

Table 1.
Overview of the highly demanded approaches, methods, and techniques dedicated to creativity development from1926 to 2006.

qualities that support creativity in the individual are curiosity, self-confidence, assertiveness, auditory and visual memory, the desire to be independent, originality, and absorption (degree of concentration).

In Ref. [13], creative tasks (possess a creative nature) can be divided into problematic tasks, problematic questions, simulation, case studies, and tasks of a divergent type, the main feature of such assignments is that they allow several possible answers. Creative assignments require students to demonstrate a high level of autonomy. Smith and Carlsson [14] suggest that in traditional teaching, convergent-type tasks

are mainly used: the conditions of such tasks assume only one appropriate answer, which can be worked out by strict logical reasoning based on the use of learned rules, algorithms, laws, etc.

Khutorskoy [15] in 2004 was one of the first to offer the following classification of creative tasks: cognitive, creative, and organizational (or methodological) tasks. In **Tables 2–4**, we consider the examples of tasks that include instruction, developed abilities, and discussion. The instruction contains a description of the problem-based situation and the task itself. Developed abilities deal with skills and abilities that can be developed or enhanced during task performance. The discussion may include tasks and questions for discussion.

Cognitive tasks are aimed at the building and development of student's cognitive skills. They include the ability to ask questions, the ability to feel the world around us, to conduct experiments and research, the ability to identify and understand the ambiguity of statements, the ability to overcome stereotypes, to find the causes of the occurrence of phenomena.

Lesson	**Natural sciences**
Instruction	Everyone knows that our planet is globe-shaped. But what does it mean? According to psychological research, many children understand this statement differently. For example, they consider it as a flat circle that floats in the sea or levitate in space. When answering a question about the shape of our planet, they say, "It is round," and it goes in line with their views. The task is to provide as many ideas (How does a round planet look like) as possible. They must be wrong conceptually but right according to the logic of presentation. The time limit is from 5 to 7 minutes.
Developed abilities	Ability to generate new ideas, ability to identify and understand the ambiguity of statements, ability to overcome stereotypes, etc.
Discussion	Students share their ideas about how we can imagine the round planet. After students are proposed to discuss the pros and cons of template thinking and creative thinking. Give the example of situations when template thinking is more appropriate than creative thinking and vice versa.

Table 2.
The example of cognitive task.

Lesson	**Classic literature**
Instruction	Everyone knows the story about Gulliver's Travels. Imagine yourself in the Gulliver's place in the country of Lilliput (where your height is as a two or three-story building) and in the country of Giants (where your height is similar to the size of a pen or pencil). The task is to think about things that can be used as sports equipment in one of those countries in different kinds of sports (e.g., ski, skating, fencing, etc.) The time limit is from 8 to 10 minutes.
Developed abilities	Ability to choose the right method (e.g., exaggeration to imagine Lilliputs and Giants), ability to notice multifunctional things, ability to be flexible, etc.
Discussion	Students present their ideas about things that can be used as sports equipment in one of those countries in different kinds of sports. After students discuss questions: Why did they choose Lilliput country or Giant country or provide arguments in support of chosen kind of sport, etc.?

Table 3.
The example of a creative task.

Lesson	Crafts
Instruction	Students are divided into three or five teams. Each team has got a piece of A4 paper and scissors. The task is to design the Arch under which every one of the participants can go. The Arch must be uninterruptible (solid). It is forbidden to use glue or other materials to connect a paper. The ways and methods of activity performance are not explained to students. The time limit is from 8 to 10 minutes.
Developed abilities	Ability to work in a team, ability to generate new ideas, ability to set goals, the ability to realize the results of the learning, etc.
Discussion	Students present their Arches and compare their results with the result of other teams. Whose idea is the most creative, feasible, or tangible? After students discuss How easy or difficult it was for them?

Table 4.
The example of organizational task.

Creative tasks provide the enhancement of creative thinking in students: the ability to make a forecast, sensitivity to contradictions, flexibility, imagination, the ability to generate new ideas.

Organizational tasks support the ability to realize and formulate the goals of their educational activities, to organize continuous educational or professional development, the ability to realize the results of the learning, to assess and review the innovative ideas proposed by classmates.

Experiments on tasks for creative thinking development were conducted in 2009 by a group of researchers [16]; let us distinguish the following requirements for creative tasks: (1) openness (the content of a problem situation, heuristic task, case study, or project method has to be widely known); (2) feasibility (tasks take into account the current level of students professional development and age); (3) diversity (the performance of tasks provides different ways of problem-solving or multiple solutions); and (4) congruence (the chosen methods of creative thinking corresponds to the problems set in the task). Besides the requirements for creative tasks development, some conditions are the prerequisites for creative tasks system usage. Among them is the construction of tasks that must be carried out on an integrative basis, when the task allows students to enhance several mental processes at the same time: thinking, attention, imagination, memory; the selection of tasks aims at the rational sequence of their presentation: from reproductive ones, aimed at updating existing knowledge, to investigative that focused on mastering generalized methods of cognitive activity, and then to innovative, which allows considering the studied phenomena from different points of view. The performance of tasks provides the fluency of thinking, consistency, and coherence, the flexibility of mind, the ability to generate hypotheses, that is, to the development of the quality attributes of creative thinking.

2.2 Criteria for creativity assessment

Some experts [17, 18] propose a three-component model of the process of creative thinking that builds three mutual connections: reflection, enthusiasm, and individuality.

Reflexivity distinguishes humans from animals and allowing to form self-awareness, self-esteem, plan through language, analyze, and reflect the world. Enthusiasm is combined with a belief that changing the environment brings a good opportunity for innovative changes. Individuality is specified in the ways the problem is solved.

Several authors believed that criteria to assess creative thinking depend on the fields of knowledge and activity [19, 20]. But this claim can be called into question as far as there are some general requirements for the process of creative thinking regardless of the field of science. When assessing creativity, we pay attention to the facts whether students (1) change the structure of internal and external data using additional conceptual differences and make decisions about similarities, (2) restructure the problem, (3) use relevant knowledge, visual thinking for creating new and innovatively using old knowledge and skills, and (4) use a nonverbal thinking model.

We can add to these factors one more as far as in some fields students use an interdisciplinary approach, it means that during their creative activity, they use innovative knowledge and well-known knowledge in other disciplines that can be transferred from one field of study into the other.

When assessing the level of the creative thinking skills, development experts propose students pass the Torrance Tests of Creative Thinking (TTCT), Guilford's Alternative Uses Test, or Wallach and Kogan's creative thinking tests. The tests include assignments for divergent thinking assessment and problem-solving skills. Torrance [21] identified for following criteria for creativity assessment originality, flexibility, fluency, and elaboration. Originality is the ability to generate nonstandard or unexpected ideas, to deviate from the generally accepted pattern. It helps to successfully get out of emergencies. Flexibility is the ability to assess a problem from all sides and apply different strategies when solving it. It helps to quickly grasp connections between different phenomena, establish patterns, find common ground in a variety of things and events. Fluency is the ability to come up with a large variety of ideas at great speed. With high levels of fluency, a person can come up with 20 ways to use an object, for example, an ordinary pencil, in a minute. The last one is elaboration—the ability not only to generate ideas but also to deepen and detail them.

In Ref. [22], our attention is drawn to the idea that the assessment of creative skills can be done through the analysis of the products of creative activity. The analysis of the results of the creative activity products made by students demonstrates a positive trend in the use of heuristic tasks. It suggests we identify the following criteria: the quality of the students' creative products; motivation and cognitive interest of students in creative activities; the level of time and self-management in creative activity.

When assessing the level of quality of products of students' creative activity, the attention has to be focused on the following parameters [23]:

1. a range of approaches used to perform a heuristic task;

2. the originality of ideas, their innovative aspects;

3. creatively different approach to solving the problem;

4. the practical value of the creative product;

5. the level of application of subject knowledge, skills, and abilities for the implementation of the original idea.

In the literature [24–26], there are a surprising number of criteria (about 17) on how to assess the creative product or idea produced by students. Thus, they can be considered as main criteria (such as originality, recency, future potential, flexibility,

efficiency, elaboration, etc.) and additional (such as applicability, attractiveness, expressivity, sustainability, etc.). In this chapter, we consider the most influential.

Assessing *recency* of creative product or idea, the teacher focuses on whether an idea is new if it offers new processes, concepts, methods, and materials. It can be manifested in the expansion of the field of study of the problem. The next one is *originality* as the most general characteristic for evaluating the product of intellectual creativity. From a practical point of view, an idea is considered original if there is no similar one among those already known to people working in a particular field. Therefore, an engineering idea proposed by an accountant may be original for him and not for an engineer. The future potential of ideas can be manifested in the ability to stimulate to find new solutions.

Flexibility is another important characteristic of an idea. On the one hand, possessing this quality, an idea gives a new look at the problem, a new way of solving it, and on the other, it is capable of change and modification. An idea is considered effective if it can be used to address any component of the problem. *Elaboration* reflects mainly the aesthetic qualities of the idea. In general, the complexity of an idea is determined by the degree to which it considers various elements—components of the problem—and brings them together into a single whole. *Applicability* characterizes the degree of convenience of using an idea to solve a given problem. This criterion is close in meaning to adequacy, which is assessed by how much the idea corresponds to the essence of the problem.

The use of *consistency* criterion in assessing the value of an idea is often surprising. We used to think that our thoughts are always logical. However, it makes sense to use the criterion under consideration to identify how an idea meets the "rules of the game," that is, correlates with generally accepted scientific facts. But using this criterion alone is not enough to determine the value of an idea. A bright logical idea should also correspond to the recency criterion, which will distinguish it from other equally logical ideas. An idea corresponds to criterion *attractiveness* if it attracts the attention of people who are considering it or those who are influenced by it. In addition, the sense of beauty is usually associated with attractiveness. *Expressivity* is understood as the clarity of the presentation of the essence of the idea. An expressive idea is better and easier to perceive. The teacher has to explain to the students that even a valuable idea can be rejected if it is not presented in an appropriate form. *Sustainability* criterion can consider that if a presented idea is complex or holistic, is it perceived as a single whole, as a system.

Thus, we state that the level of creativity possessed by students can be assessed from different points. The teacher can assess the creative thinking skills of the students or the product or idea as a result of creative activity. Further analysis showed that creative thinking isn't just a random splash of new ideas, it can bring tangible and effective output. Highly developed creative thinking skills help students achieve better results in transforming the environment, effectively and competently respond to modern challenges. These results offer vital evidence that the ability to think creatively is also based on knowledge and experience, and, therefore, it can be an object of focused training that can be assessed and enhanced.

2.3 Research methodology

To achieve the goals of the chapter, we have used complex interconnected methods of scientific research. The theoretical methods used in the chapter are the generalization of psychological and pedagogical literature to consider the concept of creativity as a phenomenon, the comparative analysis to explore approaches to the construction

of tasks to develop creative thinking, the content analysis to identify criteria for creativity assessment as well as products of creative activity.

The empirical methods used in the chapter are the quantitative and qualitative analysis of the survey to stipulate the positive or negative effects based on the implementation of the model of creativity development in the educational process.

To illustrate the positive and negative effects of the implementation of the model of creativity development implementation in the educational process, the survey was carried out among 150 bachelor students of different specialism who study at Igor Sikorsky Kyiv Polytechnic Institute (Ukraine).

To stipulate the impact of the model of creativity development in the educational process, the study was carried out among teachers of English work on the Department of English Language for Humanities in Igor Sikorsky Kyiv Polytechnic Institute (Ukraine). A total of 45 teachers of English were recruited for semistructured interviews. Interviews were conducted informally.

Representatives of the students (SG) group were asked to express their attitude to different kinds of creative tasks proposed by teachers, to identify the difference between the standard tasks and creative tasks, to identify difficulties that occurred during tasks performance.

Representatives of the teachers (TG) group were asked to express their views concerning the aims, principles, components, methods, technologies, activities, and results integrated into the model of creativity development in the educational process.

The study employed a qualitative and quantitative analysis of data collected from the survey, interview, and observations.

Considering the data provided in **Figure 2**, we can see that almost all students possess a positive attitude to the performance of the creative tasks. Nevertheless, almost all students demonstrate a positive attitude to the performance of all creative tasks, the most positive attitude students demonstrate to the creative project's performance (about 90% of students).

At the same time, some students demonstrate a negative attitude to the heuristic tasks (about 44% of students). One of the students said the following about difficulties:

> *"The tasks were unusual. I feel uncomfortable because I spent a lot of time while thinking whether the solution was right or not, was it feasible or not, etc."*

When students have discussed the difference between the standard tasks and creative tasks, they mentioned such criteria as attractiveness, diversity, originality, and future potential of results (**Figure 3**).

Seventy-five percent of respondents believed that variability or diversity is one of the important features, and its level is higher in creative tasks. Fifty-five percent of respondents said that level of attractiveness in creative tasks is not much higher than in standard tasks.

One of the respondents said:

> *"I feel much more responsible for the results when performing creative because they can be used in my future profession."*

Students who participated in the survey emphasized the need for creative tasks to develop their ability to creative thinking, to personal growth, to provide innovative activity, and to generate new ideas.

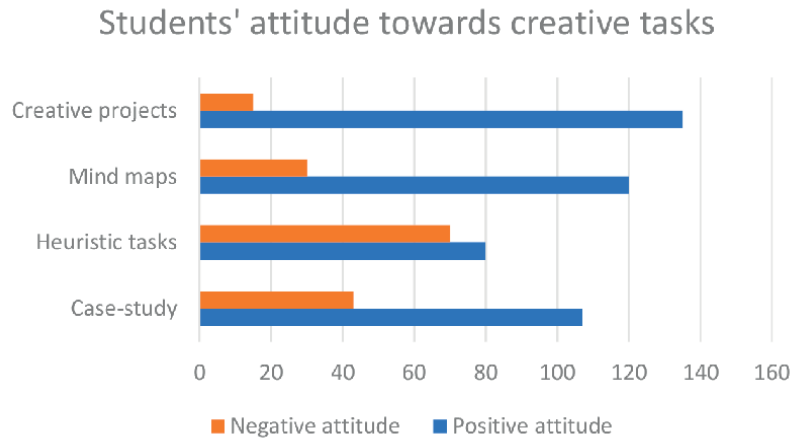

Figure 2.
Students' attitude toward creative tasks performance.

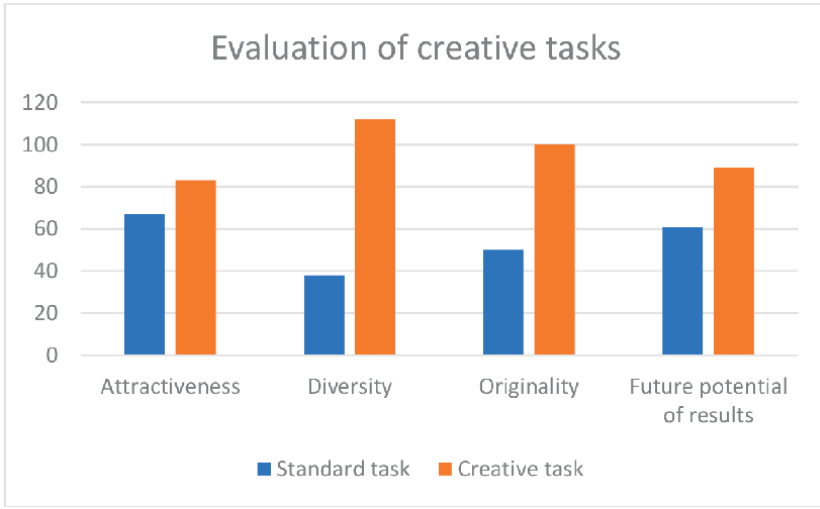

Figure 3.
The criterion used by students to evaluate the creative tasks.

During the interview, teachers mentioned that they believe that among technologies to support creative learning must be used situational learning technology, game technology, project technology, problem-based learning technology, and inventive problem-solving technology.

The ideas expressed by teachers are well consistent with the Creative Learning and Technologies Strategy [27] that suggests that blended technologies effectively provide digital resources to support learning; flip learning; communicate with students; encourage active learning and collaboration.

Taken together, the results from teachers' interviews suggest that creative abilities can belong to a certain component of creative competence and can be supported with specific tasks and activities.

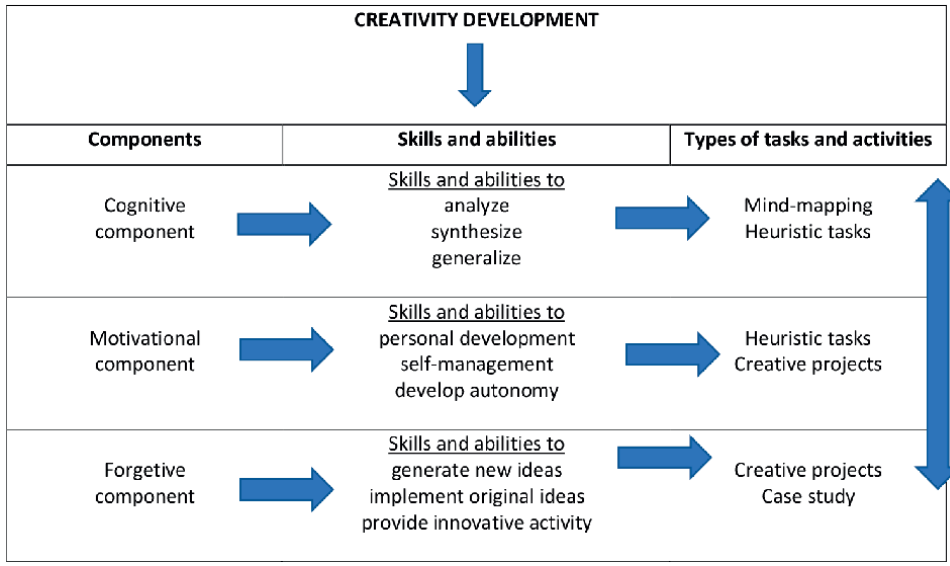

Figure 4.
Interconnection of components, skills and abilities, tasks and activities during creativity development.

Thus, **Figure 4** helps us to demonstrate the interconnections between components, abilities, and tasks.

These findings help us to design the model that will support creativity development in the educational process.

2.4 How creativity development can be supported in the educational process and everyday life

Some Ukrainian researchers claim that the effect of learning activity decreases, primarily due to unproductive methods of teaching [28]. In our opinion, it happens because the necessary methods are not developed and strengthened enough.

In many institutions, the interdisciplinarity is not developed, the lack of educational actions in various situations, the most difficult tasks are not practiced enough, the more complex methods are not used, which often leads to unsuccessful activities. Due to this, students are not satisfied with activities, on the one side, they consider them as obstacles that are hard to overcome.

Traditional teaching contains, mainly, explanation and illustration elements, when the teacher poses problems based on his/her own experience and indicates his/her own ways to solve them. With this type of training, the criterion component becomes the determining one. This approach organizes educational processes based on the predominance of reproductive activity, with detailed results. Due to the said above, it is necessary to gradually change teaching methods in order to intensify the learning process, increase motivation for learning. Thus, our idea is to implement the model of creativity development in the educational process using creative projects, mind maps, case studies, and heuristic tasks (**Figure 5**).

The main difference between the model proposed and the traditional teaching model is that the teaching method used in the model is close to the assimilation of knowledge. While in traditional teaching, the assimilation of knowledge goes on a

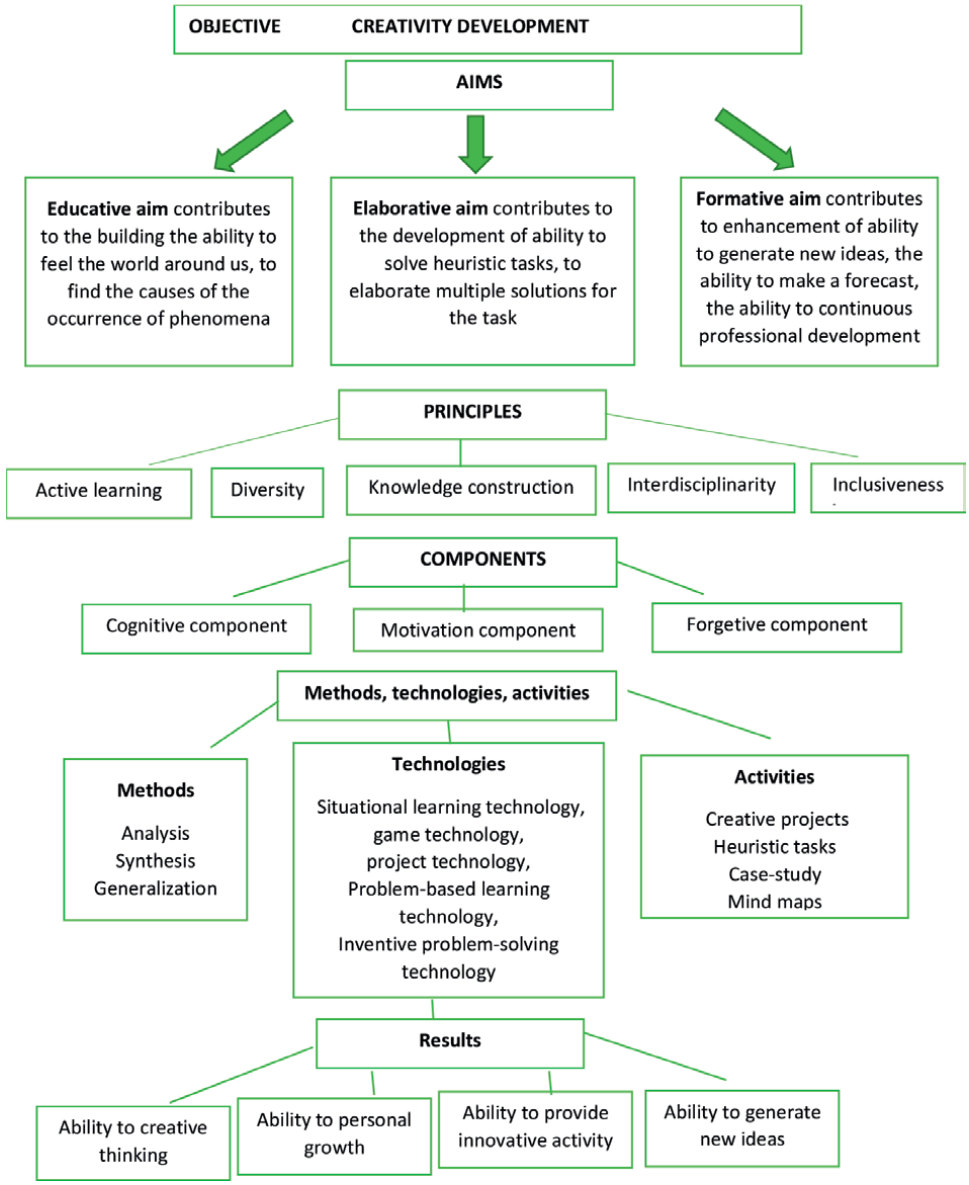

Figure 5.
The model of creativity development in the educational process.

reproductive level with some minimum elements of creativity, the proposed model presents different creative tasks that correspond to a creative level of teaching.

Teaching and learning using the creative project method, mind maps, case studies, and heuristic tasks in contrast to the traditional one are a complex type of interaction system, in which the management of students' activities plays an important role. For example, in the creative project method, the level of problem items in the above method is set by two-level characteristics: the complexity of questions, problem-based tasks, and assignments. Their quantity and quality are taken into account as far as the ratio of four independent types of tasks: reproductive, cognitive-practical, reproductive-search, and creative.

Teaching and learning using the creative project method, mind maps, case studies, and heuristic tasks in the model reflect the following structure: research and sustainable research (problem-based statement, hypothesis advancement, testing, and idea generation); study of the case and discussion (identification and comparison of points of view); mind mapping and simulation in the subject-content (imitation-game) and heuristic assignments.

The essential characteristic of the specified teaching model based on such activities as the creative project method, mind maps, case studies, and heuristic tasks is the reflective activity of students in intellectual and emotional-personal terms. The focus can be shifted from a procedural training plan into a context-based one and can be carried out in the following areas: special training in search procedures, the formation of a reflective thinking culture; special training in the processes of mastering and applying new techniques of the method of creative design; the formation of a discussion culture; special development of the emotional and personal side of educational activity associated with its role components; an emotional and intellectual reflection of the course of training, including simulation and heuristic modeling.

3. Conclusion

Our work has led us to conclude that one of the priority vectors of modern higher education is the development of a creative personality, the formation of readiness for professional mobility, social and creative activity. In the twenty-first century, creativity is the central, pivotal characteristic of a competitive personality. Students with a constant and conscious interest in creativity, who realize their creative potential, can successfully adapt to the changing conditions and challenges of life. In the future, such students can easily create their own individual style of activity, they are more capable of self-improvement and self-realization in professional activities.

In this chapter, we have outlined that a student's creative thinking is a type of thinking that manifests itself as an integrative feature of personality. This chapter underlined the importance of criteria for creativity assessment as well as products of creative activity. The evidence from this study suggests that the results-oriented use of heuristic techniques, mind maps, project methods, and case-study enhance creativity development.

These findings add to a growing body of literature on the issue of how creativity development can be supported in the educational process and everyday life. Future studies on the current topic are therefore required experimental research in order for the proposed model of creativity development in the educational process to be verified by a larger sample size.

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Conflict of interest

The authors declare no conflict of interest.

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Chapter 10

Sunni, Shia, Whabbi, Salafi, Berelvi, Sufi and Deobandi: The Different Islamic Perspectives on Creativity in Islam

Cameron Iqbal

Abstract

The purpose of this study is to understand how seven different Islamic sects namely Sunni, Shia, Whabbi, Salafi, Berelvi, Sufi and Deobandi have different perspectives when it comes to creativity (bid'ah). Each participant provided a unique insight into their understanding and interpretations of Islamic scriptures and texts in relation to creativity, and to determine how creativity in Islam is assessed. This study provides a unique understanding of differences and similarities of creativity and innovation and explains how each participant's sect analyses and affords its own perspective on creativity.

Keywords: Quran, Islam, Ahadith, creativity (bid'ah) and sects

1. Introduction

The purpose of this chapter is to understand how seven different sects in Islam, namely Sunni, Shia, Whabbi, Salafi, Berelvi, Sufi and Deobandi (Seven Sects) have different perspectives on creativity in Islam.[1] As Islam is a complete way of life and the religious, financial and political platforms must be part of the assessment of creativity. Creativity in Islam can only be assessed by educated and intellectually qualified Islamic *Ulema* (scholars) that hold the relevant knowledge and are authentic *Ulemas*. This chapter will explore the stages of Islamic creative thinking, legal reasoning and deductive reasoning in Islam relating to the seven different *Ulemas* belonging to seven different Islamic sects. The *Ulemas* will provide a unique insight into their

[1] As a matter of openness and transparency, the author confirms that the research in this chapter from part of another chapter namely Islamic Creativity Framework [1] and such works have also been published with the same publisher. The previous works [1] focused on the Islamic Creativity Framework, but this chapter focuses only on the responses of the Seven Sects. This chapter includes new research and may have some repetition.

understanding and interpretations of Islamic scriptures and texts in relation to creativity and how their perceptions and practices of differing Islamic traditions compare with each other concerning creativity.

Prior to this study, there has been research conducted examining how creativity is effective in Islam [2]. However, that research did not focus on how Seven Sects assesses creativity. It does not look at the required support of *ulemas* and the application of Islamic reasoning to determine effective and approved creativity in Islam. It also does not examine how creativity is rejected in Islam. The need for this study was due to gaps in other studies. This study will explore the stage of Islamic creative thinking, legal reasoning, and deductive reasoning in Islam differs between Seven Sects and this comparison and differences have yet to be researched.

This study was conducted by examining seven different leading Islamic traditions based in the UK. Each sect provided unique insight into their understanding and interpretations of Islamic scriptures and texts in relation to creativity and its assessment. This study demonstrates how perceptions and practices of differing Islamic traditions compare with each other.[2] The uniqueness of creativity research in Islam is the explorative nature of this research that lends itself to qualitative studies, such as religious ethnography and discourse analysis will form two key approaches [3]. Religious ethnography will assist in eliciting responses from each of the Seven Sect's representatives, and discourse analysis will be used to identify different perspectives [4].

2. Literature review

2.1 Creativity and innovation: The Quran (recitation)

Islam came at a time when there was prevalent ignorance in pre-Islamic Arabia. The Quran guided Muslims to be creative and to use their creativity for the benefit of humanity and in accordance with Sharia law and Islamic principles [5]. The Quran promoted creativity by providing examples of creativity to inspire and make Muslims understand in a greater depth. The Quran created a system that allowed Muslims to become focused on helping people and societies by being inventors of new theories and ideas. Science, math, biology, languages, culture, geography, psychology, sociology, algorithms, and many other areas began to take shape, assisting and creating new building blocks that lead to the great Islamic civilisations that followed.

Before examples are provided of the Quran promoting creativity, it is important to first examine an unsupported supposition amongst many Muslims. Muslims believe that Allah is the creator of the universe, therefore a question sometimes arises that can the word '*to create*' or the Arabic word '*khalq*' be used in reference to human beings. It

[2] There are approximately 72 different Islamic followings and traditions, all with different interpretations of the Quran, Sunnah, and the Ahadith.

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is a consensus (*Ijma*) amongst the Scholars that Allah is the creator of all creation but it is sometimes debated whether can Muslims or people be referred to as a creator? The Quran uses the word '*khalq*' when addressing and referring to the people, it states: '*You only worship idols besides Allah and you create (khalq) a lie.*' [6]. This is clear evidence that the Arabic word '*khalq*' can be used in reference to human invention and creativity as Allah has used it to highlight the lies created.

Another example, where Allah describes his creativity and also identifies creativity of the people in the Quran, is in the verse: '*Then we made the seed a clot, then we made the clot a lump of flesh, then we made (in) the lump of flesh bones, then we clothed the bones with flesh, then we caused it to grow into another creation, so blessed be Allah, the best of the creators*' [7]. The verse ends with '*so blessed be Allah, the best of the creators*', firstly, this confirms that Allah is the best of creators as He has created from nothingness. Secondly, Allah confirms that He is not the only creator, but He is the best. Thirdly, as for human beings, Allah states He is the best, therefore, if human beings create or are creative then that is acceptable in Islam as they can never be better than Allah for what He has created. Fourthly, Allah accepts that creativity or creation by human beings will be limited to their needs and intellect, as the above verse relating to the creation of a human being by Allah, can only vest in Allah as He has the intelligence, creativity and power to be that creative. It appears by this verse that Allah sets the creativity framework in Islam by acknowledging that He is '*the best of the creators*' He is acknowledging that there will be creative thinkers and creators less blessed than Allah who will also create and be creative and innovative.

The *Quran* is seen as a creative miracle as it holds accounts of the past and the future and cannot be duplicated by human beings. Allah, knowing this, provides three creative challenges to all of creation including the Muslims to display creative intellect. In the first challenge He states: '*Say: 'If all mankind and the jinn*[3] *would come together to produce the like of this Quran, they could not produce its like even though they exerted all and their strength in aiding one another*' [8]. *There is also the verse: 'Knowing that they have failed in their creativity, He challenges them again to become creative by issuing a second challenge He states:* ***'Or do they say that he has invented it? Say (to them), 'Bring ten invented chapters like it, and call (for help) on whomever you can besides God, if you are truthful'*** [9]. Also, '*The humans and Jinns, unable to successfully complete the creative task of providing 10 Chapters, Allah further challenges them lowering the degree of the challenge to a single chapter only where He states: 'And if you all are in doubt about what I have revealed to My servant, bring a single chapter*[4] *like it, and call your witnesses besides God if you are truthful*' [10].

Allah in His three challenges challenged the whole of creation to create a chapter as He has done in the *Quran*. Allah's challenge was also towards those that spoke Arabic eloquently and they too after attempting to draft a chapter of the Quran were unable to successfully produce a chapter like that in the *Quran*. This is an example of Islam

[3] Jinn are the creation of Allah, made out of a smokeless flame, which exist alongside Muslims but cannot see the Jinn. The Jinn can see the human beings.

[4] The smallest chapter in the Quran is Al-Kawthar, which consists of only three verses, Allah is challenging the whole of creation to be creative and create just three verses of the Quran.

promoting creativity and asking people to become creative and innovators and even asking the whole creation to team up together to challenge Islam. This very challenge threatens the very fabric of Islamic existence but still remains today open to the whole of mankind to participate in.

2.2 Creativity and innovation: the sunnah of prophet Muhammad (pbuH)

Prophet Muhammad (pbuH) understood that all answers can be obtained from the Quran and that if any matters required clarification, then Muslims could go to Islamic scholars who are learned in the Quran, Ahadith, and Sunnah. The Prophet (pbuH) required Muslims to be learned and acquire knowledge throughout their lifetime. It is important to explain that many sects—including Salafi, Deobandi, and Wahabi—do not believe in Ahadith and Sunnah but rely solely on the Quran. They believe that any individual can translate the Quran. The Sunni, Sufi, Shia, and Berelvi sects believe the contrary. Such debates have led to segregation between the sects, causing difficulties for dialogue and rapport[5] [11].

To provide an example, the Prophet (pbuH) states: 'O Abu Huraira! I have thought that none will ask me about it before you as I know your longing for the (learning of) Ahadiths.' [12]. It was reported in the same *Hadith* that Umar bin Abdul Aziz wrote to Abu Bakr bin Hazm who stated '*Look for the knowledge of hadith and get it' written, as I am afraid that religious knowledge will vanish and the religious learned men will pass away (die) …* '

Scholars at the time of the Prophet pbuH were afraid that there may be a dispute about the reliance on the *Ahadith* and for that reason asked for the *Ahadith* to be written so that it may never be forgotten. As the Prophet pbuH Himself highlighted the learning of the *Ahadiths* and di not object to learning them qualifies a Muslim to rely upon them for guidance. This same understanding can be applied to all *Ahadiths*.

In relation to the *Sunnah*, the Quran states: '*Your companion (Muhammad) is neither astray nor being misled. Nor does he speak of his own desire. It is (only) the revelation with which he is inspired*' [13]. Therefore, Muslims are required to believe that the *Quran* and *Sunnah*[6] go hand in hand together as their sources of legislated law. The confusion between the sects relation to *Ahadith* and *Sunnah* is just a misunderstanding.

To understand the importance of knowledge in Islam from which creativity is derived, it is important to examine the first revelation to Prophet pbuH which was:

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[5] For example, the Prophet (pbuH) states, "O Abu Huraira! I have thought that none will ask me about it before you as I know your longing for the (learning of) Ahadith" [11]. It was reported in the same hadith that Umar bin Abdul Aziz wrote to Abu Bakr bin Hazm, who stated, "Look for the knowledge of hadith and get it written, as I am afraid that religious knowledge will vanish and the religious learned men will pass away (die)" [11].

[6] The Sunnah is the primary source of law, legal ways, orders and acts of worships and statements of the Prophet pbuH that Muslims are to follow.

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'*Read in the name of your Lord Who created. He created man from a clot. Read and your Lord is Most Honourable, Who taught (to write) with the pen. Taught man what he knew not.*' [14].

This is a very important revelation as the first revelation in Islam is asking the Prophet (pbuH) to read. By reading this revelation the reader would understand, by understanding the reader would gain knowledge and by gaining knowledge the reader would bring about new ideas and creativity. Allah is then saying '*He created man from a clot*', '*Who taught (to write) with the pen*' and '*Taught man what he knew not*', this is very important as Allah is telling the Prophet (pbuH) His creative nature. He is telling the Prophet (pbuH) that He taught man and provided knowledge and creativity to man as '*pen*' is a creative idea.

3. Questions and responses from the seven sects relating to the questions asked

The participants from the Seven Sects were asked the following semi-structured questions:

1. In Islam, what is creativity?

2. Do different traditions have different perceptions of creativity in Islam?

3. Does Islam promote creativity?

4. How do you view creativity?

5. Does Islam limit creativity?

6. Does Islamic Law block the expansion of creativity in Islam due to its stringent rules on ethics?

7. Do you believe Islam should have a greater contribution to creativity?

8. What is the process of determining creativity in Islam in the absence of any guidelines that one can follow?

9. What would you say has been the biggest prevention in the rise of Islamic creativity?

	Sect	Response to Question 1	Response to Question 2	Response to Question 3	Response to Question 4	Response to Question 5	Response to Question 6	Response to Question 7	Response to Question 8	Response to Question 9
1	Sunni	*In Islam, creativity (bida'h) is to create and Islam is not against it.*	*There are limitations on creativity definition, some people have a complete ban. There is a good innovation and then there is also bad innovation. Good innovation is something good that does not contradict with Islam. The bad is that contradicts Islam. We do not see anything that would complete stop creativity. Or else in the Quran, which came after such as the pulpit in the Mosque, something that is not against Islam, you cannot say anything against it. If Islam was against innovation then things that have*	*Yes, Islam states things that are not against Islam, and benefit people is fine. For example, the translation of the Quran, benefits people and does not go against Islam. There are some technologies that benefit people and Islam allows that*	*The Quran allows creativity and we are not against it*	*There are limitations, just that rule or obligations of Islam is not contradicted then that cannot be agreed to If Allah and Prophet pbuH state that there are four rakat (stages) in a prayer and someone reads five, then they have gone against Islam and its rule. This will be rejected.*	*No, absolutely does not block it, a person must follow the rules of Islam and Islam will not stop you. According to Islam, there are certain rules that allow and permit people to do certain things and it is not against Islam*	*Absolutely, I believe that in Islam the trouble started when people started to interpret innovation in a manner that prevented people to push forward for creativity … … Some people believe that they do not understand the limit of Islam and then they do not wish to cross that limit … Islam does not allow you to put your intelligence on the back foot, this is not acceptable in Islam. The Quran states: 'Oh intelligent people the wisdom is for you … ' That is why the Quran has directed the intelligent*	*There are rules in Islam such as permissible, obligatory, unlawful etc … A person must contact an Ulema for this. If you do not know if something is good or bad, or permitted or not permitted then an Ulema can tell you. But if something is against Islam then no that is not permitted*	*In every society, there are people that are against creativity and knowledge. In Islam, there are these hardliner people, and these people start placing fatwa on people. Then research will be stopped as a result of this. The authentic Ulema should only decide and the hardliner people should not listen to.*

Sect	Response to Question 1	Response to Question 2	Response to Question 3	Response to Question 4	Response to Question 5	Response to Question 6	Response to Question 7	Response to Question 8	Response to Question 9
		been derived would not have been done. Islam does not ban creativity.					*people to seek knowledge. In other religions, the intelligence stopped when creativity stopped. I believe that a person in Deen (religion) will expand Deen by expanding Deen through creativity. Question: Deen and Bida'h are two different things: Answer: Yes, there are so many technologies that they benefit from. Now the news can travel faster, and people can travel faster, and that benefits people. When the loudspeaker was introduced, people placed a fatwa on it, whenever a new*		

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								thing appears, some people attempt to discredit it by labelling it wrong. Allah has given intelligence so that people can understand and be responsible and be knowledgeable		
2	Shia	*In Islam, where there is ignorance then there will be concerns and there will be rejection. It does not mean that thing does not exist. I do not know medicine but I cannot deny its existence. After Ibn Hasina etc, for 500 years they have been creative and after that, they have not done*	*[no response]*	*Yes, Islam has asked Muslims to obtain knowledge even if you have to China. The word China was never said by the Prophet pbuH but knowledge was important and people just accepted that was said as it was good to obtain knowledge.It was discussed that how is it that we can*	*Islam is creative as it mentions test-tube babies and the internet in the Quran.*	*Islam has not provided people with freedom but rather has asked them to remain within guidelines.*	*Islam has rules, Islam does not prevent from spending money but not on yourself, Islam does not prevent you from ownership, but stops you from taking someone else's, Islam does not stop you from eating well but stops you from kicking a hungry person away. In Islam, there are rules that must be*	*Islam has not provided people with freedom but rather has asked them to remain within guidelines.*	*The biggest thing is the intention of creating, secondly Islam has not provided people with freedom but rather has asked them to remain within guidelines. It is the intention and that creation how it benefits the people, and looking at all this then a conclusion can be reached.*	*There is a concern, that Muslims have not contributed… It is because Islam wants Muslims to follow it and Muslims want Islam to follow them… Muslims see Islam as a commodity that they can mould to their satisfaction. If Muslims want to achieve success and creativity*

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		anything practical.		*obtain knowledge from a religion that is not Islam, it was said that you (Muslims) have a right over knowledge so should.*			*followed for the benefit of you and the people…*			*then they need the Quran and the knowledge of the Ahl Ul Bayt and… after that… even if Muslims wanted to step on the surface of the sun they would find a way to do so.*
3	Wahabbi	*The answer to this is the Hadith of the Prophet pbuH who states: 'He who innovates, or creates or brings into Deen (Islam) and that thing is not part of the Deen, that thing will be rejected'. So anything which Prophet pbuH did not teach or did not practice or anything the Sahabah, the Companions (of the Prophet*	*Others… will see bida'h with a different point of view… Others (Salafi)… will see practices of sects as bida'h*	*In terms of Deen no, things which are already set for us, we have to follow them, in terms of creativity in terms of duniyah (world) and we create things in this world, that we have to make sure we remain in the guidelines of Islam*	*A lot of people have a misunderstanding that means the cars we drive… the houses we live in… the planes we travel in are also bidah… these things were not present during the great era of Sahabah. In the Hadith, it states: 'He, who innovates in this matter of Deen'… anything to do with worldly things… there is no stoppage to*	*Creativity, innovation or bida'h has no place in Islam. Deen is complete and there is no room that we can start saying that we can start bringing this thing into Islam or that thing into Islam, Islam does not allow that.*	*You need to ask a Mufti*	*In terms of duniya, the West has exceeded in science and technology and definitely Muslims, must make sure they remain in the guidelines of Quran and Sunnah, must contribute…*	*Within Muslim groups there are certain scholars and certain Ulema's will sit down and assess a situation or … a product and then will make a judgement and say this complies with Quran, Sunnah or Shariah, or if it does not comply… they will say this thing is wrong or haram… On a world level, scholars…*	*Back in the days, when Islam was one unit, the government was run through the Islamic jurisprudence, the Quran and Sunnah, and they fund Scholars and they will do their researches. The whole idea was to benefit mankind and humanity, since this is not the case and has not been the case for several*

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		pbuH) never understood as Deen and also the students of the Sahabah, those that came after them and what they class as out of Deen is classed as bida'h. The three generations that we talk about … anything to do with Deen was present in these three times that will be classed as-Sunnah and contrary to that will be bidah, something new to Islam.			*that. The Prophet pbuH states that 'all bida'h is misguided' and will lead you astray and will not keep you on the right path.*				*get together and discuss issues … and accordingly, they will pass their judgements …*	*centuries … greed has crept into … gone away from the Deen and Islam, the true teachings of Prophet pbuH … Therefore, anything that we do we do not look at it from a universal point of view and we have gone away from the Deen and the love of the duniyah has come into our hearts so that has stopped us from creativity.*
4	Deobandi	*Imam Nawani says something that was not in the time of Prophet pbuH is bida'h. Whatever was not in the time of*	*Yes everyone has their own different opinions regarding bida'h.*	*There are two types of bidah, the good bida'h and bad bida'h.*	*I go along with the view of my teachers.*	*Islam limits, there is good bida'h and bad bidah which must fall into seven categories, permitted, obligatory,*	*No*	*I do not know the answer to this*	*There are seven types as I have said, you have to view it under that, is it permitted, obligatory, recommended,*	*It is not the religion itself, it is probably the people.*

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		the Prophet pbuH is bida'h (bad bida'h). Question: Celebrating the birth of the Prophet pbuH what category would that fall in? Answer: If it was celebrated in those times by the Sahabah (Companions of the Prophet pbuH) then yes.				*recommended, unlawful …*			*unlawful … You have to view it under those categories*	
5	Barelvi	*Bida'h means, it has come from the word badah which means something new and innovative. According to many Ulemas something not in the time of Prophet pbuH.*	*There is one interpretation … but different schools of thought have taken control of this issue from different angles … not every innovation is bad … in Bukhari … every bidah is misguidance and … leads to hell-fire.*	*Everything is allowed unless proven wrong… If in Islam something wrong and Islam will not praise*	*I personally view bidah as seeing something and seeing what Islam says about it, is it good for me … Does it take me closer to Allah … to Prophet pbuH and does not have any physical and spiritual harm then we will promote that …*	*if there is no Quranic injunction against it or any injunction against Hadith against it then we will promote it. If there is solid proof or Quranic or injunction or from hadith then we will reject it …*	*In Islam, Islam does not basically block bidah … Islam is a Deen, a religion that has come for all times, so it means that after 20 30 40 50 years new things will take place … and if they are beneficial to the Muslim for*	*Islam does have a great contribution to bidah. There are many things that Islam allows us to do, for example, the carpet infront of us, it has prayer marks on it, it wasn't at the time of the Prophet pbuH, but we have the marks to tell me*	*All the work that needed to be done has been done by the pious predecessors and the Ulema. People need to look at their life … all the groundwork has been done … Acknowledging the works of … Imam Nawani (ra) Imam*	*The biggest prevention … in creativity … is lack of knowledge in the minds of the people and they need to be taught and they can only be taught if they have interest … The other thing that is blocking creativity is where we have*

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		The collection of Hadith … was not at the time of Prophet pbuH. … Is Sahih Al Bukhari a good bidah or bad bidah? … People are acting on it and successfully practising Islam … There are some schools of thoughts that say all bidah is bad bidah. … Our pious predecessors have given us … what good and bad bidah is …				*example the iPhone, people can read the Quran on it … even those that say bidah is wrong they even use iphone as well. Islam will only block the expansion of bidah if it seems this bidah is taking people away from the right path.*	*where they need to stand for prayer and the space they have. If this form of bidah carries on … it will be allowed*	*Tabrezi (ra) … great men who worked in the field … if we do not acknowledge that work and do not rely upon their trust and on their hard work then we will be misguided. Our pious predecessors Allah has given them much more … than this generation … every time and every era were much closer to the time of the Prophet pbuH and is better than the time coming after it. … people undermining … the Ulema*	*small groups of self styled scholars, self styled Imams, self styled teachers, can speak good English … get on the media … and think he can speak Islam … but have no authenticity … they are extreme people have extreme mind and they always say we stick to what was in the times of the Prophet pbuH and everything after that is haram and they are the biggest hindrance and the Prophet pbuH came to make the world creative … but people have become ignorant … to the true teachings of Islam*

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6	Salafi	*Allah has completed the religion and chosen Islam for you. Islam cannot create something as it states that 'if it's not in my way it is rejected'. There are two types of bida'h, the good bida'h and bida'h according to Shariah Law*	*Yes—some practice Shirk*	*People create bida'h Islam does not*	*Bida'h is to bring something new to Shariah from Islam. People do not know its bida'h they think it is true or else they will not do bida'h. Something new that was not there before*	*In its entirety. If 'it's not of my way its rejected'*	*Everything in worldly life is permissible unless we have [sacred] text to prohibit it e.g. alcohol*	*Yes it is permissible, there should be engineers and scientists*	*If its haram or halal. If you create perfume then it's okay, if you create alcohol then no.*	*All good comes from practising religion—Muslims have left practising*
7	Sufi	*There are two definitions, one is anything new that was not there in the past, second is in the quran and Sunnah and complies with it*	*There are different explanations, but the definition is the same … There has been development in Islam and that is bida'h, e.g. the form of the Quran was not there before, and that is being read by Shia, Salafi … There has been a great*	*There are two types, one is the one that is against Quran and Sunnah, that is forbidden … There are certain sects that are bida'h and it is haram (unlawful) There is bida'h hasnah (good bidah) such as prayers, celebrating the*	*There are two definitions, one is anything new that was not there in the past, second is in the quran and Sunnah and complies with it*	*No, if it is Sunnah and Quran then it is a good thing …*	*No, if it is Sunnah and Quran then it is a good thing … If there is no proof then that is Bidah Seeyah (forbidden bida'h) and the Prophet pbuH said that person will enter hell-fire … … The way we celebrate weddings with music and*	*There should substantial contributions … Some have made watches … Ibn Hasina [expert in eye operations] … Muslims have done great developments*	*Has to be according to Quran, Sunnah and Hadith*	*We have become lazy, we have started fighting between ourself … If I am doing a good job, the other person will say that is bad bida'h to stop me from doing it even though he himself is doing it … There is a lot of advancement and Muslims*

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		development in the grammar of Arabic that is bida'h, that is a development and that is good bida'h. Also, a watch, that was not there in the past. Also, prayer timetable in your mobile phone, the way you live that is a development. However, at weddings, the way we do weddings that is a development… The use of loudspeaker and radio that is a good development, a good bida'h… In the past people were fighting with swords and arrows and now there are bombs… This is a development…	*birth of the Prophet pbuH… prayers of ramzan… Reading behind the Imam… This is good bida'h*			*dancing that is wrong… A good development according to Quran and Sunnah such as heart surgery*			*should be part of it… some developments have to be seen if that is according to Quran and Sunnah… and if we advance then that is good bida'h*

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4. Analysis and interpretation

This study examined how the Seven Sect Islam assesses creativity. Seven interviews were carried out with *ulemas* from seven different sects: Imam Nasar (Sunni), Imam Alvi (Shia), Imam Chisti (Barelvi), Imam Rasab (Sufi), Imam Dawud (Salafi), Imam Younas (Wahabi), and Imam Huzayf (Deobandi).

Islam is a religion that was revealed to Prophet Muhammad pbuH that incentivised the seeking of any knowledge for its believers [10]. It is important to note that Islam views knowledge as a base of human intelligence and creativity as a branch of that intelligence. Therefore when Islam refers to knowledge it is sometimes referring to creativity too. In the pursuit of any knowledge, Islam provides rewards in the hereafter to Muslims for any knowledge gained in this world. Islam incentivises the thought process of creativity, the journey and the destination of accumulating knowledge and creativity and those rewards are rewarded separately at each stage. Islam makes it lucrative for Muslims to seek any knowledge and as the Prophet pbuH states: '*The best of people are those that bring the most benefit to the rest of mankind*' [15].

Islam leads Muslims to question not only the existence of man but also the creation of mountains, trees, space and so forth [16]. Islam holds itself out to be questioned so that through such questioning knowledge can be gained progressing to the creation of theories and leading to creativity. Islam openly challenges its followers and non-believers to creativity even at the threat of its own existence [8, 10]. Islam uses itself as a mechanism, providing a platform to Muslims to bounce ideas against and advancing ones understanding and mind to grasp what Allah has created, why it was created and the open challenge by Allah to mankind to do better than what He has done [8, 10, 12, 17].

As a universal religion, Islam places great importance on creativity and innovation to create an *Ummatan Wasatan* a 'Middle Ummah', a balanced society that avoids extravagances making it a practical and fair religion that is in the middle path avoiding the extremes and excesses. Islam requires its followers to be moderated on belief (*Aqidah*), in acts of worship (*Ibadah*), in their understanding of Islamic Law (*Shariah Law*) and morals and manners (*Akhlaq*). By being moderate it will allow the Muslims to see the liberal side of society and the extreme side of society making it a fair religion that is able to view the whole of society and its creativity will then assist the whole of society too.

However, despite Islam seeking to create a 'Middle Ummah', Muslims have been faced with great difficulties due to religious interpretations of the terms *bid'ah* (innovation) and *ijtihad* (critical legal thinking) and the application of these processes. Many Islamic sects use terms: *bid'ah*, *ijtihad*, *kufr* (disbelief or denial) and *shirk* (avoid or neglect in the Oneness of Allah) to counter opposing views when the topic of creativity or innovation arises.

From the interviews, all informants understood what *bida'h* meant in Islam. Imam Nasar (Sunni) explained that the definition of *bida'h* means to create and Islam is not against *bida'h*. Imam Alvi (Shia) highlighted that just because *bida'h* has controversy surrounding it, it does not mean it does not exist in Islam. He indicated that Muslims are not implementing *bida'h*. Imam Chisti (Barelvi) provided an interpretation that the word *bida'h* comes from the word *badah*, which means something new in Islam. Imam Rasab (Sufi) similarly to Imam Chisti (Barelvi) explained that it is something new. Imam Dawud (Salafi) provided his interpretation of *bida'h* which is what was accepted at the time of the Prophet pbuH. He explained that there is good *bida'h* and bad *bida'h*. Imam Younas (Wahabi) explained that it is something new to Islam. Imam Huzayf (Deobandi) described that *bida'h* is what was not at the time of the Prophet pbuH. Imam Dawud (Salafi) and Imam Huzayf (Deobandi) responses placed a

negative outlook upon their understanding of *bida'h* as times have since changed from the Prophet pbuH's time.

4.1 Islam promoting creativity

On the question of Islam promoting creativity, Imam Nasar (Sunni) explained that Islam does promote creativity but only those things that are not against Islam. He provided an example that the translation of the Quran was a new creative idea after the demise of the Prophet pbuH. He stated that this benefits people and does not go against Islam. He also stated that some technologies that benefit people are allowed under Islam. Imam Alvi (Shia) agreed that Islam promotes creativity. He explained that Islam has asked Muslims to obtain knowledge even if you have to go to China. He explained that the word 'China' was never said by the Prophet pbuH but knowledge was so important and people just accepted that He pbuH had said it as it was good to obtain knowledge. He described that currently, people may feel that to be creative, one must obtain Western knowledge or from people that follow a different religion than Islam. He provided a response to that and said that Muslims have a right over knowledge so they should go where knowledge is even to other religions. Imam Chisti (Barelvi) believes that Islam allows all forms of creativity unless particular creativity is wrong. He highlighted that if Islam views something as wrong that thing will not be praised. Imam Rasab (Sufi) emphasised that Islam promoted creativity and it is divided into two categories: the good and bad *bid'ah*.

Imam Dawud (Salafi) explained that people create *bida'h* Islam does not. Imam Younas (Wahabi) explained In terms of *deen* (Islam) there is no creativity, things which are already set for us, we have to follow them, in terms of creativity in terms of *duniyah* (world) and we create things in this world, but we have to make sure we remain in the guidelines of Islam. Imam Huzayf (Deobandi) similarly to Imam Rasab described that there are two types of *bidah*, the good *bid'ah* and bad *bida'h*. Imam Dawud (Salafi) comments regarding the promoting of creativity vesting with humans and not Islam creates the possibility that Salafi may have negative reflections upon what *bida'h* is as Islam promotes creativity.

4.2 Differing perceptions of creativity in Islam

The *Quran* has acknowledged that human beings are able to create (*khalq*) [6] and be inventive. The Prophet pbuH also understood that to obtain creativity a Muslim has to gain knowledge and through knowledge, a Muslim would obtain a creative imagination (*khayal*). A Muslim imagination cannot become an automatic creation, therefore, his creative ideas are always within the confinement of Islam even at the very beginning. The Quran states: '*Allah will raise in rank those of you who believe and those who have been given knowledge*' [18]. The Prophet pbuH states: '*The seeking of knowledge is obligatory for every Muslim*' [19] and further stating: '*One who treads a path in search of knowledge has his path to Paradise made easy by God …* ' [20]. The Prophet pbuH is clearly indicating that knowledge is very important for Muslims and telling them that if you go in search of knowledge then their path to paradise will be made easy. This *Ahadith* does not state, you will achieve the knowledge that you set out to gain, but only that you will be rewarded on deciding to go to seek knowledge. This is important as the Prophet pbuH is incentivising the journey to knowledge, not the destination, as not all knowledge leads to creativity.

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Despite having such clear direction from the *Quran* and the *Hadith*, Muslims remain absent from seeking knowledge that may lead to creativity and innovation due to numerous interpretations of the *Quran*, *Hadith* and *Sunnah*. Sects including *Salafi*, *Deobandi* and *Wahabi* have certain reservations with the *Ahadiths* and *Sunnah* but rely solely on the *Quran*, which they interpret themselves. They believe that any individual is capable of translating the *Quran*. The *Sunnis*, *Shia*, *Sufi* and *Barelvi* sects believe the contrary and rely on the *Ahadith* and *Sunnah* to interpret the *Quran* [11].

On the question of there being different perceptions of *bida'h* in Islam, Imam Nasar (Sunni) explained that some people have a complete ban on *bida'h*. He explained that in the Sunni sect, there are limitations on creativity definition but never a complete ban. He indicated that if Islam was against innovation then things that have been derived from Islam and Islam would not have been successful. He suggested that Islam does not ban creativity but seeks its progression.

Imam Chisti (Barelvi) explained that there is one interpretation but different schools of thought have taken control of this issue from different angles. Imam Chisti (Barelvi) suggested that due to this control Muslims are not able to be creative. Imam Chisti (Barelvi) in his response to those that attempt to control the explanations of bida'h provided an example of Sahih Al Bukhari a collection of *Ahadiths*; he asked if they were a good thing or a bad thing as they came after the time of the Prophet (pbuH).

Imam Rasab (Sufi) said that there are different explanations, but the definition is the same. He provided his own examples of Arabic grammar, the book version of the Quran, prayer timetable and even the mobile phone. He said that these developments are a benefit and accepted in Islam. Imam Dawud (Salafi) response was that there are different perceptions of *bida'h* in Islam and that some practised s*hirk*. Imam Dawud (Salafi) comments emphasise that some sects fall outside the limits Islam has set.

Imam Younas (Wahabi) and Imam Huzayf (Deobandi) both agreed with Imam Chisti (Barelvi) that there is one interpretation but different meanings. There are many different interpretations of the *Quran* and *Hadith* relating to *bida'h*, but Allah states that: '*And whoever opposes the Messenger after guidance has become clear to him and follows other than the way of the believers - We will give him what he has taken and drive him into Hell, and evil it is as a destination*' [21]. Allah is giving a warning that if any believer separates from the Prophet pbuH guidance, which includes the Prophet pbuH's guidance on *bid'ah* then his abode will be hell. Despite this clear warning, many Muslim *Ulemas* specifically in *Salafi*, *Deobandi* and *Wahabi* take the literal meaning of the *Hadith*: '*The most evil affairs are the innovations (bida), and every innovation (bida) is an error*' [22]. These sects have reservations about *Hadiths* due to the word *Hadith* not appearing in the Quran, and their position becomes contradictory as they rely upon a *Hadith* despite having reservations about their authenticity as a source of guidance. However, *Sunni*, *Shia*, *Sufi* and *Barelvi* are more open to the idea of relying on *Ahadith* [23] and despite the word *Ahadith* not appearing in the Quran, they believe that *Hadith* is the guidance from the Prophet pbuH and that is what Allah refers to when He states: '*And whoever opposes the Messenger after guidance has become clear…* '.

In relation to the *Sunnah*, the Quran states: '*Your companion (Muhammad) is neither astray nor being misled. Nor does he speak of his own desire. It is (only) the revelation with which he is inspired*' [13]. Therefore Muslims are required to believe that the *Quran*, the *Ahadith* and *Sunnah* go hand in hand together as sources of law.

4.3 Each sect own view of creativity

Imam Nasar (Sunni), Imam Alvi (Shia), Imam Chisti (Barelvi) and Imam Rasab (Sufi) all agree that creativity is a necessity. Imam Dawud (Salafi) believed that *bida'h* is wrong or else people will not be doing it but did not provide any further response. Imam Younas (Wahabi) believed that there is a misunderstanding amongst people as to what it means but indicated towards the practices of the Prophet pbuH, and Imam Huzayf (Deobandi) believed that he has been taught by his teacher is correct and did not wish to provide his opinion.

The Prophet (pbuH) states: '*The best speech is that which is embodied in the Book of Allah, the Al Quran; and the best guidance is the guidance given by me, Mohamed. The most evil affairs are the innovations (bid'ah), and every innovation (bid'ah) is an error*' [24]. This is where the confusion stems between the Muslims. The reference to *bid'ah* in this *Ahadith* here is relating to the creation of statements that oppose what has already been clarified in the Quran and the guidance provided by the Prophet pbuH, therefore, it is permissible to innovate that, which benefits the religion and are compliant with *Sharia Law*.

4.4 Islam limiting creativity

On the question of Islam limiting creativity, Imam Nasar (Sunni) believes that there are limitations on creativity, which is for a Muslim to comply with the rule or obligations of Islam and that the creativity should not contradict Islamic principles or else it will be rejected. Imam Alvi (Shia) stated that Islam has not provided people with freedom but rather has asked them to remain within guidelines and that they should be within the Islamic guidelines. Imam Chisti (Barelvi) explained that if there is no *Quranic* injunction against it or any injunction against it, or there is no *Hadith* against it then Islam will promote that creativity. However, he explained that if there is solid proof or *Quranic* injunction or creativity goes against the *hadith* then Islam will reject that creative idea.

Imam Rasab (Sufi) explained that if *Sunnah* and *Quran* are complied with then it is good *bida'h* and Islam will not restrict it. Imam Dawud (Salafi) explained that Islam rejects *bida'h* in its entirety. He explained that Prophet (pbuH) stated that if it is not of my way then it is rejected.

Imam Younas (Wahabi) explained that there is a complete ban on creativity, innovation or *bida'h* and it has no place in Islam. He stated that Islam is complete and there is no room that Muslims can start saying that new innovations will be brought about within Islam. Imam Huzayf (Deobandi) stated that Islam does limit creativity but as there is good *bid'ah* and bad *bida'h* it must fall into the categories set out in *Shariah Law* such as permitted, obligatory, recommended, unlawful and offensive/disliked.

However, the Prophet (pbuH) states: '*If somebody innovates something which is not in harmony with the principles of our religion, that thing is rejected*' [25]. Therefore, the Prophet pbuH permitted *bid'ah*, but only opposed it when it was not in harmony with Islam. Furthermore, this *Ahadith* confirms that introduction of new innovations or ideas are welcomed if they were in conformity with Islamic principles and beliefs. At the time of the Prophet (pbuH), there were many new inventions and innovations, therefore, the issue surrounding *bida'h* must only refer to religion and religious practices, not inventions and creative ideas that do not change the Islamic principles.

Bid'ah only has any legal standing if it complies with *Shariah Law* and the *Sunnah* of the Prophet (pbuH). *Bid'ah* is being used as a tool to prevent free-thinking of ideas,

which affects and withers away the critical legal thinking (*ijtihad*) process of the Muslims due to the substantial opposition to those that commit good *bid'ah*.

In response to those that oppose good *bid'ah*, the following *Hadith* states: '*He who introduced some good practice in Islam which was followed after him (by people) he would be assured of reward like one who followed it, without their rewards being diminished in any respect. And he who introduced some evil practice in Islam which had been followed subsequently (by others), he would be required to bear the burden like that of one who followed this (evil practice) without theirs being diminished in any respect*' [26]. Sects, such as *Deobandi*, *Salafi* and *Wahabi* provide limitations that go far beyond the required limitations required by Islam, preventing their followers from being creative by propagating the understanding that innovation is wrong. *Sunni*, *Shia*, *Barelvi* and *Sufi* are utilising this *Hadith* to spread and promote creativity in Islam.

The difficulties due to religious interpretations or applications of *bid'ah*, *qiyas*, [27] *ijtihad*, *kufr* and *shirk* when addressing the topic of creativity or innovation are based upon peer pressure, ignorance, lack of knowledge in Islamic teachings which leads to a schism preventing an *ijma* to finally put these matters to rest. However, in the absence of an *ijma*, Muslims are to only look at the inventions and creative thoughts of the Muslims that have had a positive impact on the Western civilisation [4] to reach a conclusion that Islam does not prevent or limit creativity.

4.5 Islamic law (*Shariah Law*) and creativity in Islam

On the question of Shariah Law blocking creativity due to its ethics, Imam Nasar (Sunni) disagreed that *Shariah Law* blocked creativity. He stated that if a Muslim needs to follow the rules of Islam and Islam will not stop you. He explained that there are certain rules that allow and permit people to do certain things and which are not against Islam. Imam Alvi (Shia) stated that Islam has rules and these rules that must be followed and if they benefit you and people then *Shariah Law* will not block it.

Imam Chisti (Barelvi) explained that Islam does not basically block *bid'ah*, and if that *bid'ah* is beneficial to the Muslims then *Shariah Law* will not stand in your way. *Shariah Law* will only block the expansion of *bida'h* if it seems that the *bida'h* is taking people away from the right path. Imam Rasab (Sufi) explained that *Shariah Law* does not block *bida'h* if it is in agreement with the Quran and the Sunnah and if it is a good thing. There are guidelines that need to be followed to be in compliance with *Shariah Law*.

Imam Dawud (Salafi) explained that everything in worldly life is permissible unless we have sacred text prohibiting it. Imam Younas (Wahabi) proposed that a Mufti be approached to seek an answer to this question and Imam Huzayf (Deobandi) said *Shariah Law* does not block *bida'h* and explained the need to look at the categories of *Shariah Law* to seek compliance with it.

However, these interpretations prevent an open dialogue about creativity in the Islamic world. The importance of *Quranic* exegesis, *Hadith* and jurisprudence (*fiqh*) are important when addressing *Shariah Law* but for any argument to be valid in Islam it must have the backing of, and be in compliant with *Shariah Law* and the *Sunnah* or else the interpretation has no validity.

An Islamic ruling under *Shariah Law* against *al- aḥkām al-khamsa* (the five status), which form part of *fiqh* when deciding *bida'h* discovered that Islam does not prevent innovations unless it attempts to change the religious ideology or religious framework that covers the principles of Islam as then that would be unlawful. The *al- aḥkām al-khamsa* under *Shariah Law* is: obligatory, recommended, unlawful, offensive/disliked,

and permissible. Out of the 'five status', only 'unlawful' status prevents certain *bida'h* from taking place that is against the Islamic principles. As a result, the Muslims are able to validate their creative ideas and innovations from the four remaining statuses in Islam. *Shariah Law* propagates *Al-tafkir al-ibda'l* (Creative Thinking) by making it a law upon all Muslims to be creative thinkers.

The literal meaning of the *Hadith*: '*Every Bidah is misguidance and every path of misguidance goes to hell*' [28] in light of the verse of the *Quran*: '*This day I have perfected for you your religion and completed My favour upon you and have approved for you Islam as religion*' [17] does not conform to this *Quranic* verse as it raises the question as to why Allah would prevent Muslims from being creative or being intellectually advance when He Himself has provided examples of His brilliance and then challenged the Muslims to create as He has and then incentivises them to do so [7, 29–31].

4.6 Islamic contribution to creativity

It has been a challenging time for *Ulemas*, who have attempted to bring the legal process in *Shariah Law* more close to the social norms in our society. As a result of the differing interpretations between sects, there is a substantial misinterpretation of the *Quran* and the *Hadith* surrounding *bid'ah* resulting in the reduction of creativity in Islam. The *Ulemas* in different sects have to guide and provide a balance between religion and worldly affairs, and it is this difficulty and possible fear that may have led *Ulemas* to interpret all creativity and innovation as *bid'ah*. The *Hadith* states: 'Scholars are the inheritors of the prophets' therefore, the *Ulemas* are the inheritors from Prophet Muhammad (pbuH). This is a great responsibility and many Islamic *Ulemas* are too fearful to make a mistake resulting in the notion that it is safer not to do something than to do it thereby depicting that Islam is limiting innovation when it is really some *Ulemas* fear of the responsibility that they carry.

All informants, except for Imam Huzayf (Deobandi), believed that Islam or more specifically Muslims should have a greater contribution to creativity as Islam permits creativity. Imam Huzayf (Deobandi) did not have a response to this question.

All informants believed that if *bid'ah* looked to change the principles of Islam then that *bid'ah* will be rejected, but if the *bid'ah* looked to benefit the world having no direct changes to Islamic principles then that *bid'ah* will be accepted.

The Hadith states: 'If a question relates to your worldly matters you would know better about it, but if it relates to your religion then to me it belongs' [32]. The Prophet (pbuH) has confirmed that the Muslims know better when it comes to their worldly affairs, which include necessities and through necessities comes creativity and innovation. The Prophet (pbuH) has confirmed that bid'ah is permissible in Islam, and He (pbuH) has also confirmed that it is up to the Muslim to decide his worldly affairs. Therefore, if the Ulemas and their congregations decide that they will not be creative or innovative then that is a choice that they have made as Shariah Law does restrict innovation but limits its function to avoid unlawfulness. Other than that, Shariah Law is not an obstacle to creativity but makes it an obligation to participate in creativity and innovation to assist Islam.

4.7 Prevention of creativity in Islam

There are political, financial and international obstacles leading to environmental effects that prevent the rise of Islamic creativity. Imam Nasar (Sunni) stated that in every society, there are people that are against creativity and knowledge. In Islam,

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there are these 'hardliner' people, and these people start placing *fatwa* (decree) on people resulting in creative research being stopped. The authentic *Ulema* should only decide and the 'hardliner' people should not be listened to.

Imam Alvi (Shia) stated that Muslims have not contributed to creativity, for some time, it is because Islam wants Muslims to follow it, and Muslims want Islam to follow them which leads to misunderstanding and stagnation of creativity. He stated that Muslims see Islam as a commodity that they can mould to their satisfaction. He explained that if Muslims want to achieve success and creativity then they need the *Quran* and the knowledge and guidance of the *Ulema*. Imam Chisti (Barelvi) stated that the biggest prevention in creativity is lack of knowledge in the minds of the people. He highlighted that Muslims lack interest.

The other thing that is blocking creativity according to Imam Chisti (Beralvi) is small groups of self-styled scholars, self-styled Imams and self-styled teachers, who can speak good English but have no authenticity and misinterpret Islam. Imam Rasab (Sufi) stated that Muslims have become lazy and have started fighting between themselves. He explained that if a particular Muslim is doing a good job, the other person will say that is bad *bida'h* to stop him from doing it even though he himself may be doing it.

Imam Dawud (Salafi) stated that all good comes from practising religion and Muslims have left practising. Imam Younas (Wahabi) believes that the whole idea was to benefit mankind and humanity, since this is not the case anymore and has not been the case for several centuries, greed has crept in and Muslims have gone away from their religion. Imam Huzayf (Deobandi) stated it is not the religion itself, it is probably the Muslims that are the prevention to creativity.

4.8 Mechanisms needed to assess creativity in Islam

All informants believed that the guidelines to follow when addressing creativity in Islam must include either all or some of the following stages: the intention (of the creator), the *Quran*, the *Sunnah*, the *Hadith*, *Shariah Law* and the *Ulema*.

This study provides an Islamic Creativity Framework with reliance on the *Quran*, *Hadith* and the *Sunnah*, which embeds authority in Islam and provides clear guidance and direction to Muslims to be creative. Abd-Allah in his study 'Innovation and Creativity in Islam' [33] does not provide a methodology in assessing creativity in Islam but provides a methodology in promoting creativity. He also uses the methodology of *ijtihad* [33] to further the promotion of creativity in Islam but does not provide a connection or a process linking *Ijtihad* to the *Quran*, *Sunnah*, the *Ahadith* and *Qiyas*.

Similarly to Abd-Allah's work Al-Karasneh and Jubran study of 'Islamic Perspective of Creativity: A Model for Teachers of Social Studies as Leaders' [34] use the content analysis approach of the Quran to determine a model for teachers in social studies as leaders. Al-Karasneh and Jubran do not propose an Islamic creative framework despite the Quran being an analysis of their research. Their methodology relies heavily upon the primary source in Islam which is the Quran. They confirm that there is not a developed Islamic methodology of creativity and possibly for this reason they have created a methodology to teach creativity in Islam.

Al-Karasneh and Jubran then rely upon *ijtihad* (and *Shariah law* as a secondary source) as a good methodology in reaching creative ideas and new solutions. They then rely upon *Quranic* verses. The difficulty with their research is that some verses of the *Quran* cannot be taken in their literal form. The *Quran* requires an interpretation

that is found within the *hadith* and *Sunnah* and explained by *Ulemas*. Al-Karasneh and Jubran have not done this. They have attempted to translate the *Quran* without any authority and as a result, they have not actually explained anything as there is no interpretation to back up the verses of the *Quran* that they have cited. This study has cited the Quranic verses and backed them up with *Sunnah* and *Ahadiths*.

5. Conclusion

The Seven Sects each have their own interpretations of scriptures, whoever, what binds them is the similarities and not the differences. Unfortunately, the differences between them are what separate them, creating the possibility of further debate which exceeds the bounds of open dialogue and rather leads to some sects being neglectful of the other's beliefs. What is apparent is that the Seven Sects do believe that creativity can be accepted but for some (Whabbi, Salafi and Deobandi) this is limited to what was acceptable in the 6th Century. Despite advancements in technology at the very least on a social level, it is difficult to accept that innovation can only be accepted to what was available in the sixth century. Sunni, Shia, Berelvi and Sufi have a contrary view that innovation is acceptable, provided it brings about good to a greater amount of people. Islamic creativity it appears, is accepted widely, but may be due to religious and political aspects there is influence on certain sects not to accept, what can be defined as a wider acceptance of Islamic creativity by its followers. The scope of this study does not extend further than this and further academic contribution will be required to answer such research questions.

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[8] The Holy Quran 17:88

[9] The Holy Quran 11:13

[10] The Holy Quran 2:23

[11] Sahih Bukhari, Vol. 1, Book 3, Hadith No. 56 and 98

[12] Sahih Bukhari, Vol. 1, Book 3, Hadith No. 098

[13] The Holy Quran 53:2-4

[14] The Holy Quran 96:1-5

[15] Sunan al-Daraqutni, al-Mutalif wa-l-Mukhtalif, Ilal al-Hadit and at-Tatabbu

[16] The Holy Quran 18:22

[17] The Holy Quran 6:125

[18] The Holy Quran 58:11

[19] Sunan At-Tirmidhi, Hadith No. 74

[20] The Holy Quran 4:80

[21] The Holy Quran 4:115

[22] Sunan Al Tirmizi/Tirmidhi, Hadith Collection, Vol. 2. p. 39

[23] The Holy Quran 4:136

[24] Sahih Muslim, Hadith No. 1885

[25] Sahih Bukhari, Vol. 3, Book 49, Hadith No. 861

[26] Sahih Muslim, Book 34, Hadith No. 6466

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Chapter 11

Perspective Chapter: New Approaches to the Assessment of Domain-Specific Creativity

Zehra Topal Altindiş

Abstract

Science and technology getting continue to advance, the true wealth of our civilization will manifest in human creative output. Accordingly, technological developments offer great opportunities for creativity researches and assessment of creativity. While there are studies in the literature on the creation of computer-based creative products on the one hand, studies on whether creativity can be evaluated automatically or not, on the other hand, have started to attract attention. In addition, field experts turned to new research to understand whether creativity assessment could be automated and measured more quickly and qualitatively, and to explore whether this calculation method could be standardized. Researches conducted in the last 10 years have shown that computational approaches towards semantic distance have made significant contributions to the field both in theory and in practice. However, it can be said that there are very few studies that measure creativity based on semantic distance. This chapter presents a brief overview to discuss whether a computer-based measurement tool that can perform automatic calculations can be used in the evaluation of linguistic creativity in light of the evidence obtained from the literature.

Keywords: creativity, assessment of domain-specific creativity, tests of creative thinking, semantic distance, latent semantic analysis, This chapter is converted from some part of author's PhD thesis

1. Introduction

> *"Without knowing the force of words, it is impossible to know more."*
>
> *Confucius*

Although, there have been tremendous studies on creativity over the decades, it can be said that there are many treasures that can be found in "the mining of creativity". Over the years, both the development/change process that humanity have been through and the technological advancements have resulted in the formation of various resources ranging from the definition to the evaluation of creativity. Despite these advancements, as each era brings its own needs, new necessities are occurring in the field of creativity. One of the necessities can be said to develop a web-based automatic scale to evaluate fairly the potential of the twenty-first century individual called as digital native. In this

chapter of the book, the questions tried to be answered: "What quantitative measures of semantic distance applied in research tell us about creativity or domain-specific creativity? Why is LSA getting be popular in recent research? Is LSA scores successfully predicted the average human creativity scores?". In addition, the definition of creativity, the tendency of creativity studies through the process, the studies about the evaluation of the creativity, the automatization about the evaluation of the domain-specific creativity and the usage of LSA and the related knowledge were discussed.

1.1 The potential that humanity has and cannot be defined: creativity

> *"The beginning of wisdom is to call things by their right names."*
>
> *Socrates*

If the invention of writing is a turning point for the history of humanity, the speech that Guilford gave in the 1950s in American Psychological Association is the same for modern creativity studies. It can be said that this speech had an impactful effect on the domain experts. Before the speech of Guilford, the researches related to creativity were only % 0.2 in the Psychological Abstract index [1]. However, after this speech, it can be seen that both the amount of the studies and the results of them have increased in the field of creativity.

Recently, there are many definitions, theories, methods and scales available in the field of creativity. To begin with the definitions, Treffinger [2] has reviewed over 100 definitions in the field. Some of researchers has compiled 101 contemporary definition proposals from the children and the adults [3]. Despite so many definitions, as the studies of creativity cannot present a clear definition, this situation leads to inconsistent results [4]. This problem in the field of creativity can be likened to blind men and the elephant issues. When the recent studies are looked into, there is a wide range of discussions in the topics of like Covid-19 [5], defining oxytocin level [6], migration studies [7], creative process studies [8] using blind men and elephant issue for explaining. The blind men and elephant issue is based on the artwork of famous calligraphy artist Hanabusa Itchô (see more detail in [8]). In this artwork, a group of blind men tries to understand and define an elephant by touching its body but they have limited knowledge during this process. The shortage of knowledge leads them to make wrong or limited guesses. Similarly, this metaphor reflects the situation of the creativity field. Although, the studies focus on the different viewpoints of the creativity, the sum of the studies can be worthy for understanding the creativity.

When we look into the studies focusing on the theory and methods of the creativity, the most well-known classification in the field is seen to be the 4P Framework of Creativity (process, person, product, press) [9]. The other noticeable theories and models in the field can be listed as Associative Theory: stimulus-response (S-R) perspective [10], Structure of Intellect Model (SOI) [11], Incubation and Intuition [12, 13], Componential Model [14], Geneplore Model [15], Investment Theory of Creativity [16], Systems Model of Creativity [17], Amusement Park Theory [18], H-creativity [19], multiple levels of creativity (Big-C, Pro-c, little-c, and mini-c) called The Four-C Model of Creativity [20], The 5A's of Creativity: Person/Actor, Process/Action, Product/Artifact, Press/Audience & Affordances [21] and more recent one can be shown as the Minimal Theory of Creativity Ability [22]. All these studies can be seen as concrete proof of the hard work that field experts do to understand, evaluate and form the theoretical framework of creativity.

Creativity is studied for over a century, so there are many competing and complementary creativity tests in the field. It can be claimed that the situation is not pessimistic

regarding the evaluations done to evaluate creativity. For instance, according to the National Center on the Gifted and Talented, there are more than 100 techniques [3], 72 tests to evaluate the creativity by the center for creative learning, CLL [23] and Cropley [24] stated that there are at least 255 creativity tests in the literature [25]. According to Weiss, Wilhelm & Kyllonen [26], there are 228 identified creativity measures appearing in the literature since 1900. The many competing and complementary creativity tests in the field make it difficult for potential users to decide on their appropriateness. The most widely used creativity tests in the literature are presented by grouping in terms of 4P of the creativity and schemed by using Coggle.it in the below:

Because creativity is multidimensional and can be represented with different viewpoints, the way how creativity is defined affects how it will be measured and evaluated [25]. For that reason, in which ways creativity is evaluated has been tried to be explained in the above section. However, the scales that are known to measure creativity are usually limited in the sense of conception and psychometry. Moreover, as the choice of the staff and the training of them increase the expense, it reduces the functionality of these tests [27, 28]. According to Baer's severe criticism, the future of these tests is independent of their existence in the twenty first century or not is clearly suspicious [29].

1.2 The tendency of creativity studies in the process

Compared with the definition of creativity, it can be said that measuring creativity by using criterion-based objective rating scales is more difficult [30]. There are hundreds of tests to evaluate the creativity in the literature [31]. The methods and classifications used to classify and define the assessment types previously mentioned have been tried to be explained above (see **Figure 1**). The way of the tendency of the studies focusing on creativity has been explained below.

Sawyer [32] divided the studies related to the creativity into three categories. The first category consisted of the studies focusing on the creative person and the features of him/her; the second category consisted of the cognitive psychology experiments in the 1980s and the studies focusing on the cognitive aspect of creativity; the third category was defined as the studies dealing with the experiments conducted within the scope of sociocultural and interdisciplinary approach in the 1990s. The recent creativity studies focusing on the neurology and the computer-aided studies can be seen as the fourth category. Just as Guilford criticized the field of psychology for being indifferent to creativity, today, similar criticism is valid for the lack of studies in the field of neurology and artificial intelligence. In the visual given below, the previously mentioned four processes are schemed and presented (**Figure 2**).

It will not be a good approach to think of these categories separately from each other. Because science has a cumulative and progressive structure, it can be claimed that the results of the former studies shape and contribute to the latter studies.

1.3 Where does the nose of the ship show? Is creativity domain-general or domain-specific?

Due to the fact that the creativity's own features, it is a quite generous field to do studies for the field experts. Besides, it can be said that it gives directions to creativity studies in each period. The field of the creativity has been a remarkable study field focusing on a particular field or discipline within the last 15–20 years (see [29, 33–36]). One of the reasons for this situation may be thought resulting from the fact that whether the creativity is domain-general or domain-specific. In other words, the wheel

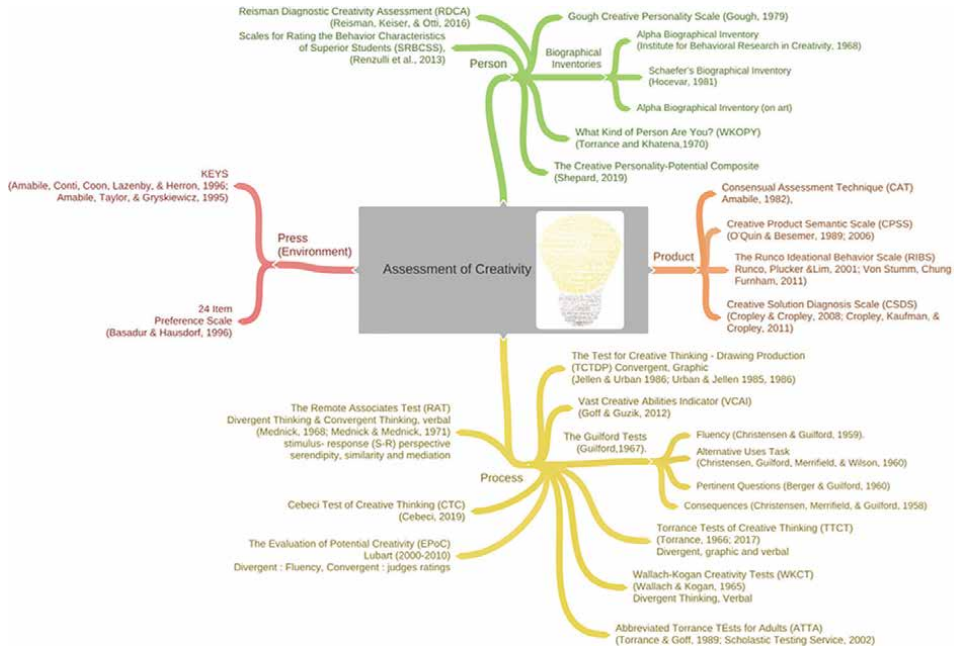

Figure 1.
Tests of creativity within the 4P framework.

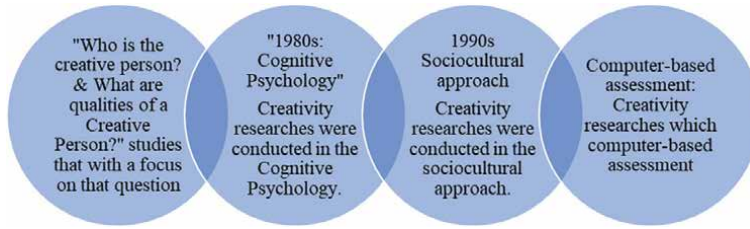

Figure 2.
The tendency of creativity studies in the process.

of the ship has turned with an angle of 180°, and it is a sign of the fact that the nose of the ship also turned from domain-general to domain-specific. Along with this information, scientific creativity tests, artistic creativity tests, tests measuring the potential of linguistic creativity can also be included into the roof of the scales recognizing the creativity as domain-specific. Although, there are tests named verbal tests in the field, the tests which measure the potential linguistic creativity are needed in the field.

2. Language and linguistic creativity

> *"The language is the infinite use of finite means."*
>
> *Wilhelm von Humbolt*

It can be claimed that language, which is the common ground especially for linguists, philosophers, sociologists, anthropologists, psychologists, educators, communication experts and even computer scientists, Then we can ask the question that

why the language means so much for many different disciplines? Language is a talent representing a unique feature that is only special to human beings according to many researchers [37]. In other words, language is a tool used for the service of thinking [38] and also a tool aiding for making arrangements [37]. According to the writer of the chapter, language is both the representative of the creative potential of the person and a tool for expressing the creative potential of the person. Similarly, Holtgraves [37] states that language can be seen as a tool, which can be used to achieve particular goals.

Just as language is known to have more than one skill (listening/observing, speaking, reading, writing), creativity also has more ways/aspects. Because both of them have multiple structures, language and creativity can be likened to each other. The evaluation of these two concepts is very difficult because of the aspects they have.

It can be said that there are a great number of theories and models related to the creativity in the literature. A similar situation may also be seen in the scientific creativity (see [39–43]). However, the linguistic creativity does not have the same richness [44] and unfortunately has a limited research database in the literature. Furthermore, when the linguistic creativity is concerned, it is a limited perspective to think of the studies of language teaching. Moreover, it can be said that there are limitations in terms of the conceptual perspective.

The definition of language creativity varies just like creativity. For instance, there are researchers who state that language is an ongoing creation, and those who state that language can expand until the newly formed borders by exploring new resonances [3]. These definitions show that linguistic creativity has a turbulent history in the twentieth century linguistic [45]. Not only the term of the linguistic creativity is a special gift or draws an unexpected path with words but also it has a wide range of meaning starting from the understanding of the linguistic creativity to the special usage of the term. Variability is related with the concept of linguistic creativity. In other words, to be able to create different language structures, the flexible association of the language units is needed [46].

It can be said that if there is language in a place, there are also ideas. If there are ideas, associations are also there because the relationships, which are based on the associations, happen within the framework of the language person has. This situation reminds us the words that Wittgenstein said: "The borders of our language determine the borders of our World". On the other hand, it can be said that the language skill has both cognitive and social way. For instance, we benefit from language in our academic life, doing our daily chores, communicating with people, analyzing the events we face and use them through filtering personally and cognitively and as a result, we come to an assumption or conclusion.

When real life problems are mentioned, as a solution of them, maths and science based disciplines are remembered or there is a perception regarding of them. As mentioned above, in the focus of the experience and problem takes place the language. Thereby, it can be said that in the solution of every kind of problems, language processes remain. For that reason, associations and analogies take place in the framework of the domain-specific creativity.

3. The controversy face of the evaluations: creativity

The questions that what the creativity really is and if it is possible to measure it or how the ideal evaluation scale should have always been discussed by the field experts. In the field of psychology and psychometry, the persuasive and convincing seen criterions are mentioned as the "validity" criterions. In this sense, a couple of

validity kinds were defined. One of them is defined as "face validity" and it means that the content of the test has a meaning for field experts. The second kind of validity is known as "construct validity". This validity type means whether the content of the test is based on the nature of the creativity. The third kind of validity is named as "predictive validity" [47]. In this kind of validity, test should foresee everything related to the creativity concept. For instance, to be successful in the field of life needs creativity. Just like Weisberg's [36] example pointing out that RAT measures the potential of the creative thinking capacity: "If you want to determine the potential of a good marathon runner, you should measure his capacity of lungs not his speed of running". Why shouldn't we use the scales which will help the creativity integrate into the education programmes or measure the potential of the creativity automatically? Because the biggest service of an assessment tool is to determine the individuals who have the potential of the creativity in the future?

3.1 The problem of the twenty first century: how the digital immigrants assess the digital natives?

> *"Our task, regarding creativity, is to help children climb their own mountains, as high as possible. No one can do more."*
>
> *Loris Malaguzzi*

In the digital society changing fast, creativity is accepted as one of necessary basic skills of the twenty first century for professional and personal success [20]. For that reason, many countries have been focusing on the creativity in terms of their education process more and more. It has been a primary subject to determine and develop the creativity of the students in the early ages of them [48, 49]. So, reliable psychometric tests are necessary to select creative individuals and determine the potential of the creative individuals in the field [27, 28]. Consequently, the usage of the assessment scales that will measure the potential of the creativity of the individuals and can make automatic calculations, which are suitable for the conditions of the twenty first century, is not a choice but a necessity.

Education and instruction environments can be defined as the places preparing the individual for life. If it is the case, what kind of assessment scale(s) should we use to measure the creativity of these individuals? Teachers are not always the right people measuring or assessing the creativity in a best way. As an example of it, Torrance's [50] (the father of the creativity was an English teacher) 12-year-study can be given. According to the result of the study, the relationship between the assessment and the creative features of the students could not be found. The same students are seen to have shown their creativity in their adulthood [51]. The reason for this matter should be questioned. How much do teachers know their students? or how can teachers choose the students who have the creativity potential? If the teachers are expected to find answers for these questions, the system should also be regulated to serve for the aims of the teachers. So, where is the basis of the current system based on? Let's get ready to find out by going back in time.

The organizational processes, which see the creativity as a concrete aim, are very few. No matter thinking out of the box, being eager to take risk and being original are the words that are uttered frequently, it is open to discussion whether the system and decision-makers in the system truly want it. For example, the starting point of the current school-based education is based on the book of "The principles of Scientific Method", which is a book by mechanical engineer Frederick Taylor written in 1911 to

increase the productivity in the workplace. The "Taylorism" approach, which was put forward in his book, still has its effect on the education system. The reason why this approach had so much impact on the education can result from the fact that it was supported by the father of the American psychologist Edward Thorndike. Taylorism claims that the individuals should be placed based on their talents and supports the idea that the scale of the system should be based on the speed. Because, the measurement of the speed is easier than determining the individual's talent on a field. Therefore, to assessment people's ability, they were looked into how much they were fast. As a result of this, standardization was focused not on the individualism and creativity [52]. The fact that how much this approach serves to meet the requirements of the human profile needed in the twenty first century is open to discussion.

Individuals grown up as digital natives [53] and known as the twenty first century individual, can be defined as game age or application generation [54]. If we want to assess this age's native, we should design a scale appropriate for the conditions of this age. While assessing the creativity, we should get used to it. If not, as the digital immigrants, how can we guide to the digital natives who have a great potential to contribute their potentials to the universe?

When the scales are checked in the worldwide, it is clearly seen that using paper-pen-tests have been replaced with the web based tests. This change shows itself not only in the format of the tests but also in the process of the assessments (see [55]). For example, PISA, which is a test applied globally, was planned to be in the computer based environment and delayed to 2022 due to the global pandemic, but even so, it is seen that the test was revised according to the needs and the conditions of the period. The change in the application and assessment in PISA has also been seen in the question styles. According to the announcement published on the formal website,

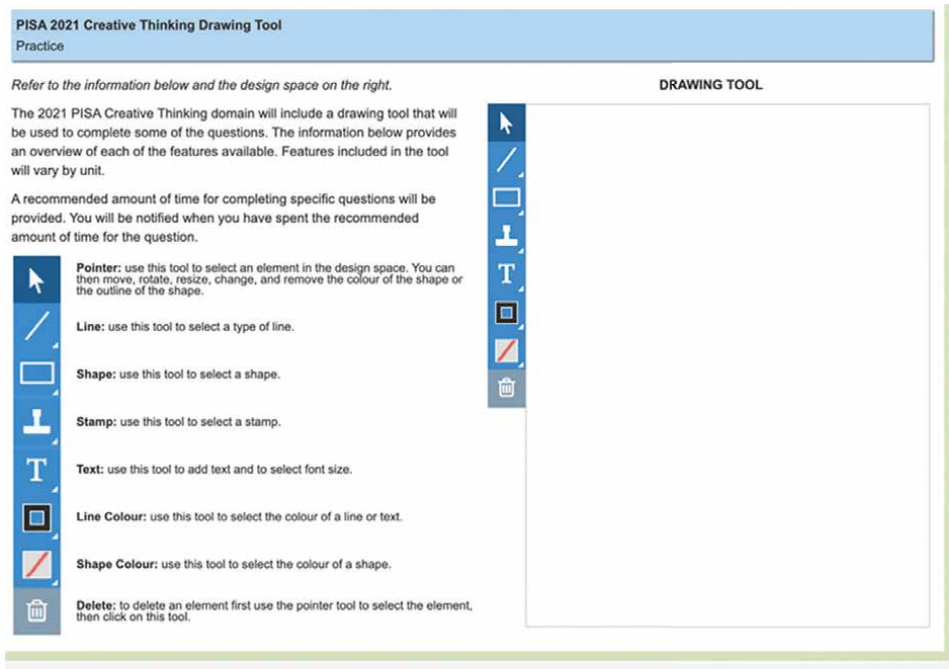

Figure 3.
A question related to creativity in PISA.

for the first time in the exam of PISA in 2022, students are expected to produce a visual artwork instead of giving a written answer or choosing one correct answer to measure the creative potentials of the students, The assessment includes open-ended tasks in which the answers do not have only one single answer but many of them [55]. This means that collecting answers from many students in the world and gives the hint of using computer-based (objective and automatic) assessment techniques. One example from the question of the PISA is shared below (**Figure 3**).

In addition to this, the tendency of preferring the subjective assessment approach to objective (and automatic) assessment is also observed in the field of creativity [44, 56–59]. This can be stemmed from the needs of the age. Furthermore, field experts should be open to progressive approaches to accelerate the growth of the proofs belonging to the assessment of the creativity [60].

4. New approaches to the assessment of domain-specific creativity

Computer-based analyses allow for objective methods to make an assessment of the semantic-linguistic quality of narratives at the text level. In this regard, researchers have begun to explore the benefits of automated scoring approaches using computer-based computational tools [33, 61–67]. One of these approaches is Latent Semantic Analysis (LSA).

Being one of the automatic scoring approaches LSA, is a technique to extract and represent sentences with mathematical or statistical calculation. LSA express the ideas about that the similarities and differences in the meaning of words can be influenced by the similarities and differences in the overall context in which the word is there or not [68].

On the other hand, LSA is a language learning model in which meanings of words are extracted from statistical analyses of large chunks of text. LSA determines whether the words are related or not through analysis of the relationship between words based on which words are frequently used together and which words are rarely together [57, 69].

In addition, LSA is also used to measure the consistency of texts [70]. The aim of LSA is to create a structure that shows the level of similarity between words [69, 71]. With LSA, hidden connections in textual data are revealed. Unstructured data must be converted to structured format so that LSA can be used. Thus, LSA can be applied to any document stack whose syntactic and grammatical structure is cleaned [72]. Also, Heinen and Johnson [63] found that LSA-based measures of semantic distance relate to measures of novelty and appropriateness, measures of creative output [34, 67].

4.1 Using semantic distance in assessing creativity

The semantic distance plays a role in various models about creative process research in field. So, Latent Semantic Analysis is a popular computational method to represent semantic distance in creativity research is through [65, 66, 69]. The role of semantic distance in creativity is rooted in the associative theory of creativity [10, 65, 73]. Therefore, the further a new concept moves away from a concept in a semantic space, the newer or more creative it will be. This is consistent with the "Associative Theory of Creativity," which states that creativity involves the ability to connect relatively weak or distant concepts to each other and to combine them with

new and useful objects. That is, the greater distance there is between the concepts produced, the newer combinations are produced and the more creative the produced thing is [10, 65, 69].

Creativity involves the ability to associate relatively weak or distant semantic components and to combine them into new and useful objects [74]. Researchers focusing on creativity have long struggled with how to measure creativity [56]. Examining studies showing that creativity can be achieved through computational processes, Boden [19] argued that it may be possible to create a program that can create works of art or symphonies [36]. The literature contains studies suggesting that computer-based and artificial intelligence supported creative products can be developed [75–77] on the one hand and studies on whether creativity can be assessed automatically [57, 58, 78] on the other hand. However, it is stated that there are limited studies on measuring creativity based on semantic distance [74]. For example, the creativity literature does not include much research on estimating the originality of an idea in a written work [44]. It is seen that there are just a couple of studies, and they deal with behavior [79] and words or expressions as a creative way of using language [80]. In addition, other studies in the literature show that writing quality is associated with stronger reading skills [81–83], broader vocabulary [81, 84], grade level [85], more flexible thinking skill [86], and level of knowledge on the topic to be written about [87].

In the study conducted by Runco, Turkman, Acar, & Nural [88], one of the more recent studies in the literature, the relationship between idea frequency and creativity is investigated. Another recent study [44] has incorporated new measurement techniques (keyword study) into the assessment process of linguistic creativity. With the computer-based keyword method used, yet another study [88] demonstrated how creativity revealed itself in written works (products) and to what extent this method reduced the time and effort cost in scoring multiple thinking tasks. Furthermore, the tests administered to the participants were assessed by domain experts (subjective) along with computer-based (objective and automatic) assessment, the new method. The obtained assessment results were promising for the objective assessment in hand.

Researchers in the literature [89, 90] found that divergent thinking (DT) tasks can be properly scored using LSA [72, 91]. The semantic word categorization performance of LSA [92] is reported to be satisfactory and comparable to human performance [65]. Additionally, LSA is preferred as it is objective, not based on human judgment, which allows obtaining reliable results among users, measurable and numerically applicable, grounded on a theoretical background, and justified [93] and it offers a strong way for quantitative analysis [73]. It can be stated that these findings show the usefulness and effectiveness of semantic distance measures to measure domain-specific creativity.

5. Method

This chapter is a descriptive study. The method of research which concerns itself with the present phenomena in terms of conditions, practices beliefs, processes, relationships or trends invariably is termed as "descriptive survey study" [94]. In addition, descriptive research is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. This type of research method is not simply amassing and tabulating facts but includes proper analyses, interpretation, comparisons, identification of trends and relationships. It is

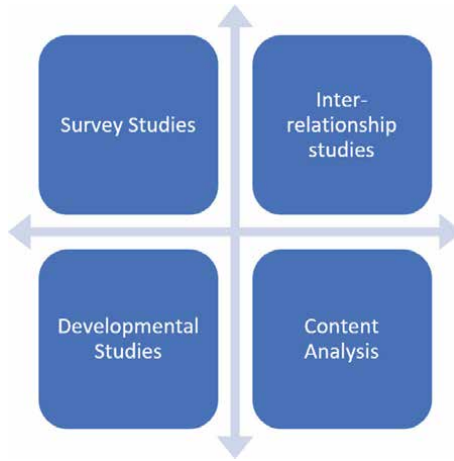

Figure 4.
Types of Descriptive Method.

concerned with the present and attempts to determine the status of the phenomenon under investigation. The survey research employs applications of scientific method by critically analyzing and examining the source materials, by analyzing and interpreting data, and by arriving at generalization and prediction [95].

According to Pandey and Pandey [95], Types of Descriptive Method: Descriptive method is divided into four parts. You may view the schematic below (**Figure 4**).

6. Discussion and conclusion

In this chapter, the context is discussed through the questions asked. What quantitative measures of semantic distance applied in research tell us about creativity or domain-specific creativity? The application of such methods can potentially provide a more quickly and objective measure of the output of creative thinking [65]. Why is LSA getting be popular in recent research? LSA, unlike many other methods, employs a preprocessing step in which the overall distribution of a word over its usage contexts, independent of its correlations with other words, is first taken into account; pragmatically, this step improves LSA' s results considerably [69]. According to Kenett [65], a growing number of studies are applying quantitative measures of semantic distance in creativity research. In addition, more recently, LSA may have inspired some researchers to examine. So, it may cause more recent research is getting prefer to use LSA. Is LSA scores successfully predicted the average human creativity scores? Yes, according to Forster and Dunbar [90], LSA scores successfully predicted the average human creativity scores. and the success of this measurement technique was confirmed with a scale independently judged by humans and shown to be a better approximation of human responses than traditional measures.

Creativity has various definitions, theories and models and creativity can be assessed in many ways as well. The many competing and complementary creativity tests in the field make it difficult for potential users to decide on their appropriateness. On the other hand, there is still a surprising gap regarding in the field about computer-based (objective and automatic) assessment of creativity. However, recently new developments as implementing new technologies [96], digitalization

[97] and scoring or assessment methods [56, 98] have been proposed. Despite the remarkable developments in technology, the literature on providing new scoring methods to pioneering creativity tests is still sparse [26].

As a matter of fact, the doctoral dissertation of the author of the chapter also includes the use of LSA in the automatic assessment of linguistic creativity [dissertation writing process in progress]. It is thought that the study will make a humble contribution to meet the need in the field. On the other hand, research focusing on LSA continues to be added to the literature day by day. In this regard, using LSA seems to be an effective method in the automatic/objective assessment of linguistic creativity. In summary, in this section, it is aimed to raise awareness of the need for computer-based (objective and automatic assessment) new scoring methods in the field of creativity.

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What is creativity? There are many definitions, many of which involve trying different experiences, searching for new solutions, exercising our brains, and meeting and talking with new people. To be creative we need to believe in our skills and step outside our comfort zones in the search for new challenges. This book is a discussion of creativity in four parts: creativity behaviour, creativity learning, creativity in science and arts, and creativity tendencies. Chapters address such topics as creativity in children, creativity in education, creativity at the emotional level, and more.

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