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FOSTERING COGNITIVE AND CREATIVE THINKING STYLES THROUGH THE USE OF INNOVATIVE PEDAGOGICAL TECHNOLOGIES IN THE PROCESS OF VOCATIONAL TRAINING

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Abstract. *This study reveals the effect of a sustainable training program, based on the technology-mediated learning environment, cognitive load, and self-efficacy has on cognitive and creative thinking styles through increasing learning motivation. The experimental model was based on five hypotheses which were as follows: (1) technology-mediated learning environment will positively affect cognitive and creative thinking styles; (2) technology-mediated learning environment will positively affect students’ learning motivation; (3) the cognitive and creativity purpose load will contribute to students’ learning motivation; (4) self-efficacy will considerably affect learning motivation; (5) learning motivation will substantially affect fostering cognitive and creative thinking styles. Cognitive reflection test, creative personality scale, the questionnaires were used to collect data. SPSS and SmartPLS statistical analysis tools were used to process collected data. A descriptive statistical analysis was used to analyse general information from the first section of the questionnaire. The partial least square (PLS) was applied to process the second section of the questionnaire. A confirmatory factor analysis (CFA) was used to exercise a measurement model, and then a structural model was employed to investigate the path analysis of the potential factors. The results of this study found that the technology-mediated learning environment improved cognitive and creative thinking styles through increasing learning motivation. This study confirms that there is a positive relationship between learning motivation and the development of cognitive and creative thinking styles. However, the study proved the fact that when students are overloaded with cognitive tasks, they are not able to manage to be engaged in critical thinking or creativity purpose activity productively. The research result could provide design guidelines for organising cross-disciplinary and cross-institutional teaching-learning environments.*

Keywords: *cognitive style, creative thinking style, innovative pedagogical technologies, sustainable models of teaching and learning, vocational training, tertiary school.*

Introduction. Cognitive and creativity thinking styles of individuals have been the platform for the emerging economic and societal trends (knowledge-based economy [6], information society [19], creative economy [3], key ideas for innovative educational concepts, digitalization of education, STEM and a goal (or rather a challenge) to pedagogical science in terms of adopting or creating innovative pedagogical technologies to be capable to meet that goal. Various innovative pedagogical methods and technologies for innovative teaching and learning are being developed towards that goal. One example is the model of gaining knowledge through sustainable innovation learning (SIL) environment. Tertiary educational institutions are increasingly taking basic and essential steps, and it has become a trend, to implement sustainable communication models and sustainable models of teaching and

learning to redevelop educational strategies [5; 11; 2; 29; 30]. Those sustainable models are aimed at creating a technology-mediated learning environment, which has proved not only green but cost-efficient, resources and time-efficient, easy-tailored, flexible, affordable, easy-scalable, and adjustable to anyone's intellectual style or learning pace. It also has the potential to accelerate the formation of cognitive and creative thinking styles of the tertiary school students in the process of vocational training [24; 30].

Analysis of recent researches and publications. A cognitive style was associated by Riding [26], with a prevalent and habit-based approach to structuring and delivering information that is learned or taught. Riding [27], states that a cognitive style provides an impact on decision-making that consequently provides an impact on a person's thinking process and one's attitudes. Though differing from the ability, a cognitive style is seen by scientists as a feature determined by an individual's intelligence, gender, and personality [27; 18; 4; 25].

Zhang & Sternberg [31], liken a cognitive style to such terms as intellectual (thinking) style, conceptual tempo, decision making and problem-solving style, mind style, thinking style perceptual style, and learning style regarding any of the latter as some person's preferred way of perceiving information and dealing with tasks. The scientists' reasoning is based on the fact that any intellectual style combines cognitive, affective, physiological, and sociological aspects of the approach to processing information and dealing with tasks.

Ziętek & Roehr [32], further elaborated on the concept of Riding and Fanning [27] regarding whether to differentiate between cognitive and learning styles or use them as synonymous. A cognitive style is dependent on the working memory while learning outcomes are determined by a cognitive style [1].

The cognitive styles can be categorised into four groups: wholist verbaliser, wholist imager, analytic verbaliser, analytic imager. The components of each style may either complement or augment each other [26].

In their paper "Threefold Model of Intellectual Styles", Zhang and Sternberg [31] categorise all existing intellectual (cognitive) styles into three types: Type I, Type II, and Type III. Type I individuals best deal with a low degree of task structure requiring individuals to process information using thinking styles that are more complex, and that allows originality and a high degree of autonomy. The above indicates if frequently expressed, that those are highly creative individuals or groups. Type II style performers are best at structured tasks processing information in a more simplistic manner and traditional ways of doing things. The representatives of this style are less creative. Individuals falling under Type III may manifest the characteristics of either Type I or Type II styles, depending on the stylistic demands of a specific situation. Therefore, Type I might be claimed to be a creativity-generating intellectual style as its representatives tend to use a wide repertoire of styles to deal with tasks.

Minchekar V. S. [20] puts cognitive styles into two broad categories: systematic and intuitive implying that the intuitive cognitive style is positive significantly related to creativity.

Creativity implies different contexts and in educational settings, it can be used to address academic achievement or academic ability, on the other hand, is relatively more easily defined, measured, and interpreted [21].

According to Radovic [23], creative thinking is a synergy of cognition and personality traits allowing the person to apply their intellectual abilities and knowledge to resolve the problem using an imaginative and experimental approach. Based on bi-polar concepts such as 'right vs. left-brain' thinking or 'rational vs. intuitive' thinking, there are attempts to distinguish the main types of creative thinking. One of them specifies five key thinking styles such as divergent (exaggeration), lateral (out-of-the-box), aesthetic (beauty and taste), system-based (synthesis towards the whole), and inspirational (emergent, radical insight) [13].

The relation between cognitive styles and creative thinking

Kirton suggested that a person's cognitive style preferences are related to creativity [16]. He described a cognitive preferential style 'as a bipolar continuum with adaptors at one end of continuum and innovators at the other'. Puccio, using Kirton's Adaption Innovation Inventory found that students with more innovative cognitive styles were more fluent and original when asked to generate problem statements based on a real business problem [22]. Again using Kirton's measure, Hurley [12] reported a significant relationship between students' cognitive style preferences and application of creative problem solving [In 22]. Sternberg and Lubart [28] claimed that cognitive style was an integrated part of creative thinking.

The **purpose of this study** was to

investigate the effects of using a sustainable training program on cognitive and creative thinking styles through increasing learning motivation. Moreover, this research investigated the moderating effect on motivation to understand whether the amount of information to be studied by the students will affect the process of learning motivation, and as a result, cognitive and creative thinking styles.

The model is based on five hypotheses which are as follows: (1) technology-mediated learning environment will positively affect cognitive and creative thinking styles; (2) technology-mediated learning environment will positively affect students' learning motivation; (3) the cognitive and creativity purpose load will contribute to students' learning motivation; (4) self-efficacy will considerably affect learning motivation; (5) learning motivation will substantially affect fostering cognitive and creative thinking styles.

The research question is to investigate the effect of a sustainable training program, based on the technology-mediated learning environment, cognitive load, and self-efficacy has on cognitive and creative thinking styles through increasing learning motivation.

Methods. This study focused on the effect of a sustainable training program, and observation of whether technology-mediated learning environment, cognitive and creative load, and self-efficacy have an impact on cognitive and creative thinking styles through increasing learning motivation. This section contains the research model, definition value, questionnaire, participants and procedures, and common method variance.

It appears that learning preferences significantly impact on learners' attitudes, motivation, and academic performance. Moreover, the instructional method is a precondition for a learner's success. In view of the fact that there is a relationship between learners' cognitive styles and creative thinking styles and pedagogical technologies suiting them, this study will use instructional technologies, which might be appropriate for all cognitive and creative thinking styles.

Description of a sustainable training program. The training program was run in several stages: preparatory, implementation, and reflexive. The core of this program was a technology-mediated learning environment, which stipulated doing a project through *Office 365* cloud services. The goal of the project was to design a new product (the examples were knowledge pills, centrally-heated bikini, portable lie detector, etc) and packaging for them as if the students were cross-functional task forces. The students were supposed to consider the questions like what material they could use, what shape, colour, logo, photo, and text would be appropriate, how the packaging would make the product look different in a shop, etc. The communication was run through the *Office 365 services.* All theoretical materials and assignments were downloaded to *Office 365* services, such as *OneDrive, OneNote, GoogleForms*. The students additionally used software such as *Prime Decisions* for training their decision-making skills and *MS Project* to substantiate the sequence of actions in fulfilling the project.

Sample. The subjects of this research were undergraduates being in their 2-4 years of study at the National University of Life and Environmental Sciences of Ukraine (NULES of Ukraine) and Kyiv National University of Trade and Economics (KNUTE) who had received their grade point average and had never taken similar tests. The population for this research population was 234 individuals who were 133 students from NULES of Ukraine and 101 students of KNUTE. Those students were distributed into three major-based groups like social sciences (SS), life sciences (LS) and engineering sciences (ES) using an assessment system in Next Generation Science Standard adopted in the USA. The Cumulative Performance Index (CPI) was used to describe students' academic achievements.

At the end of the semester, to calculate CPI, whose scales were from 0 to 4, the ratio of the score which the student got in every subject matter was weighted with the total number of class credits (ECTS) the student had taken [15].

After the population was identified, cognitive reflection test (CRT) and creative personality scale (CPS) (see Instruments section) were applied to determine participants' cognitive styles and creativity indications.

As the CRT score of the pooled mean (0.85) suggested, most of the students could not answer all the test questions correctly, and only a small proportion answered some or all the three. There were 52.8% of students who scored 0; 22.1% scored 1; 12.1% scored 2; and 13% scored 3. Those figures implied that the respondents mainly had used intuitive thinking as their cognitive thinking style as they had tended to made non-reflective or wrong answers based on wrongly applied logical form. Additionally, it was found a slight difference between NULES of Ukraine and KNUTE

students in their CRT scores meaning that NULES of Ukraine students were slightly more analytical than KNUTE students.

Concerning creativity, students from both universities got CPS scores varying from 5 to 15. The pooled mean was 3.15, which was approximately the same as the expected median for Gough's CPS. Overall, the figures for both universities also had the mean of CPS nearly the same as median CPS and did not show any difference.

The above seeming homogeneity in the CRT and CPS score was considered an indicator of approximate equality of those groups.

Following that, random selection, based on the above test scores, was used to form an experimental group (EG) (30 people) and a control group (CG) of 30 people. The EG was split into five cross-functional teams of six people each.

Instruments

Cognitive reflection test (CRT) and Creative personality scale (CPS)

To identify participants' cognitive styles, the cognitive reflection test (CRT) was used [7]. The test was administered without preparation and there was no time limit set. There were three questions and the correct answers were summed for the CRT scoring.

The creative personality scale (CPS) [9] consisting of 18 adjectives representing positive indications of the creative individual and 12 negative ones was used to test creativity. Students were asked to check off all adjectives that they think match them. Creative qualities were assessed by summing positive and negative checks, whereas non-checked adjectives were given zero value [17].

Questionnaire

The questionnaire comprised two sections. The first section included general information and the second one was aimed at each dimension. The dimensions in this study were a technology-mediated learning environment, cognitive and creativity purpose loading, self-efficacy, learning motivation, and cognitive and creative thinking styles. The scale of each dimension in this paper changes according to the situation in which students use technology-mediated learning. After collecting responses to the questionnaires (30 responses), they were analysed using SPSS and SmartPLS statistical analysis tools. A descriptive statistical analysis was used to analyse general information from the first section of the questionnaire. The partial least square (PLS) was applied to process the second section of the questionnaire. A confirmatory factor analysis (CFA) was used to exercise a measurement model, and then a structural model was employed to investigate the path analysis of the potential factors.

Results. The PLS algorithm was used to calculated composite reliability and average variance extracted (AVE). The internal consistency reliability was calculated through the application of Cronbach's alpha. Three aspects of the criterion of evaluating convergent validity were considered to explain the latent construct. Those were (1) all outer loading should be higher than 0.50; (2) composite reliability (CR) should be higher than 0.70, and (3) AVE should be higher than 0.50 [8]. (See Table 3 showing the results of the reliability analysis). Table 2 illustrates the mean, standard deviation, composite reliability, Cronbach's α, and Fornell-Larcker criterion. As is shown in Table 1, the square root of AVE in each construct is higher than the correlations of other constructs, which indicates that all constructs have good discriminant validity. The Cronbach's α of each latent construct is between 0.80–0.88, and the CRs are between 0.88–0.91. The results indicated good consistency between participants and each item of the constructs; also, the results of the survey were statistically representative and reliable.

Table 1.

Means Standard Deviations, Reliabilities, and Correlation of Constructs

Construct	Mean	STD	Outer Loadings	Cronbach's Alpha	CR	AVE	Fornell-Larcker Criterion				
							TML	CCPL	SE	LM	CCTS
TML	5.89	0.95	0.82	0.88	0.90	0.65	0.82				
CCPL	5.68	1.21	0,86	0.86	0.89	0.72	– 0.57	0.82			
SE	5.79	1.01	0,83	0.87	0.91	0.65	0.76	–0.53	0.82		
LM	5.94	0.95	0.83	0.88	0.91	0.69	0.72	–0.57	0.72	0.81	
CCTS	5.31	1.05	0.78	0.85	0.90	0.63	0.71	–0.61	0.65	0.82	0.81

Note. TML - Technology-mediated learning, CCPL - Cognitive and creativity purpose load, SE - Self-efficacy, LM - Learning motivation, CCTS - Cognitive and creative thinking styles.

Each hypothesis for this research was tested using PLS (SmartPLS) statistical analysis tool. After confirming that each construct has good reliability and validity, this research evaluated the structural model, including evaluating the prediction of the model and the relationship between the constructs. The evaluation of the model has five steps: (1) Evaluate the collinearity; (2) Evaluate the significance and the correlation of the structural model; (3) Evaluate the coefficient of determination (R2); (4) Evaluate the f^2 effect size.

The variance inflation factor (VIF) was used to evaluate the collinearity problem. The VIF of all the variables is lower than 5.00, thus, this research does not have a collinearity problem.

The path coefficient of the structural model was conducted after the PLS algorithm was used. The standardised values of the path coefficients should be between −1 and +1. The value that is positive and highly correlated is closer to +1; conversely, the value that is negative and highly correlated is closer to −1. The closer the value to 0, the weaker the relationship. The significance of the path coefficient is determined by the empirical *t* value through bootstrapping [10]. Due to the sample being 30, the data are close to *t*-distribution. This research used the quartile of the normal distribution as the critical value to compare the empirical *t* values of the data.

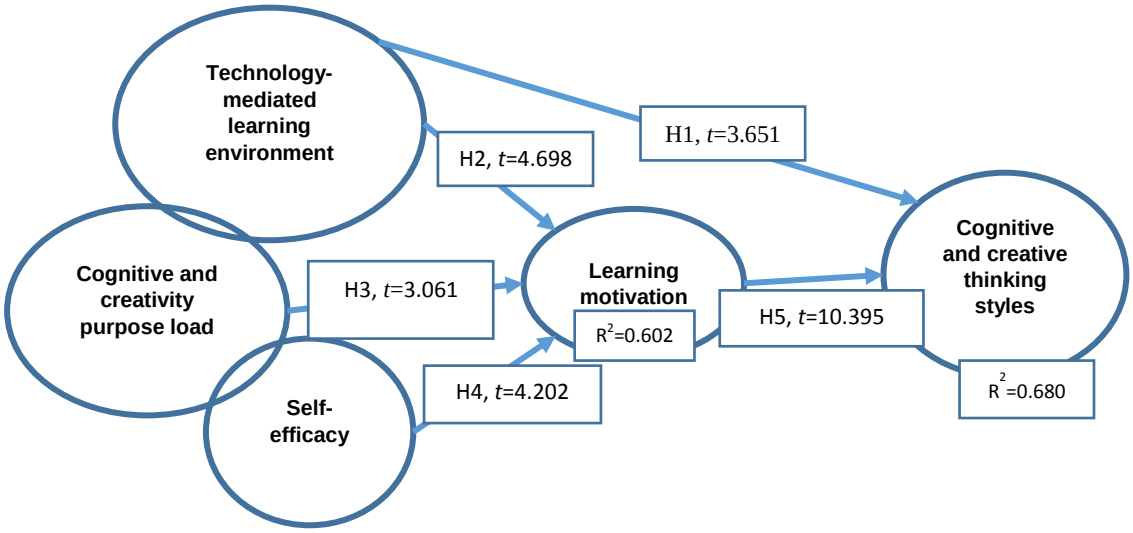

Figure 1. Path coefficient of the structural model

As Figure 1 suggests the path coefficient of the model [10], R^2 of learning motivation (LM) and cognitive and creative thinking styles (CCTS) are addressed as moderate (R2 = 0.62, R2 = 0.680)

The f^2 effect was calculated using the equation below:

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

The difference is between including and excluding the exogenous construct. The principle of evaluating f^2 was classified as 0.02, 0.15, and 0.35, which is described as the small, medium, and large effect. The path coefficient of the model (see Figure 2), $R^2_{included}$ value of LM is 0.602, relatively $R^2_{excluded,TML}$ value is 0.563, the $R^2_{excluded,CCPL}$ value is 0.576, and the $R^2_{excluded,SE}$ value is 0.564. Therefore, f^2 effect sizes TML and LM are medium while the effect size among CCPS, SE, and LM are small. The f^2effect size between TML and LM is small, while f^2 effect size between TML and CCTS is large.

This research limitation. The greatest limitation of this study is the time limit, which might cause claims that the findings are arguably significant. Since the idea of this project was to focus on different extracurricular contents, support better skill formation and learning effectiveness through more tasks and assignments, it was, though, limited to a few knowledge areas.

Discussion. The objective of this study was to investigate the degree of influence of technology-mediated learning environment, here viewed as a sustainable pedagogic technology, cognitive and creative load, and self-efficacy, on cognitive and creative thinking styles through increasing learning motivation.

This study found that the technology-mediated learning environment improved cognitive and creative thinking styles through increasing learning motivation. The experiential results indicate that the students who participated in this training program reported higher grades in their regular studies, higher learning motivation, and quick thinking, and being better at generating new ideas. This study confirms that there is a positive relationship between learning motivation and the development of cognitive and creative thinking styles. However, the study confirmed the fact that when students are overloaded with cognitive tasks, they are not able to manage to be engaged in critical thinking or creativity purpose activity productively [14].

Conclusion. Plentiful studies are investigating tertiary students' cognitive and creative thinking styles. However, few have investigated how technology-mediated learning environment, cognitive and creative loading, and self-efficacy contribute to students' learning motivation and through its cognitive and creative thinking styles. Having considered this study results, this model helps students transform their practical experience into knowledge. Additionally, the improvement of students' learning motivation accelerates fostering tertiary students' cognitive and creative thinking styles.

This study contributes to both psychological and pedagogical theories in terms of using sustainable pedagogic technology to fostering competencies and developing 21st-century personality. The research result could provide design guidelines for organising cross-disciplinary and cross-institutional teaching-learning environments.

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ПОКРАЩЕННЯ КОГНІТИВНОГО ТА ТВОРЧОГО МИСЛЕННЯ ЧЕРЕЗ ВИКОРИСТАННЯ ІННОВАЦІЙНИХ ПЕДАГОГІЧНИХ ТЕХНОЛОГІЙ У ПРОЦЕСІ ПРОФЕСІЙНОЇ ПІДГОТОВКИ

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***Анотація**. Це дослідження аналізує вплив стійкої навчальної програми, заснованої на опосередкованому технологіями навчальному середовищі, когнітивному навантаженні та самоефективності на стилі когнітивного та творчого мислення через підвищення мотивації навчання. Експериментальна модель базується на п'яти гіпотезах: (1) навчальне середовище, опосередковане технологіями, позитивно впливає на когнітивні та творчі стилі мислення; (2) навчальне середовище, опосередковане технологіями, позитивно впливає на мотивацію навчання учнів; (3) навантаження на когнітивні та творчі здібності сприяє мотивації учнів до навчання; (4) самоефективність істотно впливає на мотивацію навчання; (5) мотивація навчання впливає на формування стилів когнітивного та творчого мислення.*

Для збору даних використано когнітивно-рефлексійний тест, шкалу творчої особистості й анкети. Для обробки зібраних даних використані інструменти статистичного аналізу SPSS та SmartPLS. Метод описового статистичного аналізу уможливив

характеристику загальної інформації з першого розділу анкети. Частковий найменший квадрат (PLS) був застосований для обробки другого розділу анкети. Аналіз підтверджуючого фактора (CFA) використано для здійснення моделі вимірювання, також використана структурна модель для дослідження аналізу через певні потенційні чинники.

Висновковуємо, що опосередковане технологіями навчальне середовище покращує когнітивні і творчі стилі мислення з опертям на рівень мотивації навчання. Дослідження підтверджує, що існує позитивний взаємозв'язок між мотивацією навчання та розвитком когнітивного і творчого стилів мислення. Однак дослідження довело той факт, що коли студенти перевантажені когнітивними завданнями, вони не в змозі продуктивно займатися критичним мисленням чи діяльністю. Результат дослідження може надати керівні принципи для організації міждисциплінарного та міжінституційного середовища викладання та навчання.

Ключові слова: *когнітивний стиль, стиль креативного мислення, інноваційні педагогічні технології, стійкі моделі навчання, професійне навчання, заклад вищої освіти.*