Contribution of mind map design software in improving the creative potential of CRMEF trainees

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Abstract. To achieve meaningful, effective, and successful learning, education increasingly uses digital technologies in the teaching-learning process, thus focusing on the learner and their potential and making them an active part of the learning process.

This study focuses on the use of mind-map design software by trainee learners of the Regional Center for Education and Training Professions of Oujda (CRMEF) of French specialization and its impact on the creative potential of this category of trainee learners. It aims to identify whether the learner's creative potential through the identified indicators of cognitive (Selective com-bination, Flexibility, Originality, Fluidity) and conative (Choice, Cognitive engagement, Performance, Perseverance) factors of the multivariate approach (Lubart & al 2015), could be impacted by the use of these software.

In this study, we opted for a hypothetical-deductive approach. We first opted for a descriptive (univariate) analysis of the collected results reflecting the learners-trainees' perception of mind-maps, their use, creativity, mind-map creation software… We cross-referenced the data for each selected factor and sub-factor with the variable using mind-map software (Bivariate analysis).

Analysis of this study's results has shown that potential creative development depends on certain sub-factors of the multivariate approach to creativity.

Keywords: Creativity, Mind map software, Education system, Creative potential, Learners-Trainees.

1 Introduction

Education today focuses on the learner and their potential and makes them an active part of the learning process. This, however, is not a recent research concern. Aware of the importance of technology for improving the education system, studies have been conducted on integrating technology into the teaching-learning process. This integration has been the subject of various research issues.

Most of this research has focused mainly on the contributions of technology integration in education or on the added value of creativity for the learner. The subject of this

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study finds its originality in the study of the relationship between technology and creativity. The focus is on using software dedicated to creating mind maps and developing the creative potential of the CRMEF (Regional Center of Education and Training) learners of Oujda.

In this study, we opted for a hypothetical-deductive approach as problematic: What is the relationship between software implementation for creating mind maps and the learner's creative potential?

We identified two factors of the multivariate approach (Lubart & al 2015): cognitive and conative. We have not taken into consideration the emotional and environmental factors. Admittedly, these last two factors are essential for measuring creative potential. However, we cannot study all the factors in a single study, and on the other hand, they are more suggestible than the first two factors (cognitive and conative). In addition, our selection was also made in light of the probable similarities between these factors and the different characteristics of mental maps.

2 Theoretical framework

2.1 Creative potential through the multivariate approach

The multivariate approach to creativity has developed since the 1980s (Amabil, 1988, Woodman, Sawyer, and Griffin, 1993; Taggar 2002, Lubart & al 2015); it illustrates the complexity (Csikszentmihalyi, 1988 and Lubart & al 2015), the nature of creativity and views it as a creative potential. The individual's creative potential is thus considered a variable that can be observed, analyzed, stimulated, and evaluated.

Based on the work of Guilford and Amabile (1988), Lubart & al (2015) have set up the multivariate approach to measurable creativity using a set of factors that we will detail from characteristics that consider both the individual and their environmental context. It is the complex set of interactions that gives rise to creative behavior. The multivariate approach emphasizes that creativity brings together both individual and contextual factors: cognitive, co-occurring, emotional, and environmental factors.

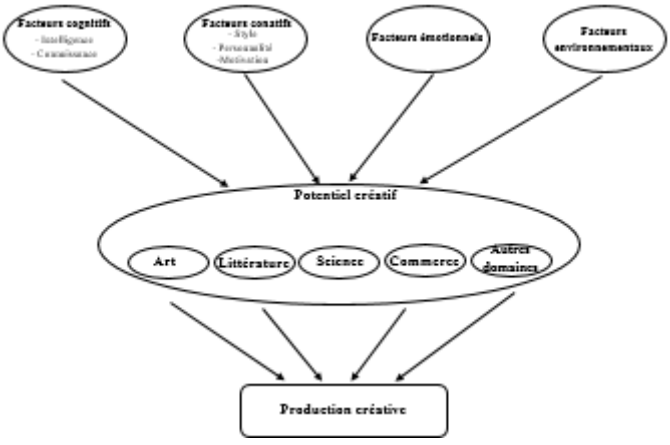

Fig. 1. Multivariate model of creativity (Lubart & al 2015)

We chose the multivariate approach model as the theoretical reference model for our study. It is a more recent model, taking into account different previous approaches to creativity and bringing together a variety of factors. According to this model, various components interact to achieve a result. We have focused on a few cognitive factors and others, as mentioned above. We did not consider emotional and environmental factors necessary for measuring creative potential, except that they are more suggestible than the two factors we selected (cognitive and conative).

Each of these factors has a set of sub-factors or indicators. First, cognitive factors refer to the processing of information and the knowledge acquired; this type of factor brings together: selective encoding, which refers to the selection of information related to the problem to be solved in its surroundings; the selective com-bination, which designates the discovery of reconciliations between elements of information which, at first sight, have no link between them and which serve to illuminate the problem; the evaluation of ideas which refers to a self-evaluation, a choice of ideas to keep and those to eliminate; and divergent thinking which means generating various ideas from a single piece of information.

In order to have more indicators in terms of divergent thinking, we turned to the work of Guilford (1950), who, according to him, this type of thinking brings together three indicators allowing its measurement (Laustriat, D. & Besançon; M., 2015):

- Fluidity, which is quantitative, represents the number of ideas to be produced.
- Flexibility to find solutions and alternatives to problems.
- Originality that is qualitative and represents the least cited, least generated, or unique ideas.

As for conative factors, we find risk-taking, which refers to going out of one's comfort zone to arrive at unusual proposals; perseverance, which refers to the ability to focus on completing a task despite its complexity and the problems encountered; the tolerance for ambiguity that makes the individual involved in a complex task by removing anxiety, rushing solutions and analyzing the problem from different angles; the openness to new ideas which refers to the curiosity to discover without being reluctant or anxious towards novelty; the individualism which allows the individual to be unique and different from others; and motivation which represents a push to engage the person in an activity or task. According to Rolland Viau (2009), motivation refers to:

A phenomenon that draws its source from the student's perceptions of himself and his environment and results in him choosing to commit himself to the pedagogical activity proposed to him and persevering in his accomplishment with the aim of learning. (Viau, 2009, p.12)

Motivation can be intrinsic when it comes from the needs of the individual who, curious to know and wanting to seek and express himself, succeeds in being creative. It can also be extrinsic regarding surroundings, the environment, social in-fluence… always about others. In order to delve deeper into this subfactor, we used the Rolland Viau (2009) motivation model, which presents four indicators: Choice, cognitive engagement, perseverance, and performance.

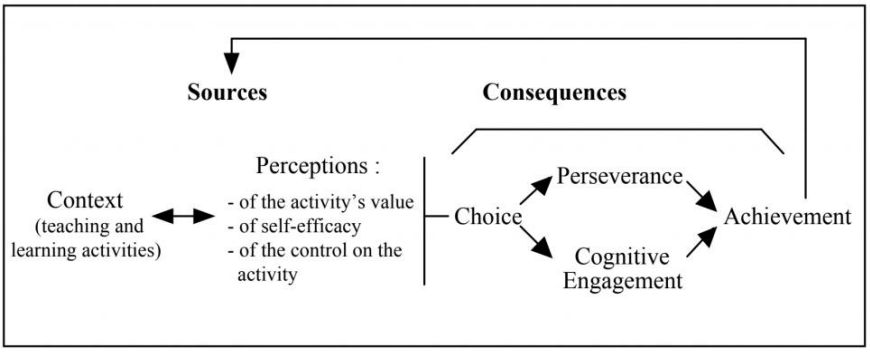

Fig. 2. Motivational Dynamic (Viau, 1994).

Rolland Viau (2009) shows that as long as the learner engages in a task and perseveres in achieving it, they have chosen to do so. This will automatically in-crease their performance.

Choice, our first indicator of motivation, refers to the learner's ability to engage or not engage in a given task. This choice depends on the degree of motivation. The second factor, cognitive engagement, involves the learner's concentration and attention to the task. Engaging cognitively makes the learner autonomous and increases his motivation. On the other hand, perseverance reflects the effort, tenacity, and time the learner spends on a given task. It is a faculty that pushes the learner to be attached to accomplish his task despite the difficulties encountered. Finally, performance represents the consequence of motivation and refers to the degree of success of the task and the result obtained.

2.2 Mind Maps and learning

The human brain functions radiantly; it is an innate mechanism. In order to in-crease the capacity for memorization and restoration of previously assimilated knowledge, opting for techniques and tools with a structure close to that of the human brain is preferable. It translates everything into words. It can transform and reflect thoughts and ideas. However, before translating them into words, the brain conceives them into images thanks to its different skills, such as shapes, colors… It also uses visuals and imagination (Buzan, T. 2018). When we coordinate, specify the existing relationships between ideas, and represent them visually, we automatically create mental connections that promote the assimilation of knowledge.

Mind maps, developed by Tony Buzan (1970), are a tool for visualizing, transferring, and sharing knowledge. They offer the opportunity to go beyond the linear way of thinking in one dimension and opt instead for a bi-dimensional way of thinking called the lateral way. From there, we can say that the mind map imitates our brain's functioning, and the subject is always complex. Mind maps form creative thinking and develop its different aspects through keywords and some-times even images.

Thus, the mind map draws its foundations from cognitivism, connectionism, and connetivism.

According to Laks Bernard (1996), the cognitive sciences are concerned with mental activity, the representations that structure it, and the manipulation of symbols that makes it possible. Cognitivism (1950-1960) then focuses on every-thing that that happens in the learner's brain, the construction of his knowledge, and especially on information processing. Its purpose is to understand how the learner can process the information, encode them in its memory and access it when needed (how he assimilates, stores, and reuses the information to under-stand or solve problems) and how it is stored and organized in its long-term memory.

This theory explains learning through information processing activities and by integrating and adding new information to other already existing information. It argues that the learner's prior knowledge, stored in their long-term memory in the form of schemas and semantic networks, must be taken into account, to which new knowledge will be added. From the moment the learner connects a new concept to a network of concepts already stored in their long-term memory, this theory considers their learning significant. This is closely related to how information is represented in the creation of a mind map but also to the cognitive factors of creativity that refer, as we have already mentioned, to the processing of information and the knowledge acquired.

As for connectionism, it is a current that is interested in cognitive phenomena, neuronal architecture, interactions, and interconnections that the brain organizes. This model came to break with the idea that information in long-term memory is stored as independent units. According to this model, when our brain receives information, the neurons associated with this information (directly or indirectly) are automatically activated. Thus, the brain establishes networks between these neurons that allow information processing. The information stored in our long-term memory is designed as interconnected single-unit networks. These structures and interconnections are similar to those allowed by mind maps, the selective combination that causes a learner to discover new, unnoticed connections at first glance and the perseverance that drives the learner to complete a task de-spite its complexity and absence of apparent links between the elements studied.

Connectivism (Siemens, 2005) focuses on the contributions of technologies in education that can help or support some cognitive tasks in information processing. Thus, they make it possible to cope with the abundance of information and facilitate its organization. This theory focuses on the links between learners themselves and technologies. These connections are necessary to facilitate continuous learning and ac-quire up-to-date knowledge. Mind maps can be considered one of the tools of connectivism. When they appeared, a human being carried out the development of mind maps manually. However, "it is an advanced form of thought, perfectly adapted to the needs of the digital era" (Tony Buzan, 2018). Indeed, technological progress in artificial intelligence has given rise to automated techniques for producing mind maps, whether in the form of down-loadable software or websites that also make it possible to create maps with the possibility of sharing them with other members and collaborating on their construction synchronously. This reminds us of the indicators of motivation (the choice of whether or not to engage in the performance of a given task via the software of mind maps, the engagement to the task to be performed through this software, and the

performance acquired through the use of this software) which we verify their relationship with the performance of a given task via this mind map creation software.

The mind map allows the brain to exploit more profoundly and differently the two hemispheres responsible for images, colors, logic, and words... Flexible rules, low complexity, and easy memorization characterize it. Indeed, to make a mental map, we start from the center, either of the paper or of the screen, where we place the central subject from which emerges one or more ramifications, a subdivision of concepts all associated with the nucleus with a juxtaposition and without explicit links (Buzan, T. 2018). This reminds us of divergent thinking that calls for fluidity (number of ideas to be produced), flexibility (finding solutions to problems encountered), and originality (unique ideas).

Technologies are not creative in themselves. It is the practices that could be creative through promoting or energizing. This is what we will verify through the practical part of our work.

3 Methodology and data analysis

3.1 Context, Collection and Analysis Tools

Based on the first part of our work, we have identified some factors of the multi-variate approach (Lubart, 2015) that influence the creative potential and constitute the dimensions of our study problem. The selected factors are cognitive (selective combination; divergent thinking: fluidity, flexibility, originality) and conative (perseverance; motivation: choice, cognitive engagement, performance).

The choice of learners-trainees who are in training at the CRMEF (Centre des Métiers de l'Education) in Oujda, more precisely of French speciality, as participants in our study, is based on their prior knowledge of mind maps: the majority, having obtained a degree in French studies at the Mohammed Premier University of Oujda, was initiated about mind maps. On the other hand, these participants are in a transitional phase ranging from learner to teacher status. Targeting these participants will first allow us to draw their attention to the use of these tools in the learning process, challenge some of the traditional teaching practices, and encourage them to use mind maps with future students because of their importance, regardless of whether or not the software has a positive impact on the learner's creative potential. It would also be possible to broaden our study by choosing the same participants as teachers.

In order to verify the impact of the selected sub-factors on the trainees' creativity, we used a questionnaire survey. The choice of such a method is explained by the fact that the questionnaire allows us, on the one hand, to question a large number of people (70 subjects in our case) and, on the other hand, to collect quantifiable data.

Our questionnaire consists of 22 categorical questions, 19 of which are closed questions and 3 semi-open questions, organized under 4 thematic axes: fact sheet (3 questions), questions on creativity (5 questions), questions about mind map creation software (5 questions), questions about the impact of using mind map creation software on the factors of creativity (9 questions).

The number of these trainees is 70. However, we distributed our questionnaire to the 55 trainees present on the day of the survey. The trainees' age varies between 21 and 32, among them 31 women.

In order to process and analyze data from the quantitative survey we conducted with trainee learners, we captured and prepared this data using the SPSS software.

We first opted for a descriptive (univariate) data analysis to have a synthetic idea of learners-trainees' perception regarding creativity, mind maps, and software for creating mind maps.

3.2 Univariate analysis

We first opted for a descriptive (univariate) data analysis to have a synthetic idea of learners-trainees' perception regarding creativity, mind maps, and software for creating mind maps.

Trainee learners and creativity. Creativity, according to learners-trainees, means a generation of new ideas (58%) and a generation that develops original solutions (51%). For 35% of learners-trainees, creativity is a challenge that al-lows the search for new avenues, and 31% think that creativity is one of the characteristics of man. However, only 4% of trainee learners believe that creativity is a gift reserved for geniuses and artists and that it is a mystery. Finally, 2% think that creativity is a distraction for children.

Most trainees interviewed (96%) believe that creativity could be developed through reading, computer tools, research, motivation, etc., and 65% believe that there are factors that influence creativity negatively. We can group their justifications into two factors: personal factors (demotivation, fear, stress, etc.) and external factors (family problems, lack of encouragement, etc.).

As for the techniques of creativity and according to the results of our study, 43% of learners-trainees think that a mind map is one of the techniques of creativity, and 37% have opted for brainstorming as the technique of creating. Also, 10% of learners-trainees consider the Scamper method as a technique of creating, and 10% the Six-Hats method as one of its techniques.

Learners-trainees and mind map software. Most learners-trainees (96%) know a mind map, and 73.5% know the software for creating mind maps. In the light of their answers, the most used software is X-mind (21 learners) and Mind-mapping (13 learners). Other software is less used, such as Free-mind (4 learners), Cmap tools (4 learners), and Draw Max (2 learners).

From the learners-trainees' perspective, 42% think it is easy to use mind map software and 33% think it is less complicated, and 25% think it is difficult to use. So according to our population's experience, using these software remains more or less accessible. This explains why most learners plan to use these mind map software with their future students (79%).

3.3 Bivariate Analysis

According to the results of the study, 78% of trainee learners believe that the use of mind map software plays a significant role in the development of creativity, whereas 22% of them think that this software for the creation of mind maps does not allow to realize original and creative productions.

In this context and in order to identify the relationship between the application of mind map software and the creative potential of the learner, we have opted for a bivariate analysis through the Chi-square independence test to determine whether the variable of "the use of mind map software" and the variables "cognitive factors" and "conative factors" of the multivariate approach (Lubart, 2015) are likely to be related or not.

Software and conative factors

Study of the independence of the use of mind map software and the "choice" sub-factor.

According to the results of the Chi-square test of independence of the variable "use of software for creating mind maps" and the variable "choice" (the degree of significance is very low: 0.013), the null hypothesis of independence between these two variables is rejected. It appears that learners-trainees who use mind map software are more motivated to choose the completion of a given task.

Table 1. Chi-square test of independence of the "use of software for creating mind maps" variable and the "choice" variable.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,111[a]	1	,013		
Continuity correction[b]	4,339	1	,037		
Likelihood Ratio	5,528	1	,019		
Fisher's Exact Test				,022	,022
Linear-by-Linear Association	5,991	1	,014		
N of Valid Cases	51				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2.82.

b. Computed only for a 2x2 table

To determine the degree of relationship between these two variables, we per-formed a Phi relationship degree test and it turned out that the value of this test is very significant ($p < 0.01$), indicating that the relationship between the choice and use of mind map software is statistically significant but of low magnitude.

Table 2. Test of the degree of relationship between the variable “use of software for creating mind maps and the variable “choice”.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,011	,007
	Cramer's V	,011	,007
N of Valid		40	

S*tudy of the independence of the use of mind map software and the cognitive engagement sub-factor.* We observe that the degree of significance is greater than 0.05, indicating that the differences between observed and expected occurrences are significant. We must therefore accept the null hypothesis of independence between the “cognitive engagement” factor and the use of mind map software. It appears that the degree of concentration and attention during the performance of a given task is almost the same for learners-trainees who use mind map software, as for learners-trainees who do not use mind map software.

Table 3. Chi-square test of independence of the “use of software for creating mind maps” variable and the “cognitive engagement” variable.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,758[a]	1	,384		
Continuity correction[b]	,182	1	,670		
Likelihood Ratio	,858	1	,354		
Fisher's Exact Test				,662	,355
Linear-by-Linear Association	,743	1	,389		
N of Valid Cases	50				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 1.98.

b. Computed only for a 2x2 table

Study of the independence of the use of mind mapping software and the performance sub-factor. We observe that the degree of significance is low ($p<0.05$), so we accept the alternative hypothesis: there is a relationship between the "performance" factor and the use of mind map software. In other words, according to the study, the tasks performed and the results obtained by the learners-trainees who use the software to create the mind maps are more successful than the learners-trainees who do not use them.

Table 4. Chi-square test of independence of the "use of software for creating mind maps" variable and the "performance" variable

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,229[a]	1	,043		
Continuity correction[b]	,020	1	,008		
Likelihood Ratio	,230	1	,031		
Fisher's Exact Test				,074	,044
Linear-by-Linear Association	,223	1	,037		
N of Valid Cases	41				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5.71.
b. Computed only for a 2x2 table

Table 5. Chi-square test of independence of the "use of software for creating mind maps" variable and the "performance" variable.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,075	,043
	Cramer's V	,075	,043
	Contingency coefficient	,074	,043
N of Valid		41	

Association measurements (Phi and V de Cramer) indicate the strength of the relationship (p greater than 0.01) between the use of mind mapping software and the performance sub-factor.

Study of the independence of the use of mind map software and the persistence sub-factor. We observe that the degree of significance is important, which indicates that the differences between observed and expected occurrences are significant, meaning that these differences would be found 777 times out of 1000 if the null hypothesis were true.

We must therefore accept the null hypothesis of independence between the factor «perseverance» and the use of software for creating mind maps. In other words, despite the use of mind map software, learner-trainees are not persevering in the face of the difficulties encountered in completing a given task.

Table 6. Chi-square test of independence of the variable "use of software for creating mental maps and the variable "perseverance

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1,777[a]	4	,777
Likelihood Ratio	2,055	4	,726
Linear-by-Linear Association	,705	1	,401
N of Valid Cases	41		
a.0 cells (80,0%) have expected count less than 5. The minimum expected count is 0.02.			

Software and Cognitive Factors

We observe that the degree of significance is important, which indicates that the differences between observed and expected occurrences are significant, meaning that these differences would be found 777 times out of 1000 if the null hypothesis were true.

Study of the independence of the use of mind mapping software and the "selective combination" sub-factor. We observe that the degree of significance is very low (below 0.05), so we must reject the null hypothesis of independence between the sub-factors «Selective combination» and the use of software for creating mind maps. Thus, the use of mind map software offers learners-trainees the opportunity to discover reconciliations between pieces of information that have, at first sight, no link between them, more than those who do not use this software.

Table 7. Chi-square test of independence of the variable "use of software for creating mind maps and the variable "selective combination"

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4,335[a]	2	,014
Likelihood Ratio	4,223	2	,021
Linear-by-Linear Association	2,814	1	,009
N of Valid Cases	51		
a. 2 cells (33,3%) have expected count less than 5. The minimum expected count is 0.25.			

Study of the independence of the use of mind mapping software and the fluidity sub-factor. According to the Chi-square table, we find that the degree of significance is very low (0.014 <0.05). Therefore, we accept the alternative hypothesis of independence between the «fluidity» sub-factor and the use of mind map creation software. Moreover, the use of these mind map software allows learners-trainees to generate many ideas on a given theme, more than those who do not use these software.

Table 8. Chi-square test of independence of the "use of software for creating mind maps" variable and the "fluidity" variable.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2,531[a]	3	,017
Likelihood Ratio	3,165	3	,036
Linear-by-Linear Association	,071	1	,079
N of Valid Cases	51		
a.0 cells (,0%) have expected count less than 5. The minimum expected count is 0.71.			

Table 9. Test of the degree of relationship between the variable "use of software for creating mind maps" and the variable "fluidity"

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,289	,144
	Cramer's V	,289	,144
	Contingency coefficient	,277	,144
N of Valid		52	

The association measures (Phi and V de Cramer) indicate an average relationship (p between 0.1 and 0.3) between the use of mind map software and the «fluidity» sub-factor.

Study of the independence of the use of mind map software and the "flexibility" sub-factor. We note that the degree of meaning is important ($p>0.05$), so we must accept the null hypothesis of independence between the factor «flexibility» and the use of software for creating mind maps. In other words, according to learners-trainees who use mind map software, the use of mind map software does not pro-vide solutions and alternatives to the problems encountered.

Table 10. Chi-square test of independence of the "use of software for creating mind maps" variable and the "flexibility" variable

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,038[a]	1	,845		
Continuity correction[b]	,000	1	1,000		
Likelihood Ratio	,038	1	,846		
Fisher's Exact Test				1,000	,562
Linear-by-Linear Association	,038	1	,846		
N of Valid Cases	52				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2.75.
b. Computed only for a 2x2 table

Study of the independence of the use of mind map software and the "originality" subfactor. We find that the degree of meaning is equal to 0.695 ($p>0.05$), so we must accept the null hypothesis of independence between the factor «originality» and the use of software for creating mind maps. Therefore, according to learners-trainees who use mind map software, this software does not allow them to generate clever, original and unique solutions.

Table 11. Chi-square test of independence of the "use of software for creating mind maps" variable and the "originality" variable

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,154[a]	1	,695		
Continuity correction[b]	,000	1	1,000		
Likelihood Ratio	,151	1	,698		
Fisher's Exact Test				,692	,499
Linear-by-Linear Association	,150	1	,698		
N of Valid Cases	41				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2.54.
b. Computed only for a 2x2 table

4 Conclusion

Our study has shown that the use of mind map creation software impacts specific cognitive (selective combination and fluidity) and conative (choice and performance) factors of creative potential without having a connection with other factors (cognitive: flexibility and originality, conative: cognitive engagement and perseverance). The fact that these tools do not impact all the factors we have selected from the mutivariate approach (Lubart, 2015) would not imply the absence of their creative impact. In part,

their use promotes the development of certain aspects of creativity, and this gap would be filled by using other tools (such as brainstorming...)

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