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Developing Independent Creativity in Pupils: Neuroscientific Discourse and Ukraine's Experience

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Abstract: *The article deals with the process of updating the content and methods of technological training. The latter aims to form pupils' skills of independent creativity and educational and handicraft activities, which act as the means of improving education quality. The international relevance of the article lies in the objectification of Ukraine's experience, which can be used in the post-Soviet countries, given that these countries follow conservative principles in planning and implementing educational content. The article proves that the effectiveness of developing pupils' experience of independent creativity during handicraft and technology lessons is determined by the following organizational and methodological conditions: comprehending the need for independent creativity; developing pupils' positive motivation towards independent creative handicraft and technology activities; improving educational and methodological support; using innovative pedagogical technologies and information and communication technologies. The article summarizes research findings of certain Ukrainian and foreign researchers, which adds up to the generalized contribution of its authors.*

Keywords: *educational and handicraft activities, technological training, situations of success, workbook, game technologies.*

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Introduction

The analysis of theoretical and practical aspects in the development of pupils' experience of independent creativity during handicraft and technology activities shows that there are several contradictions between increasing attention of society to the problem of developing creative and independent personality in pupils and an insufficient realization of technological training potential in solving this relevant problem; an objective need to reorient the vector of school education to increase the level of development of pupils' experience of independent creativity in pupils and the lack of effective methodology for developing this personal quality during handicraft and technology activities; the need to increase the level of development of the experience of independent creativity in pupils aged between 10 and 14 (Grades 5-9) and the application of only traditional educational means and technologies.

Considering themselves as adults, on the one hand, contradicts adolescents' actual abilities. On the other hand, real adults' attitude towards them does not correspond to their new insights, which is why they strive for independence and individual behavioural manifestations. Due to their lack of necessary experience in independent activities, pupils may deal with numerous life problems, which proves that adolescence is the most sensitive period for developing experience in independent creative handicraft and technology activities (Komogorova et al., 2021; Maksymchuk, 2020a; Maksymchuk, 2020b; Onishchuk et al., 2020; Palamarchuk et al., 2020; Sheremet et al., 2019).

Thus, the authors of the article have clarified the concept of "pupils' experience in independent creativity", which is considered as a complex of knowledge and skills in planning, organizing, and performing individual creative handicraft and technology tasks with the help of non-standard approaches and without teacher supervision.

The creative experience is a result of the creative and active acquisition and application of knowledge and skills during independent, highly organized, and motivated creativity.

In general, independent activity involves various tasks. It is manifested through cognitive or practical tasks, which motivate pupils towards participating in handicraft and technology activities. Each independent activity should correspond to the aim and objectives of educational material, as well as ensure gradual progression from ignorance to knowledge, from the lower to the higher level of independence.

A complex of didactic means, which contribute to developing both technological education content and its information environment, is of great importance in the organization of pupils' independent creativity during handicraft and technology lessons. It has been found that technology teachers prefer the following tools for organizing independent activities: textbooks and manuals (30.7%), blackboard (60.8%), instructional and technological cards (45.3%), creative design (3.8 %), whereas modern educational tools (computers, workbooks, multimedia projectors) are applied quite insufficiently.

However, despite many pieces of research on this problem, which consider various aspects of independent creative handicraft and technology activities of pupils, several issues related to developing the experience of independent creativity in middle school pupils during technological training remains insufficiently studied. Besides, the problem has been intensified by the modernization of content and methodology of pupils' technological training in comprehensive schools.

Therefore, the research aims to justify the effectiveness of organizational and methodological conditions for developing independent creativity in pupils during technological training

Independent Creativity of Pupils in learning: Global Trends

Recently, several theories have emerged in educational and neuroscientific discourse to stimulate the cognitive and creative potential of pupils, considering interdisciplinary research. Thus, some scholars claim that the creative intellectual activity of pupils is inseparable from their motor activity. One area stimulates another, as well as lack of motor activity inhibits both cognitive and creative spheres. There is still insufficient experimental evidence of the links between the motivation behind the independent creativity and motor activity. At the same time, Gearin & Fien (2016) state that physical activity boosts motivation towards cognitive activity and offers non-standard solutions to didactic problems.

Currently, one can observe the links between people's neurobiology and their educational, cognitive, and creative capabilities. A holistic approach to this issue has revealed the interdependence between such, at first glance, heteromorphic aspects as thinking, attention, physical activity, motivation, nutrition, lifestyle, independence, response to positive and negative stimuli (Gruart, 2014). The motivation for independent creativity in childhood is based on adaptive mechanisms, which gradually become socially oriented.

Such research much popularizes educational tools "claiming to use "right-brain techniques" (Lindell & Kidd, 2011). Besides, the idea that people are "left-brained" or "right-brained" is a neuromyth that was debunked (Lindell & Kidd, 2011). The correlation of the hemispheres in creative solving of didactic or life problems is much more complex than previously understood.

Today, some researchers justify the neurophysiological basis of independent creativity and identify specific brain circuits involved in specific higher brain functions. As noted by Dietrich (2004), "there are four basic types of creative insights, each mediated by a distinctive neural circuit". At the same time, Dietrich (2004) indicates, "by definition, creative insights occur in consciousness". Given that "the working memory buffer of the prefrontal cortex holds the content of consciousness, each of the four distinctive neural loops terminates there" (Dietrich, 2004). Also, "when creativity is the result of deliberate control, as opposed to spontaneous generation, the prefrontal cortex also instigates the creative process" (Dietrich, 2004). Thus, both spontaneous and intentional creative modes of information processing include integrated emotional-intuitive and rational (mental) mechanisms. It means that science and art find common mechanisms and systematize the interaction between knowledge and creative thinking (Dietrich, 2004).

The basis for the current stimulation of independent creativity is an assumption that educational or any other personal motivation is based on human subjectivity as one of the main bio-social functions. Moreover, social, psychological, and neurophysiological mechanisms operate simultaneously in their implementation (Della Sala & Anderson, 2012).

The other side of stimulating pupils' independent creativity now lies in reassessing the importance of motivation's emotional component. Previously, the role of emotions in cognitive activity and education was underestimated, and they were considered an additional component. Currently, scholars are proving that emotions affect the quality and intensity of such higher cognitive processes as memory, attention and, consequently, motivation for independent creativity (Li et al., 2018, p. 220). The nature and quality of emotions have more influence on cognitive and creative processes than rational attitudes. From this one can conclude that modelling educational conditions should be based on optimizing the atmosphere, receiving positive incentives and the child's stay in an emotionally ecological environment.

Stimulating Independent Creativity of Pupils in Ukrainian Discourse

Different aspects of organizing independent creativity of pupils during handicraft and technology lessons have been covered in many pieces of research. Thus, the category of independence has always been considered in didactics, psychology, and technologies teaching. In particular, the concept of independent activities has been defined by Aleksiuk & Kashin (1986), Buriak (2007), Savchenko (2007); classification characteristics of independent activities have been specified by Onyshchuk (1981) and Usova (2000). The importance of enhancing pupils' independence during technological training has been highlighted in research by Kobernyk (1998).

The analysis of certain studies (Kobernyk, 1998) shows that the problem of organizing independent creativity of pupils during technological training is rather relevant. The current stage in technological education development is characterized by the rapid increase in information volume given limited teaching hours and high requirements for the level and quality of pupils' educational achievements in handicraft and technology activities. However, one can observe that pupils' interest in handicraft and technology lessons, the volume of acquired knowledge, and the quality of technological training are decreasing. Therefore, comprehensive schools should aim to develop a creative, active, and independent personality of pupils during technological training.

The authors of the article agree with Serhiienko (2010) that organizational and methodological conditions are based on certain functions of activity: planning, organization, motivation, control and analysis. Teacher activity is not a temporary action, but a process, a series of continuous interrelated actions, each of which is, in turn, the process and the product of certain functions. An aspect-based approach to teacher activity involves taking into account and considering real-life practical situations and conditions. Therefore, organizational and methodological conditions are viewed as specific concrete circumstances concerning the organization and methods of developing the experience of independent creativity in pupils, which are aimed at improving this process.

They also agree with Erganova (2007), who defines the following goals of using workbooks in the educational process: ensuring the quality acquisition of educational material; developing educational and cognitive activity; developing the experience of learner autonomy; promoting creativity in educational and cognitive activity.

Studies by Galperin & Talyzina (1992) prove that workbooks and textbooks are complementary learning tools according to their functional purpose. The only difference between them is that textbooks are primarily aimed at highlighting educational material, whereas workbooks are intended for its understanding and consolidation and, therefore, contain a system of guidelines for the gradual development of the experience of independent creativity. The analysis of pedagogical literature shows that educational literature is represented by the educational and methodological complex in the system of didactic tools, which includes the workbooks.

The authors of the article agree with Shchukina (1998), who believes that it is expedient to single out the general sanitary and hygienic requirements, the requirements for font design and printing materials for workbooks. One of these requirements is a dedicated evaluation of the clarity of colour combinations when selecting lettering, fonts and background colours.

Considering the complexity of the problem, it is impossible to reveal all its aspects within this research. Prospects for further studies include developing theoretical and methodological principles of organizing independent creative handicraft and technology activities for different age groups of pupils, improving the content of pupils' independent activities with the help of didactic means and information and communication technologies during handicraft and technology lessons, organizing independent extracurricular activities of pupils.

The Experience of Implementing the Simulated Conditions

The selection of pupils for the implementation of the new conditions is rooted in the assumption that the level of general technological training, the level of experience of independence and creativity in learning and certain personal qualities of the pupils should be approximately the same and they should be engaged in sports sections. Given that pupils in Grades 5-9 studied in urban and rural comprehensive schools, the level of technological training was generally the same.

Pupils were more independent in their learning as they used less the help of teachers or peers in solving their learning tasks and used more additional sources of information, which is a requirement of the high level of educational achievements.

The effectiveness of developing the experience of independent creativity in pupils during handicraft and technology lessons is determined by the following ***organizational and methodological conditions***: comprehending the need for an independent creative activity as an integral

component of technological training of pupils in a modern school; ensuring the process of developing pupils' positive motivation towards independent creative handicraft and technology activities; improving educational and methodological support of organization of pupils' independent creativity during handicraft and technology lessons; using innovative pedagogical technologies and information and communication technologies while organizing middle school pupils' independent creativity.

It is certain that the effectiveness of **the first condition** directly depends on technology teachers' comprehending the importance of the organization of pupils' independent creativity during handicraft and technology lessons and considering them as an integral part of the educational process. Independent learning facilitates pupil-centred learning, intellectual development and increases the intensity of the educational process. Due to the well-developed experience of independent creativity, pupils can deepen their knowledge independently, perform practical tasks and carry out self-control, self-assessment, and self-correction of educational activities.

The second condition is realized by creating favourable conditions for pupils to increase their interest in independent creativity while performing handicraft and technology tasks. Nevertheless, these motives are related to fulfilling the existing needs of the subject of activity and, therefore, play a stimulating function, which determines the subject orientation of pupils' independent creativity. Pupils' experience of independent creativity is developed by many motives that are different in content, features and of different origin (social, cognitive, professional, and axiological). Of great significance in developing pupils' experience in independent creativity are such motives as cognitive interest and creating a situation of success. The interest in creative independent activities and their results serves as an incentive to complete independent activities. Creating the situation of success in any independent creative activity aims to encourage pupils to make optimal use of their capabilities, strive for quality performance, persist in achieving a certain goal and overcome the difficulties that may occur.

The teacher must encourage pupils to feel that they are "no worse than others" so that they can feel comfortable while performing an independent task. Therefore, teachers need to select realistic tasks for pupils and evaluate their performance, while ensuring a proper microclimate, in which the pupil does not feel insecure and afraid. There should be a comfortable pedagogical environment (atmosphere of kindness, sincerity and openness; harmonious environment facilitating independent creativity; better perception of the new

and fast reproduction of the learned material). Teachers' positive evaluation evokes positive emotions in pupils.

There is a great variety of methods for creating situations of success for schoolchildren during handicraft and technology lessons (independent search, fulfilled aspirations, positive evaluation of partial results, family joy, hidden pedagogical tools, verbal support, the joy of learning, eureka, self-knowledge, advancing, etc.), using which the teacher not only retains the natural desire of children to learn but also leads them out of the sphere of emotional impressions to the state when the child not only wants to learn but cannot but learn.

Situations of success are created by the teacher for the whole class gradually, improving the emotional climate in the team, supporting pupils in educational activities and developing a sense of self-confidence. However, the pupil is happy to communicate with the teacher and classmates, feeling that they have noticed his/her success and approve it. The whole class appreciates the success of an individual pupil, which creates a reserve for the next activity.

The third condition for developing pupils' experience of independent creativity involves developing and improving educational and methodological support of handicraft and technology lessons. Comprehensive educational and methodological support includes planning, developing, and creating an optimal system (complex) of educational and methodological documentation and teaching aids, which are necessary for an effective organization of the educational process within the allocated time and the content defined by the curriculum. Different teaching aids have different goals, didactic functions, and opportunities. Complexity in methodological support of the educational process implies selecting appropriate teaching aids based on their didactic functions for organizing independent handicraft and technology activities. Rather effective, in this case, is using ***workbooks***, which form a didactic complex intended for organizing independent creativity of pupils in class and at home, allow saving some time and performing more activities in less time. Also, they complement the basic educational material.

The main aim of using a workbook during technological training is to ensure the operational acquisition and systematization of concepts by pupils and to promote the activation of their creative independent educational and cognitive activity, the development of practical skills to organize independent work using theoretical material, textbooks and other additional didactic tools, Internet resources, etc. Therefore, it is impossible to ensure successful step-by-step creation of the experience of independent creativity in pupils without

developing the means of step-by-step control, which is the most important task in the development of workbooks for pupils.

Adherence to the complex didactic training tools enables the teacher to successfully use workbooks within the framework of the general methodological complex of crafts and technologies. Given that the workbook includes such components as drawings, diagrams, flowcharts, pictures, self-check questions and tasks, it must follow certain psychological and pedagogical requirements: 1) to correspond to the topic of the lesson under the curriculum; 2) to focus on the main aspects, be visually enhanced, contain a detailed explanation, study the essence of the phenomena, as well as to summarize the acquired educational information; 3) to include the images accorded with the scale proportions of their parts, especially if they relate to significant details, and demonstrating the most important details in tones.

Besides, workbooks have the following advantages: 1. Using a workbook eliminates the need to spend time writing homework and classroom tasks. There is a one-week gap between handicraft and technology lessons. During this time, the child can forget everything covered in the previous lesson. Homework is an elementary encouragement for the pupil to work in the next lesson. 2. The workbook allows completing a full "pre-computer" training of the pupil in the lesson. This allows him/her to work with the computer more consciously and purposefully. 3. The workbook usually contains a large number of illustrations. Considering that the principle of visual learning is one of the main ones, it contributes to a more complete perception of the information received and, therefore, to the greater acquisition of knowledge.

The intended way of performing educational tasks in the workbook can be presented through pictures, diagrams, tables, instructions and technological cards for their further material embodiment during independent practical work. In the workbook, it is necessary to place a sequence of tasks and the so-called "free space" for tasks, that is, to perform them in workbooks it is recommended to leave enough space for the creative realization of thoughts.

In turn, the teacher needs to show possible ways to find a way to complete the task, to learn how to make the algorithm independently, to perform the task. The workbook should also include some creative tasks. While performing such tasks, pupils can show their – if elementary – skills and knowledge to compile such algorithms. Combining a summary of theoretical foundations of the topic and the sequence of typical tasks creates the so-called information complex. This is the first section of each topic

covered in the workbook. The second main section of each topic discussed is a system of different tasks and exercises for pupils' classwork and homework. This section should include several different types of typical tasks. This will enhance their ability to perform tasks and improve the quality of mastering the material. Non-standard tasks can be offered to pupils only after mastering typical ones. This contributes to the purposeful and intensive development of pupils' thinking and the formation of their creative skills.

It is also advisable to include additional information in workbooks: notes, historical data, references, conclusions and summaries missing from the textbook. This is necessary to widen pupils' outlook and specify the educational material in the form of short conclusions. Some self-check questions can be suggested to teach pupils to evaluate their understanding of the discussed educational material.

The workbook should include instructions for practical work. The objectives of the lesson should be clearly stated, the training aids should be described and the algorithm for completing the task should be given.

It is also helpful to include a list of bibliographical guidance that will allow pupils to better and more thoroughly understand the topic, as well as to familiarize themselves with new information sources. This is the final component for each topic presented in the workbook.

Thus, the structure and content of the workbook include the information complex for each topic of the course: short theoretical information, algorithms for solving common problems; tasks for independent work (typical, developmental and creative ones); instructions for practical and laboratory work; generalizations and conclusions on each topic: notes, summaries, conclusions, self-check questions, references.

The fourth condition implies *using innovative pedagogical technologies and information and communication technologies* while organizing pupils' independent creativity. The introduction of innovative pedagogical technologies, in particular, project-based learning and educational games, assists pupils in developing their independent orientation skills in scientific, educational and reference literature; learning how to find the information they need without assistance; preserving and strengthening their independence, that is, the willingness to create, etc.; adapting to real self-study; seeing themselves as creators of their activities; developing creative imagination, which is a powerful stimulus for generating new ideas, searching for alternative solutions, their analysis, synthesis, which in the future will become the basis of innovative thinking.

The effective development and implementation of the project by the pupils, as well as design and technological activities should consist of the following stages: organization and preparation, designing, technologization and summary. At each stage, the pupils perform some specific sequential actions, implementing the project, and the teacher becomes the organizer of educational activities.

At the organization and preparation stage, the pupils comprehend and reveal the meaning of the next workpiece. They come up with ideas, propose different options and product parameters and, finally, discuss and choose the best one. Before choosing the product, the pupils should understand its usefulness and practicality. During this stage, they form their self-evaluation skills. *At the designing stage*, the pupils create the chain of production: they choose a sketch, tools and equipment, determine the chain of technological operations, select a rational technology for making products; they carry out economic, environmental and mini-marketing operations. *At the technologization stage*, the pupils perform scheduled operations, carry out self-monitoring and quality control of the product. At the final stage, the project is monitored, compared and tested. Thus, the pupils determine whether they have achieved their goal and what is the result of their work. After completing all the steps, the pupils defend their project (product, plan, model) before peers.

Effective technology for developing the experience of independent creativity in adolescents is educational gaming, which helps to create creative situations, exchange knowledge and organize independent mental activities. Handicraft and technology lessons provide tremendous opportunities for using **game technologies**, such as solving crossword puzzles, riddles, etc. Such tasks are performed by either one or many pupils together, competing in speed and completeness of the answers. Below are some educational games that are appropriate to use during handicraft and technology lessons to develop independence and creativity of pupils: "Journalists", "Research Laboratory", "Dreamers", "Compiling Test Papers", "Put Things Right", "The Mysterious Package", "The Advertising Campaign".

With the help of multimedia technologies, **an e-book** (e-encyclopedia) has been created. It is a training tool, whose recorded pages are shown on the display screen; computer didactic and educational games that widen the pupils' outlook, stimulate cognitive interest, creativity and form necessary skills and abilities.

It must be noted that by applying information and communication technologies while organizing independent activities of pupils during handicraft and technology lessons, one can create special conditions required

to find necessary methods for solving creative situations, modelling, and constructing creative objects, to fulfil individual needs of each pupil, to make the process more mobile, as well as highly differentiated and individual.

Conclusions

The results of observations on the pupils' experience of independent creativity, their questionaries and sample interviews, as well as the study of the pupils' creative projects and the results of their work prove that the EG pupils are more aware of the importance of independent creativity and can logically use the experience gained in educational situations. It has helped them to increase the level of independent educational creativity, to acquire skills of creative search of ways and places for applying the acquired knowledge and to strengthen interdisciplinary connections.

The criteria and indicators of developing pupils' experience of independent creativity have been determined. They include motivational and axiological criterion (the pupils' ability to set a goal, show interest in the creative process, express a positive attitude to independent activities and handicraft and technology activities, cope with difficulties, achieve good results in independent creative tasks, strive for creative self-improvement); cognitive criterion (pupils' understanding of independent creative tasks, knowledge of stages and technologies, awareness about the process of performing independent creative tasks and creative design methods) and the operational and activity-based criterion (the pupils' ability to independently perform creative tasks, use a workbook and creative design methods; the ability to design independently and improvise in so doing). Based on the outlined criteria and indicators, the levels of developing pupils' experience of independent creative handicraft and technology activities during technological training (high, sufficient, average, and initial) have been characterized. It has been found that the number of middle school pupils with the average (32.4%) and initial (21.3%) levels prevail. Only 14.7% of pupils have a high level.

The organizational and methodological conditions for developing middle school pupils' experience of independent creativity during handicraft and technology lessons have been justified. They include comprehending the need for an independent creative activity as an integral component of technological training of pupils in a modern school; ensuring the process of developing pupils' positive motivation towards independent creative handicraft and technology activities; improving educational and methodological support of organization of pupils' independent creativity during handicraft and technology lessons; using innovative pedagogical

technologies and information and communication technologies while organizing pupils' independent creativity.

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