

Defining and modeling of students' professional thinking development dependence on their training process organization

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Abstract. The professional thinking issues are analyzed in the research. The authors pointed that the technical thought concepts, images and practical actions are in a complex and dynamic interaction with each other. The components of professional thinking are considered in detail. The training method based on the implementation of forming influence is proposed. The regression analysis of the students' academic progress indicators who are trained by the traditional and innovative methodology with forming influence is conducted in the article. Analysis of thinking activity development levels in the process of professional tasks solving performed by the students of the control and experimental groups demonstrated the straight-line correlation dependence of the professional thinking development on the organization of professional activity in general and the training organization in particular.

Keywords: professional thinking development, education technology, training process.

1 Introduction

The issues of specialists' professional activity effective organization are getting urgent actualization under the current conditions of socio-economic development of industry in Ukraine. Scientific and technological progress in our country raises high requirements for the specialist' qualification and to his professional skills.

Modern young specialists need skills for solving tasks and problems productively and creatively using modern technologies when developing new models of equipment and demonstrate the ability to creative professional self-development for successful professional occupation in the new information society.

The proficiency of a qualified specialist requires active intellectual activity and continuous professional thinking development. That is why the problem of professional thinking investigation and psychological conditions of its development is highly topical issue.

2 Problem statement

General methodological and psychological aspects of thinking were studied in the scientific works of Andrei V. Brushlinskii [7], Lev S. Vygotskii [52], Petr Ia. Galperin [14], Serhii D. Maksymenko [33], Aleksei M. Matiushkin [35], Sergei L. Rubinshtein [44], Oleksandr V. Skrypchenko [45], Oleg K. Tikhomirov [48], and other scientists; nature and specialists' professional thinking development patterns in various aspects are disclosed in the researches of Vladimir P. Andronov [2], Anatolii A. Batalov [5], Larysa V. Zasiiekina [53], Evgenii A. Klimov [21], Boris F. Lomov [32], Veniamin N. Pushkin [41], Maryna L. Smulson [46], Varvara V. Chebysheva [8] and others; the essence of technical thinking and technical creativity were studied in psychological researches of Viktor E. Alekseev [1], Anna M. Vasilevskaia [51], Sergei Iu. Gubnikov [15], Tovii V. Kudriatcev [27], Boris F. Lomov [32], Petro S. Peregelytsia [40], Valerii D. Putilin [42] and others; the theory of problems, in particular educational ones, is reasoned in scientific papers of Heorhii O. Ball [4], Anatolii F. Esaulov [11], Hryhoryi S. Kostyuk [25], Yukhym I. Mashbyts [34], Lev M. Fridman [13] and others; features and methods of structural and technical problems effective solution were considered in the studies of Alla B. Kovalenko [26], Natalia A. Menchinskaia [36], Lidiia A. Moiseienko [38], Iraida S. Iakimanskaia [28], Pavel M. Iakobson [18] and others.

Nowadays the professional thinking problem is one of the most important and less investigated issue in psychology. By now, national and foreign psychology collected scientific material which reveals variety and specific features of professional tasks range and the methods of its solving at any levels of professional activity, in particular, variants for solving professional tasks at information, algorithmic and heuristic levels are highlighted, certain approaches to learning optimization concerning the solution of professional-technological and managerial tasks are outlined, etc.

However, the holistic concept of the professional thinking development has not been developed yet. Both psychologists and teachers-practitioners of professional training do not have very clear conclusions about the role of thinking and function of each types of thinking in professional activity, about principles of classification and general means of professional tasks solving, about specific features of the solving process of such tasks and lessons organization training using the professional oriented tasks in the general system of professional training and the workforce retraining.

The task is to formalize the process of professional thinking development depending on the organization of professional activity in general and the learning organization in particular, to determine the dependence of students' academic progress for different teaching methods.

3 Innovative education approaches

The concept of "professional thinking" is widely used in the XXI century's psychology in connection with the labor intellectualization increase, the need for forming a specialist (a worker, an engineer, a doctor, a teacher, an agronomist, etc.) with the

ability to update their knowledge, to think critically and find the original means of professional tasks solving, to orient within the stream of various information, to overcome “non-regular”, extreme situation. Profession for a person is a source of existence and personal self-realization; this is the social field of his possible labor actions, for realization of which he must have professional knowledge, skills and abilities, appropriate abilities and developed professional thinking. So, developed professional thinking is an important aspect of the personal mastery process and its precondition of successful professional activity.

Different approaches to the professional thinking characteristics are distinguished in modern psychology. Professional thinking is defined as a feature of the specialist thinking due to the nature of professional activity in relation to the object of labor (Hryhoryi S. Kostiuk [25], Tovii V. Kudriatcev [27], Boris M. Teplov [50], Varvara V. Chebysheva [8] and others) as a process of tasks solving in one or another area of activity (Iuvenalii N. Kuliutkin [29], Zoia A. Reshetova [43], Sergei L. Rubinshtein [44] and others).

Summarizing the experience of studying the notion “professional thinking” it is necessary to highlight that a number of scientific studies [16; 19; 20; 26] consider the professional thinking as a process of professional tasks solving in one or another area of activity and some studies [2; 55] consider professional thinking as the type of specialist orientation in the subject of his professional activity. However, more often the notion of “professional thinking” is used simultaneously in both these meanings. So, we used to discuss the “technical” thinking of an engineer, a worker in a particular industry, the “clinical” thinking of the doctor, “spatial” thinking of the architect, “economic” thinking of the economist and manager, “artistic” thinking of art workers, “mathematical” thinking, etc. [49].

Undoubtedly, the thinking processes of different specialists are manifested by the one and the same psychological laws but there is a specificity of the object, means, and the work results in respect to which mental operations are carried out. So, first of all, some features of specialist’ thinking that allow him to perform professional tasks at a high level of proficiency are quick, precise, original solution of both ordinary and extraordinary tasks in a certain subject area. Such specialists are usually characterized as people who are creative in their professional field, as people who are especially perceived the subject of their activity and are capable of rationalization, innovation, discovery. So, professional thinking is a thought-oriented activity that is directed to professional tasks solving in a certain subject area. If the specificity of professional thinking depends on the uniqueness of the tasks that are being solved by different specialists, then the quality of professional activity or the level of professionalism depends on the professional thinking development.

In our opinion, an acmeological approach is the most productive in the study of the professional thinking (Anatolii A. Batalov [5], Dinara N. Zavalishina [54], Evgenii A. Klimov [21], Iurii K. Kornilov [24], Aelita K. Markova [3]), that considers professional thinking as a structural component of professionalism. Professional thinking is explained as a system that is being developed in a structural and holistic formation education and includes cognitive, operational and personal components.

The operating component is considered as a system forming (thinking receptions,

thinking actions and operations), on the basis of which the transformation is taken place within the cognitive component and certain professionally significant features of thinking are formed. The degree of general thinking actions forming and operations determine the level of professional thinking development in any sphere of activity [22].

Consequently, the peculiarity of professional thinking is related to specialist's orientation in the subject of his activity, as well as using equipment, methods, methods of influence on this subject that is with the psychological aspect of the professional activity.

Studying professional thinking, a number of scholars are paying a lot of attention to investigation of the peculiarities of professional thinking in the process of technical tasks solution indicating the importance of studying the problems of technical thinking. As Tovii V. Kudriatcev states, "... the problems of technical thinking as a specific type of intellectual activity of a person" [27, p. 184]. In particular, the problem of the person's professional technical thinking development has found reflection in fundamental psychological research: Tovii V. Kudriatcev [27], Iuvenalii N. Kuliutkin [29], Boris F. Lomov [32], Valentyn O. Moliako [39] and others, considered the issues of the technical thinking essence; Sergei Ia. Batyshev [6], Anna M. Vasilevskaia [51], Inna P. Kaloshina [19], Varvara V. Chebysheva [8], and others studied the technical thinking development in professional activity; Nikolai D. Levitov [31], Emiliia A. Faraponova [12], Pavel M. Iakobson [18], and others analyzed the constructive-technical activities; Anatolii F. Esaulov [11], Dinara N. Zavalishina [54], Hryhoryi S. Kostiuik [25], Oleg K. Tikhomirov [48] and others emphasized the operational-scientific direction of technical thinking, the ability to apply technical knowledge to solve tasks in a variety of conditions.

Characterizing professional technical thinking, Nikolai D. Levitov singled out the following [31]:

- it is distinguished by the clarity and accuracy of the thought-oriented operations directed to accurate calculations;
- it is practical (in the sense that it is aimed at practice) thinking (to understand the idea that is put in the technical device, it is to understand the principles of its design for certain practical purposes);
- this is flexible, unconventional thinking;
- technical thinking is realized through schemes, drawings. The language of people who are endowed with such thinking is concise and laconic.

The structure of technical thinking has specific features. Tovii V. Kudriatcev defined that any technical task which needs technical thinking is a task to a certain extent of uncertainty search and has multivariate solution. Such features of technical tasks are determined by many qualities and attitudes of technical objects as material-subject objects.

Tovii V. Kudriatcev distinguished three components of technical thinking:

1. Technical thinking always has theoretical and practical nature because the process of technical activity is the process of interaction of mental and practical components of work, therefore, the theory must be continuously tested by practice and practice

by theory. As the scientist states, “any theoretical technical thinking is usually tested by practice. New car, new the technological process ... will never begin to work at the production without preliminary verification of the design in practice” [27, p. 211].

2. Technical thinking is not only the operation of technical images but also of technical concepts that are very complex because they include knowledge from different sciences. Technical notions are the connection between the laws of abstract sciences, general laws of nature and technology and the laws of a particular type of production.
3. Technical thinking often requires efficiency. Tovii V. Kudriatcev emphasizes that the specialist in the field of technology often have to “solve production-technical tasks in a limited time ...”, his idea needs “instantaneous practical implementation” [27, p. 231]. That is the ability to orient quickly, to perceive and analyze information accurately and use existing knowledge properly, react to unforeseen situations.

Consequently, technical thought concepts, images and practical actions are in complex and dynamic interaction with each other. Well-developed professional technical thinking provides an opportunity for a person to transform verbal technical problems into images and diagrams quickly and easily, images and schemes into practical actions. Such thinking allows a designer, an engineer, a technician to change over internal, mental action plan to external, practical actions and operations with material objects of work without interference.

Professional technical thinking can be described as a set of consecutive thinking actions aimed at reflecting in the human consciousness technical processes and objects, the principles of their structure and the use of technical concepts and images. A certain performance of professional technical thinking is technique understanding: rapid assimilation of the technical device structure, the principle of its operation, the imperfections detection, imperfections in it, finding problems in technical objects and mechanisms, development of means to improve the technical devices, etc. Without technical thinking it is impossible to construct new and improve already existing machines and technological processes, so technical creativity is impossible.

Scientific and technological progress raises very high requirements for the qualification of a specialist to his professional skills in our country. Therefore, the proficiency of a highly skilled specialist requires an active intellectual activity and constant development of professional thinking. The process of professional thinking developing depends on many internal and external factors. The internal ones include: genetic predispositions, personal forces of thinking, individual peculiarities of analysis, synthesis and abstraction and others. External factors make up a wide range of objective factors that stimulate the development of individual professional thinking, in particular: social needs, incentives, requirements of scientific and technological progress in various spheres of production, taking into account environmental conditions and peculiarities of professional activity, etc.

To implement socio-economic transformations, to solve extremely complex and new tasks, it is not just desirable for the person of today and for the person of tomorrow to master creative skills, strategies and tactics as tools not only in professional but even in everyday activities. So, creativity should become the norm of professional activity and

the standard of preparation for it, that is, each specialist has to be a creative specialist.

Modern psychology concerning the mental development problem study has formed approaches which indicate its dependence on:

- teach students to apply rational methods and methods of thinking activities (Natalia A. Menchinskaia [36], Lev B. Itelson [17], etc.). Representatives of this approach prove that students can learn knowledge if an explanation is carried out from specific to general;
- means of forming mental actions (Petr Ia. Galperin [14], Aleksei N. Leontev [30], Nina F. Talyzina [47], etc.);
- formation of generalized conceptual systems of students (Vasilii V. Davydov [9], Daniil B. Elkonin [10]). Representatives of this approach give special significance to the theoretical generalizations that can be designed by students in the form of the conclusion that is the assimilation of knowledge from the general to concrete.

Such factors as activity stimulation of the study subject, internal initiative and freedom of choice, creation of favorable conditions for personal growth influence on the students' intellectual abilities development.

Being formed in the process of a specific professional activity, professional as well as any highly developed, thinking assumes the presence of generalized concepts about the objects that are being investigated, the ability to conduct their mental analysis and synthesis, to make judgments, conclusions, evidence, etc.

Quality of professional activity or the level of professionalism depends on the type of thinking: a high level of professionalism is connected with creative thinking and developed practical intelligence. Thinking is aimed at solving professional tasks, therefore the training of a specialist requires a mandatory analysis of their specifics and strategies.

Investigating the general patterns of thinking, Hryhoryi S. Kostiuk [25] mentioned that thinking is being developed in the process of activity, respectively, professional thinking is being developed in the process of solving professional tasks. These are professional technical tasks for the specialists of technical area, as well as for the students of a vocational institution that simulate the situation of technical activity (it should be said more precisely about the "Educational" tasks). Ukrainian term "educational tasks", by Heorhii O. Ball covers the student's tasks solved by the student, and the tasks of managing the students solved by a teacher [4].

As professional thinking is an intellectual activity concerning the professional tasks solution it is necessary to reveal the specifics of the educational task of professional orientation because the thinking process is aimed at solving of certain tasks. In addition, the problem of studying the creative tasks nature of professional orientation becomes the special issue because, in our opinion, the training of a creative specialist in the system of vocational education is possible under the conditions of constant, systematic implementation in the educational process of diverse educational, in particular, educational and creative tasks of professional direction.

A number of studies (Iurii A. Kontcevoi [23], Tovii V. Kudriatcev [27], Natalia A. Menchinskaia [36], Evgenii A. Milerian [37], Ya. O. Ponomarov, Iraida S. Iakimanskaia [28], Pavel M. Iakobson [18], etc.) are devoted to the analysis of

peculiarities of technical tasks, effective learning methods development to solve structural and technical tasks, the patterns of thinking in the process of solving technical and production problems are defined. So, Iurii A. Kontcevoi believes that in the process of technical tasks solving it is possible to identify the components of technical thinking by solving technical problems (the only conceptual-figurative and practical structure) and to evaluate the meaning and place of each component.

As we stated in our research that the professional thinking of future professionals will be successfully developed in the condition of the systematic involvement of students in active thinking in the process of solving complicated educational tasks of a professional direction, that's why we will try to reason the notion of "task of professional direction". The professional task can be considered the one that contains the subject of a professional task of specialist's certain profile. Additionally, if we compare the total specific features of production tasks (multidimensionality, continuity, dynamism, negligence, efficiency, irreversibility) with general features student problems, then it turns out that ordinary school tasks are characterized, first of all, by opposite signs (one-plan, interpretability, static, impractical, reversible). So, the organization of vocational training needs to implement the intermediate tasks (students' tasks of professional direction) which have the sequential transition from single-plan to multi-plan, from intermittence for continuity, etc. So, the organization of vocational training needs to implement intermediate tasks (student tasks of professional direction) which have sequential transition from single-plan to multi-plan, from intermittence for continuity, etc. In addition, the student's task of the professional orientation in the future specialists training should meet such requirements:

- be formulated for professionals in a professional language;
- be a verbal model of a real production situation;
- apply the acquired knowledge of special disciplines: special technology, mining, material science, technical drawing, etc. using computer.

Yukhym I. Mashbyts [34] who is one of the national scientists examined psychological and pedagogical aspects of computer training. The author characterizes the didactic capabilities of computing learning technology in his studies.

The scientist mentions that the teacher has never had so powerful means of learning that is a computer that no technical means which used up so far, with its didactic capabilities cannot be compared with the computer and its opportunities have not been revealed to the end. Among the most fruitful use of computer in training Yukhym I. Mashbyts [34] distinguishes the following:

- use it as a means of managing student activities;
- ability to provide individual training "in mass order";
- great opportunities in the implementation of problem education;
- forming of creative thinking of students, readiness for creative work in the conditions of scientific and technological progress and information society.

The professional thinking of future specialists in the study is considered as the only thought-based structure that contains motivational-purposeful, content, process-

operational, creative, reflexive-evaluation components.

Each of the components of professional thinking are defined by the appropriate evaluation criteria.

The motivational-target component of professional thinking implies active interest in technology, the need to solve problems, the desire for success and the experience of joy because of the successful task solving.

The content component of professional thinking involves knowledge of the most important characteristics of the professionally meaningful objects functioning.

The process-operational component of professional thinking involves logic and analytical thinking, completeness of thinking operational composition.

The creative component of professional thinking involves finding the original the productive way of solving the mental problem, the flexibility of thinking, prone to visualization.

Reflective and evaluation component of professional thinking involves awareness of carried out activities, evaluation of oneself, their capabilities, self-criticism.

A set of research methods were tested in order to determine the level of professional thinking components development of future specialists and the adequacy of their use according to the set tasks is made. This allowed finding out the psychological features of professional thinking components manifestation of the future professionals and determining the level of their development. Experimental research was carried out in Kryvyi Rih National University. Students of I, II, III courses of specialties: “Software Engineering”, “Vocational Education (computer technology)”, “Computer Engineering” were involved in the research experiment.

Summarizing the peculiarities of the students’ professional thinking functioning that were discovered after the diagnosis we distinguished three levels of professional thinking development of future specialists (table 1).

Table 1. Peculiarities of functioning of students’ professional thinking that are elicited after the diagnostics

Development levels of professional thinking	Average value, %						Average index, %
	Research methods						
	Content component		Process-operational component	Creative component		Reflective and evaluation	
	V1	V2	V3	V4	V5	V6	
Low	50.5	46.7	50.07	16.6	48.33	39.7	42.0
Medium	37.9	41.5	38.33	44.8	34.6	41.8	39.8
High	11.6	11.8	11.6	38.6	17.07	18.5	18.2
Total	100	100	100	100	100	100	100

Notes:

V1 – test method “Mechanical wit” by Evgenii A. Klimov;

V2 – Bennett test of mechanical comprehension;

V3 – author’s educational tasks for the development of students’ professional technical thinking;

V4 – the method of detecting the determinant influence of the operating system on

the process of problems solving (Abraham S. Luchins);

V5 – a methodology for evaluating Williams’ divergent (creative) thinking;

V6 – the method “Self-assessment of individual personal characteristics” of Williams.

So, assessing the level of students’ professional thinking development at the statement stage of the empirical study, we found that, unfortunately, the low level of students’ professional thinking development is prevalent, and the least common is the high level.

The components of professional thinking do not function in isolation, they are interconnected. To confirm this position, we have decided to investigate the existing interrelationships between the individual components of the future specialists’ professional thinking such as conceptual, process and operational and creative. For this purpose, a correlation analysis of data with the help of Spearman’s rank correlation coefficient is carried out. Quantitative results are presented in table 2.

Table 2. Correlation matrix of connection between indicators of professional thinking ($N=60$)

Changes	Content component				Process-operational component		Creative component			
	V1	Significance level	V2	Significance level	V3	Significance level	V4	Significance level	V5	Significance level
V1	1		0.67	0.001	0.57	0.001	0.59	0.001	0.63	0.001
V2	0.67	0.001	1		0.59	0.001	0.4	0.01	0.53	0.001
V3	0.57	0.001	0.59	0.001	1		0.37	0.01	0.61	0.001
V4	0.59	0.001	0.4	0.01	0.37	0.01	1		0.43	0.01
V5	0.63	0.001	0.53	0.001	0.61	0.001	0.43	0.01	1	

Notes:

V1 – test method “Mechanical wit” by Evgenii A. Klimov;

V2 – Bennett test of mechanical comprehension;

V3 – author’s educational tasks for the development of students’ professional technical thinking;

V4 – the method of detecting the determinant influence of the operating system on the process of problems solving (Abraham S. Luchins);

V5 – a methodology for evaluating Williams’ divergent (creative) thinking.

The obtained correlation analysis data demonstrated that all components of the content component have high significant ($p \leq 0,01$) positive correlations with the constituents of process-operational and creative components of professional thinking. This confirms our standpoint that the stronger the students will understand technical objects, processes, ability to make conclusions, ability to further use of professional knowledge in practical activities, the better students will develop the ability to establish links between the main signs of technical issues, ability to analyze, synthesize technical concepts and images, to express their thoughts logically, to find analogies, to combine; the flexibility of thinking in search of the original creative approach, problem solving duration; the ability to put forward a variety of ideas, find the best variant of the solution of the thought task, origin and novelty of the associations, giving them a new functional

value and vice versa.

Results of the final stage of the experimental study are presented in table 3 gives grounds to state:

1. In the process of professional oriented task solving (table 3) students of the control group received the first rank of reproductive level of thinking activity development (48.3%), the second – adaptive (26.7%), the third grade – locally-modeling (15.0%), the fourth rank – system-modeling (creative) (10.0%). The students of the experimental group received the first rank of locally-modeling level of thinking activity development (33.3%), the second – system-modeling (creative) (30.0%), the third – reproductive (20.0%), the fourth rank – adaptive level (16.7%). It confirms the efficiency of the proposed technology of future specialists' professional thinking development.
2. One of the main criteria of the technology effectiveness of our technology were changes in professional thinking development levels: content, process-operational, creative and reflexive-evaluation.

Table 3. Ranking of the development levels of mental activity in the process of professional oriented tasks solving of the students of control and experimental groups after the forming influence

No	Mental activity developed levels	Control group			Experimental group		
		Number of people	%	Rank	Number of people	%	Rank
1	Reproductive	29	48.3	1	12	20.0	3
2	Adaptive	16	26.7	2	10	16.7	4
3	Local-modeling	9	15.0	3	20	33.3	
4	System-modeling (creative)	6	10.0	4	18	30.0	2
	Total	60	100	–	60	100	–

Research of dynamics of students' professional thinking components development of experimental groups demonstrated statistically significant positive changes in their indicators. These changes are manifested in the development of knowledge of the most important characteristics of the professionally meaningful objects functioning and the ability to further use this knowledge in practice; increasing the ability to establish links between the main features, analyze, synthesize technical concepts and images, logically express their own thoughts, to find analogies, to combine; the formation of the ability to generate creative ideas in the process of performing technical activity, inclination to search an original new approach to tasks solving; in the growth of courage to accept criticism, to assume possible failures, propensity to search alternatives and risk in solving complex tasks.

3. Statistically insignificant dynamics of changes in the students' thinking activity development in the process of professional tasks solving and the professional thinking components development in the control group states the lack of efficiency influence of the traditional vocational education system on the development of students' professional thinking.
4. The efficiency of our developed and tested program of the students' professional

thinking is evidenced by the positive dynamics of students' professional thinking development of the experimental group that is proved in a statistically significant increase in the level of all professional thinking components development and the lack of significant changes in the control group.

As a result of the conducted forming phase of the experiment in the experimental group there is a tendency to increase the rates of the content and reflective and evaluation components that is statistically confirmed developed and tested the program of the experiment has significantly increased the level of professional thinking development of the students of the experimental group.

In addition, statistically significant changes were recorded in the experimental according to the indexes of process-operational and creative components.

To confirm the efficiency of the developed and implemented technology of the professional thinking development of future specialists, we conducted a calculation of Student's statistical *t*-criterion to detect the changes in the students' professional thinking components development in control and experimental groups (before and after forming effect) (table 4).

Table 4. Calculation of statistical *t*-criterion of Student's for estimation of dynamics changes according to components of professional thinking ($N=60$ (CG), 60 (EG))

Components of professional thinking	Research methods	Experimental group (EG)					Control group (CG)				
		Arithmetic mean	Dispersion	Arithmetic mean	Dispersion	Student's <i>t</i> -criterion, significance level	Arithmetic mean	Dispersion	Arithmetic mean	Dispersion	Student's <i>t</i> -criterion, significance level
		before forming influence	after forming influence	at the beginning of the traditional system training	at the end of the traditional system training						
Content	V1	25.9	140.7	34.4	169.8	3.7	26.05	150.1	30.07	183.2	1.7
	V2	27.3	93.4	34.2	148.4	3.44	26.3	105.4	26.6	108.7	0.16
Process-operational	V3	10.45	13.2	12.87	14.63	3.55	10.02	13.85	11.18	11.4	1.8
Creative	V4	1.81	1.67	2.63	1.55	3.48	1.63	1.62	1.81	1.57	0.8
	V5	64.8	285.97	74.4	204.2	3.34	67.83	195.7	68.78	240.04	0.35
Reflective and evaluation	V6	46.08	492.6	56.3	508.3	2.5	43.6	338.9	44.7	327.9	0.32

Notes:

Student's t -criterion for 60 people $t = 2$ at the level of significance ($p \leq 0.05$)

V1 – Bennett test of mechanical comprehension;

V2 – test method “Mechanical wit” developed by Evgenii A. Klimov;

V3 – author's educational tasks for the development of students' professional technical thinking;

V4 – the method of detecting the determinant influence of the operating system on the process of problems solving (Abraham S. Luchins);

V5 – a methodology for evaluating Williams' divergent (creative) thinking;

V6 – questionnaire “Self-assessment of creative personality characteristics” developed by Williams.

Figure 1 shows the dependence of the learning success of the control and experimental group of students. The approximation was carried out using linear function while the determination coefficient was not less than 0.5. Trends demonstrate the learning quality improvement over time. Innovative training method based on forming influence allows achieving higher academic progress by 20% compared with traditional methods.

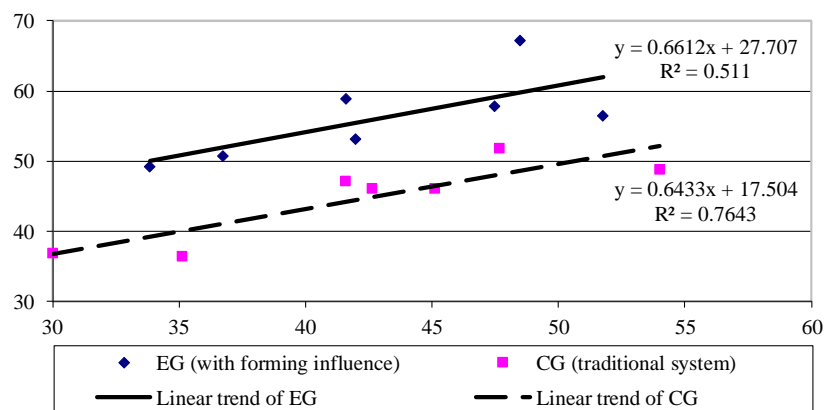


Fig. 1. Approximation of the dependencies of the academic progress for the control and experimental groups of students

4 Conclusions

So, to sum up, we need to state that there is a direct dependence of the professional thinking development on professional activity organization in general and on training organization in particular.

At the same time, it is not the spontaneous “maturation” of thought actions and operations but the search for techniques that promote intensive intellectual development of a person (problem learning organization, the tasks' complication method implementation, the phased formation of mental activities, the training orientation to

the creative thinking development, etc.). Therefore, in our opinion, the problem of future specialists' training at different levels of education, in particular, in higher education institutions will be successfully realized if the students will solve the professional oriented tasks independently in the learning process that correspond to this specialization instead of learning standard solutions for separate technical tasks.

In addition, the ability to solve the professional tasks will enable the student to master the samples of new technology independently; it will enhance the practical experience of a future specialist and mastery of professional skills.

References

1. Alekseev, V.E.: *Pedagogicheskie problemy razvitiia tekhnicheskogo tvorchestva molodezhi* (Pedagogical problems of the development of technical creativity of youth). Fan, Tashkent (1980)
2. Andronov, V.P.: *Psikhologiya professionalnogo myshleniia* (Psychology of professional thinking). Izdatelstvo Mordovskogo universiteta, Saransk (2018)
3. Bakulin, I.I., Markova, A.K., Mikhailov, G.S.: *Sootnoshenie professionalnykh sposobnosti k priniatiu i ispolneniu reshenii* (Correlation of professional abilities to make and execute decisions). Narodnoe obrazovanie, Moscow (2003)
4. Ball, H.: *Pro sutnisnyi zmist osobystisnoi orientatsi v osviti* (Essential content of personal orientation in education). Profesiino-tekhnichna osvita 2, 39–43 (2006)
5. Batalov, A.A.: *Poniatie professionalnogo myshleniia (metodologicheskie i ideologicheskie aspekty)* (The concept of professional thinking (methodological and ideological aspects)). Izdatelstvo Tomskogo universiteta, Tomsk (1985)
6. Batyshev, S.Ia.: *Proizvodstvennaia pedagogika* (Production pedagogy). Mashinostroenie, Moscow (1976)
7. Brushlinskii, A.V.: *Kulturno-istoricheskaiia teoriia myshleniia* (Cultural-historical theory of thinking). URSS, Moscow (2009)
8. Chebysheva, V. V. *Psikhologiya trudovogo obucheniiia* (Psychology of labor training). Vysshaia shkola, Moscow (1983)
9. Davydov, V.V., Rubtcov, V.V., Kritckii, A.G.: *Psikhologicheskie osnovy organizatsii uchebnoi deiatelnosti, oposredstvovannoi ispolzovaniem kompiuternykh sistem* (The psychological basis for the organization of educational activities mediated by the use of computer systems). Psikhologicheskaiia nauka i obrazovanie 2, 68–72 (1996)
10. Elkonin, D.B.: *Psikhologiya igry* (Game psychology). Vldos, Moscow (1999)
11. Esaulov, A.F.: *Dialektika tekhnicheskoi mysli: zakonomernosti tekhnicheskogo tvorchestva* (Dialectics of technical thought: patterns of technical creativity). Izdatelstvo Krasnoiarskogo universiteta, Krasnoiarsk (1989)
12. Faraponova, E.A. (ed.): *Psikhologicheskie osnovy trudovogo vospitaniia shkolnikov* (Psychological foundations of labor education of schoolchildren). Pedagogika, Moscow (1988)
13. Fridman, L.M.: *Osnovy problemologii* (Fundamentals of problemology). URSS, Moscow (2009)
14. Galperin, P.Ia.: *Lektsii po psikhologii* (Lectures on psychology). Knizhnyi dom Universitet, Moscow (2010)
15. Gubenkov, S.Iu.: *Didakticheskie usloviia obucheniiia professionalnomu tvorchestvu uchashchikhsia proftekhuchilishch vo vneklassnoi rabote na osnove khozraschetnykh*

- otnoshenii (Didactic conditions for teaching professional creativity of students of vocational schools in extracurricular activities based on self-supporting relationships). Dissertation, Sankt-Peterburg (1991)
16. Gurova, L.L.: *Psikhologicheskii analiz resheniia zadach* (Psychological analysis of problem solving). Izdatelstvo Voronezhskogo universiteta, Voronezh (1976)
 17. Itelson, L.B.: *Osnovy metodiki professionalnogo obucheniia shkolnikov* (Fundamentals of the methodology of vocational training for schoolchildren). Uchpedgiz, Moscow (1963)
 18. Jakobszon, P.M.: *Az érzelmek pszichológiája*. Tankönyvkiadó, Budapest (1964)
 19. Kaloshina, I.P.: *Bolshaia teorema Ferma, tvorcheskie zadachi, modeli poiska resheniia* (Fermat's Big Theorem, creative problems, solution search models). Moskva (1998)
 20. Kaposloz, H.V.: *Psikhologichni aspekty vyrishuvannia taktychnykh zadach* (Psychological aspects of solving tactical problems). Aktualni problemy psikhologii **6**(3(1)), 101–106 (2002)
 21. Klimov, E.A.: *Vvedenie v psikhologiiu truda* (Introduction to the psychology of labor). Kultura i sport, Moscow (1998)
 22. Koneva, E.V.: *Strukturno-funkcionalnaia organizatsiia i genezis prostranstva situatsii problemnosti v professionalnom opyte subekta* (Structural and functional organization and the genesis of the space of problem situations in the subject's professional experience). Dissertation, Iaroslavskii gosudarstvennyi universitet (2011)
 23. Kontcevoi, Iu.A.: *Psikhologo-pedagogicheskaia diagnostika interesov i otnosheniia k ucheniu uchashchikhsia PTU i tekhnikumov* (Psychological and pedagogical diagnosis of interests and attitudes towards the teaching of vocational school students and technical schools). Rostov-na-Donu institut selsko-khoziaistvennogo mashinostroeniia, Rostov-on-Don (1983)
 24. Kornilov, Iu.K.: *Myshlenie v proizvodstvennoi deiatelnosti* (Thinking in industrial activity). IaGU, Iaroslavl (1984)
 25. Kostyuk, G.S.: *Uchebno-vospitatelnyi protsess i psikhicheskoe razvitie lichnosti* (The educational process and the mental development of personality). Radianska shkola, Kiev (1989)
 26. Kovalenko, A.B.: *Psikhologhiia rozuminnia tvorchykh zadach* (Psychology of understanding creative problems). *Psikhologhiia i suspilstvo* **4**(18), 110–127 (2004)
 27. Kudriatcev, T.V.: *Psikhologhiia tekhnicheskogo myshleniia* (Protcess i sposoby resheniia tekhnicheskikh zadach) (Psychology of technical thinking (Process and methods for solving technical problems)). Pedagogika, Moscow (1975)
 28. Kudriavtcev, T.V., Iakimanskaia, I.S.: *Razvitie tekhnicheskogo myshleniia uchashchikhsia* (The development of students' technical thinking). Vysshaia shkola, Moscow (1964)
 29. Kuliutkin, Iu.N.: *Evristsicheskie metody v myslitelnoi deiatelnosti i v obuchenii vzroslykh* (Heuristic methods in mental activity and in adult learning). Dissertation, Leningrad State University named after A. A. Zhdanov (1971)
 30. Leontev, A.N.: *Problemy razvitiia psikhiki* (Problems of the development of the psyche). Mysl, Moscow (1965)
 31. Levitov, N.D.: *Detskaia i pedagogicheskaia psikhologhiia* (Child and educational psychology). Prosveshchenie, Moscow (1964)
 32. Lomov, B.F.: *Metodologicheskie i teoreticheskie problemy psikhologii* (Methodological and theoretical problems of psychology). Nauka, Moscow (1999)
 33. Maksymenko, S.D.: *Henetychna psikhologhiia uchinnia liudyny* (Genetic psychology of human learning). Slovo», Kyiv (2017)

34. Mashbitc, E.I.: Psikhologo-pedagogicheskie problemy kompiuterizatsii obucheniia (Psychological and pedagogical problems of the computerization of education). Pedagogika, Moscow (1988)
35. Matiushkin, A.M.: Myshlenie, obuchenie, tvorchestvo (Thinking, learning, creativity). Modek, Voronezh (2003)
36. Menchinskaya, N.A.: Researches in psychology of learning. Moscow (1958)
37. Milerian, E.A.: Psikhologiya formirovaniia obshchetrudovykh politekhnicheskikh umenii (Psychology of the formation of labor polytechnic skills). Pedagogika, Moscow (1973)
38. Moiseienko, L.A.: Psykholohiia tvorchoho matematychnoho myslennia (Psychology of creative mathematical thinking). Fakel, Ivano-Frankivsk (2003)
39. Moliako, V.A.: Tvorcheskaia konstruktologiya (prolegomeny) (Creative constructology (prolegomeny)). Osvita Ukrainy, Kiev (2007)
40. Perepelitca, P.S., Rybalka, V.V.: Psikhologiya izobretatelskoi deiatelnosti (Psychology of inventive activity). Znanie, Kiev (1981)
41. Pushkin, V.N.: Psikhologiya i kibernetika (Psychology and cybernetics). Pedagogika, Moscow (1971)
42. Putilin, V.D.: Psikhologo-pedagogicheskie osnovy formirovaniia tvorcheskoi aktivnosti shkolnika (Psychological and pedagogical foundations of the formation of creative activity of a student). Izdatelstvo Magnitogorskogo gosudarstvennogo pedagogicheskogo instituta, Magnitogorsk (1998)
43. Reshetova, Z.A.: Psikhologicheskie osnovy professionalnogo obucheniia (Psychological foundations of vocational training). Izdatelstvo MGU, Moscow (1985)
44. Rubinshtein, S.L.: Osnovy obshchei psikhologii (Fundamentals of general psychology). Piter, Moscow (2015)
45. Skrypchenko, O.V., Dolynska, L.V., Ohorodniichuk, Z.V.: Zahalna psykholohiia (General psychology). Lybid, Kyiv (2005)
46. Smulson, M.L.: Psykholohiia rozvytku intelektu (Psychology of the development of intelligence). Nora-druk, Kyiv (2003)
47. Talyzina, N.F.: Teoreticheskie problemy programmirovannogo obucheniia (Theoretical problems of programmed learning). Izdatelstvo Moskovskogo universiteta, Moscow (1969)
48. Tikhomirov, O.K.: Psikhologiya myshleniia (Psychology of thinking). Akademiia, Moscow (2008)
49. Trofimov, Yu.L., Rybalka, V.V., Honcharuk, P.A., Aleksieieva, M.I., Kyrylenko, T.S.: Psykholohiia (Psychology). Lybid, Kyiv (2005)
50. Tyeplov, B.M.: Psichológia. Tankönyvkiadó, Budapest (1953)
51. Vasilevskaia, A.M., Ponomareva, R.A.: Razvitie tekhnicheskogo tvorcheskogo myshleniia u podrostkov i iunoshstva (The development of technical creative thinking in adolescents and youth). Vishcha shkola, Kiev (1982)
52. Vygotskii, L.S. Myshlenie i rech (Thinking and speech). AST, Moscow (2011)
53. Zasiakina, L.V.: Osoblyvosti formuvannia profesiino-tvorchoho myslennia maibutnoho fakhivtsia inozemnoi movy (Features of formation of professional and creative thinking of the future foreign language specialist). Dissertation, Volynskiy derzhavnyi universytet imeni Lesi Ukrainky (2000)
54. Zavalishina, D.N.: Prakticheskoe myshlenie: spetsifika i problemy razvitiia (Practical thinking: specificity and development problems). Institut psikhologii RAN, Moscow (2005)
55. Zeer, E.F.: Professionalnoe stanovlenie lichnosti inzhenera-pedagoga (Professional formation of the personality of an engineer-teacher). Izdatelstvo Uralskogo universiteta, Sverdlovsk (1988)