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The structure of intellectual competence in late adolescence¹

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Abstract

Construct of intellectual competence, understood as a special type of knowledge organization, is considered in terms of conceptual, categorical, semantic abilities and cognitive-and-personality components of mental activity. Participants: 102 students at the age of 15 years. Methods: "Generalization of the three words", "Conceptual synthesis", "The visual semantics of words", "The semantic differential", "Features of thinking", "Narrative". According to the results, the structure of intellectual competence can be described by semantic abilities. Indicators of cognitive-and-personality components of mental activity associated with the conceptual and categorical abilities. The results display the complexity of cognitive-and-personal structure and the principle of multi-level organization of intellectual competence in late adolescence, explore the development of competence in ontogeny and mechanisms for its formation.

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Keywords: intellectual competence; activities; abilities; structure; adolescence; ontogeny.

1. Introduction

There's a number of different definitions of intellectual competence. All this diversity is due to the fact that different authors focus on one or another aspect of the construct. Goryunova [Goryunova, 2002], for example, notes the resource aspect of intellectual competence. The opportunities that can be realized by intellectually competent person are linked in her study. Savin [Savin, 2002] explores the intellectual competence as a measure of the success of human activity in a particular subject area. In our study, as in Kholodnaya's studies [Kholodnaya, 2002], intellectual competence is defined as a specific form of mental knowledge's organization, which ensures the successful implementation of any activity with respect to which a person had formed competence.

The next step to understanding the intellectual competence was to consider its structure and its various manifestations. In view of the large number of scientific papers in which the phenomenon of intellectual competence is studied on professionals and experts, people, who have already achieved practical results in a particular profession, we decided to conduct the research on children. It is not possible to explore such advanced forms of

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intellectual competence in childhood, which can be fixed in adult, included in professional activities. Nevertheless, intellectual competence doesn't appear simultaneously. If we accept the principle of evolution, it is obvious that intellectual competence is developed and may be manifested in childhood. Further, we have assumed that the components of intellectual competence, that have been already identified in other studies, can be identified in late adolescence. Previously been studied (for professionals) cognitive, personality, motivational indicators: 1) subject knowledge; 2) conceptual and categorical abilities; 3) intellectual self-regulation; 4) intentional knowledge; 5) specific motivation; 6) cognitive-and-personal components of mental activity (some qualities), namely: cognitive demands, flexibility, criticality, creativity. These characteristics have been partially extended and supplemented by us, and our study we investigated: 1) the manifestation of intellectual competence as the ability to generate narrative (actively transforming domain knowledge); 2) conceptual skills; 3) categorical abilities, 4) the ability of semantic and cognitive-personal components of mental activity: cognitive demands, criticality, creativity, selectivity of interests, rationality, independence, dialogue, general intellectual culture.

Theoretical hypotheses of the study: indicators of intellectual competence related to conceptual abilities; categorical abilities; semantic abilities; indicators of intellectual competence are associated with certain cognitive-and-personality components of mental activity, such as high cognitive demand, criticality, creativity, selectivity of interests, rationality, independence, dialogue, general intellectual culture

Objective: to disclose the specifics of intellectual competence in late adolescence.

Exploratory hypotheses of the study: 1) there is a connection between the level of development of conceptual abilities (in terms of categorical, conceptual and semantic abilities measured by methods "Generalization of the three words", "conceptual synthesis", "visual word semantics", "semantic differential") and rates of formation of intellectual competence (measured in terms of narrative); 2) there is a connection between the level of development of intellectual competence and certain cognitive-and-personal components of mental activity (measured by questionnaire "quality of thinking"): cognitive demands, criticality, creativity, selectivity of interests, rationality, independence, dialogic, general mental culture.

Thus, the subject of the study – the structure and the manifestation of the intellectual competence, the object of the study - students 9th grade Moscow schools, whose intellectual competence is forming in the process of schooling.

2. Methods

Participants: 102 students (59 girls and 43 boys) 9th grade Moscow school at the age of 13 - 16 years (median - 15 years).

2.1. Techniques

2.1.1. Techniques for extracting conceptual (categorical, conceptual and semantic) abilities

"Generalization of the three words" [Kholodnaya, 2002].

Material of methodology "Generalization of the three words" consists of 10 triads of words. Each triad is read out to the participants sequentially. Students should think what is common between these three words and write down this feature in one or two words. 25 seconds are given to find out and to write the answer for each triad of words. The answer should be filled into the form.

Each answer was rated by the range from 0 to 2 points for each of the 10 triads. The criteria: 0 points - lack of generalization; thematic generalization based on spatial or temporal proximity of objects; 1 point - analytic generalization; formal generalization; 2 points - strict categorical generalization using generic terms. The overall score is the sum of points for all triads. Variables: categorical abilities.

"Conceptual synthesis" [Kholodnaya, 2002].

Material of methodology "conceptual synthesis" consists of three triads of the words, that are unrelated by the meaning. The participants asked to make the maximum number of meaningful sentences containing all these words. One triad of words is printed on each A4 form. Participants were given instructions verbally, in accordance with which the participants were asked make different versions of semantic connections between these three words, write each connection into the form in one or two sentences, so that all three words were used. Three minutes are given for each triad.

Each answer was rated by the range from 0 to 3 points for each of the three triads. The criteria: 0 points - lack of sentences; no semantic connections, or used only two words; 1 point - a simple listing of words in a sentence; 2 points - creating a context within the description of a specific situation; 3 points - a sentence with comparisons, analogies; all three words are of summarized by category or by detailed casual connections. The overall score is the sum of points for all triads. Variables: conceptual abilities.

"Visual semantics of words" [Artemieva, 1980].

This methodology involves two tasks. Participants are given a white A4 sheet. Graphic representation of indeterminate shape is given in the upper part of that sheet. Students should answer two questions about each image. The first question: "What is it? What is it like?" (The response is written down). The second question: "What properties applied to this object?" (List of these properties is written down). There were given 5 images.

Analyzation of the semantic interpretations allocated different subtypes of interpretations: object-type interpretation (e. g. sun, bird); abstract-type interpretation (e. g. universe, God, mandala); geometric-type interpretation (circle, square). Analiyzation of semantic features allocated different subtypes of semantic features: touch-type semantic features (e. g. cold, prickly); emotional-and-personal-type semantic features (kind, cheerful, sad); dynamic-type semantic features (running, developing speed of light); logical-type semantic attributes of (worn, complex, untidy, add). Points of the selected subtypes are summed with the points corresponding to the subtype for the rest of pictures. Variables: the ability to objective-type semantic interpretation, the ability to abstract-type semantic interpretation to geometric-type semantic interpretation; the ability to form touch-type semantic features, the ability to form emotional-and-personal-type semantic features, the ability to form the dynamic-type semantic features and the ability to form logical-type semantic features.

"Semantic differential" [SD, modification, Holodnaya, 1983].

The protocol is filled for each image of previous methodology "Visual semantics of words": participant had to put a label in one of the 7-column - "strong", "medium", "weak", "no", "weak", "medium", "strong". For each of the 20 antithetic scales participant rats the extent the two ends of the scale emphasized in relation to a specific image (elections in the "weak", "medium", "strong" columns) or fix the lack of any impression (selection in the "no" column). Time of the task is not limited, however, participants were asked to work faster, focusing on first impressions.

Each of the 5-graphics were graded by counting the number of elections in the "no" column (a measure of the lack of sensory expression, unemotional in intellectual activity), the responses in the "weak" and "medium" (a measure of differential participation of sensory expression) and the responses in the "strongly" (a measure of over-inclusiveness of sensory impressions, "flight to fantasies"). Scores for each of the columns were summed with scores corresponding graphs for the rest of the 4th pictures. Variables: the degree of involvement of sensory and emotional experiences in intellectual property: the number of elections in the two graphs "strongly" SD - indicator of excessive severity of sensory and emotional expression in intellectual activity; the number of elections in the four columns "medium"and"weak" SD - indicator of differential involvement of sensory and emotional expression in intellectual activity; the number of choices in the "no" diabetes - an indicator of the lack of sensory and emotional expression in intellectual activity.

2.1.2. The methodology to extract cognitive components of personal's mental activity.

Questionnaire of "quality of thinking" [Sipovskaya, Kholodnaya, 2009].

There were chosen 3 teachers in order to get expert's review (deputy director, the class teacher and subject teachers of the faculty). The experts assessed each student for ten qualities (their content is given on the title page of the technique). The criteria: absent (0 points); very weak (1 point); weak (2 points); medium (3 points); strong (4 points); very strong (5 points). Next we construct a general profile for each student. Variables: cognitive-and-personal components of mental activity (cognitive demands, flexibility, criticality, creativity, selectivity of interests, rationality, reflexivity, independence, dialogue, general intellectual culture).

2.1.3. Methodology to extract intellectual competence "Narrative."

A narrative is an essay on a free theme. It reveals features of structuring and transformation of the data in the process of generation of a new context. Students were given 2 white A4 sheets for writing essays. Participants were asked to write an essay on any theme they prefer. There were no information about standards or volume of the narrative. Participants were reported only that they should write as much text as it would be necessary to disclose the topic.

Indicators of the methodology "Narrative": general score. In particular, the measure of mental narrative's complexity. Criteria: 0 points - lack of written narrative; 1 point - a formal written narrative with descriptive sentences without expressing any point of view; 2 points - an narrative with the causal relationships; 3 points - a narrative with an argued position or contemplation; 4 points - two essays. Also the texts were analyzed by sentences. There were: 1) the narrative of a factual type (facts, for example: "The Moscow Battle took place in 1941"); 2) narrative of systematizing type (selection of general categories, such as: "The Stalingrad Battle consisted of 3 stages: Stage 1: defense; Stage 2: the battle for the city, the 3rd stage: counteroffensive"); 3) narrative of argument type (argument of a statement such as: "He had not eaten for a few days: there was the famine in Leningrad"); 4), narrative of a question type (questions, suggestions, for example: "Could I fight against people?"); 5) narrative of interpretive type (alternative or more general context, for example: "But if we had not defeated Napoleon, the whole world would be ruled by the French – it wouldn't be normal"); 6) narrative of emotional-substantial type (an impersonal assessment in broad categories, such as: "Let us remember the heroism!"); 7) narrative of emotional-and-personality type (personal position to the described events, for example: "I cry when I watch movies about the war"). Points for each of the selected narrative types are calculated for each of these types separately throughout essay. Variables: intellectual competence (general score), factual-type narratives, systematizing-type narratives, argument-type narratives, question-type narratives, interpretive-type narratives, emotional-substantial type narratives and emotional-and-personality type narratives.

3. Results

The first section of data analysis is checking the normality of the distribution of all variables. For these purposes, descriptive statistics were used: expectancy, variance, kurtosis and asymmetry with all the errors. This statistical analysis revealed that the distribution of some variables differs from normal. This could greatly reduce the chances of a statistical analysis of the data - in case of a significant deviation from the normal distribution, only methods of nonparametric statistics can be applied to the analysis of variables. However, taking into account a sufficient sample volume - 102 people involved - we performed a normalization of all scales. Special software was developed for this purpose. So, only normalized data was subjected to further analysis.

The next step in the analysis of the data was the factor analysis (principal component analysis with rotation). The issue of application of the rotation in the process of factorization should be mentioned specifically. In this case, we have assumed that there is a correlation between variables. It has been proved theoretically and

practically on more aged samples. In addition, the extraction of orthogonal factors does not correspond to the subject of our study.

It was proven by the factor analysis that three-factor model best of all covers the structure of intellectual competence. All selected abilities (conceptual, categorical and semantic) are disclosed exactly in this structure. Conventionally, they can be called (based on the composition of these factors): conceptual and categorical personality; semantic and sensory and intellectual competence. A typical matrix of factor loadings is presented in Table 1.

Table 1. Factor structure of intellectual competence, including conceptual and cognitive-personal components of mental activity

	Factor - 1	Factor - 2	Factor - 3
Conceptual synthesis	0,645816	0,137299	0,334072
Conceptual generalization	0,599996	-0,111389	0,125745
Semantic interpretation of the object-type	0,000335	0,671890	0,449346
Semantic interpretation of the abstract-type	0,378954	0,680757	-0,286614
Semantic interpretation of the geometric-type	-0,130083	0,790761	0,178338
SD medium-weak	0,022581	0,079955	0,712105
Narrative	0,363766	0,107676	0,708381
Cognitive demands	0,757220	0,074373	-0,046401

Notes: Marked loadings are >, 500000

As can be seen from Table 1, the conceptual and categorical ability are included in single factor with cognitive-personal component of mental activity with cognitive demands. In all factorization cases, the conceptual and categorical abilities were accompanied by one or another cognitive component of personal intellectual activity. This factor includes such indicators of cognitive-personal component of mental activity, as rationality, reflexivity, creativity, critical, independent and dialogic. Selectivity of interests is included in the same factor as the ability to semantic interpretation of an abstract type. Indicators of intellectual competence and differentiated measure of participation sensory component of mental activity are included in conceptual-categorical abilities factor. Cognitive-and-personality component of mental activity - flexibility - entered into a categorical abilities factor, so categorical abilities have a negative index. The position of "flexibility" in the conceptual abilities factor is occupied by indicators of intellectual competence and differentiated measure of participation sensory component of mental activity. In all cases, without exception, semantic abilities factor is emphasized, sensory-and-intellectual competence factor is changing following the changes in the composition of conceptual-and-categorical-personality factor.

4. Discussions

According to the most standard (for our study) distribution and composition of factors. It is assumed that the release of the conceptual and categorical personality factor emphasizes cognitive conditionality of the cognitive-and-personality components of mental activity. These components of mental activity suggest a high level of most of these conceptual and categorical abilities. There is impossible to use cognitive-and-personality components of mental activity without mastery of conceptual and categorical abilities. Otherwise, it can be uncontrolled and aggrieve activity.

Factor of semantic abilities, as we assume, emphasizes in view of the fundamental differences between stands of these variables on well-verbalized conceptual and categorical abilities. Semantic abilities involve making sense in some objects and events of the world. Therefore, they are characterized as being weak verbalized. This property of semantic abilities most clearly seen in the late teen years, when meanings are just begin to take shapes – transform and enrich actively. The sensory-and-intellectual competence factor stresses the importance of semantic capabilities for productive intellectual activity. Ability to differentiate, but not overly or inadequate use their emotions and semantics contributes to achieving high performance in many activities, including intellectual.

We should also mention atypical (for our study) factor structures. They are very representative. They indicate that the manifestation of intellectual competence is closely related not only to semantic abilities, but also the conceptual and categorical.

First of all, we note the case of "selectivity of interest." This cognitive-and-personal component of mental activity is characterized by high selectivity of a subject. This property is important for the differentiation of information on relevant and non-relevant, giving you the choice, preference of something one and ignore or abstract from the other. This property explain the occurrence of cognitive-and-personal component of mental activity as a separate factor, along with the ability to semantic interpretation of an abstract type.

The second case - the emphasis of a separate factor "flexibility" and categorical abilities with a negative index. It is anticipated that the use of categories of objects and formulation of categories should use the clear differentiation attributes of the objects, the allocation of the total base, essential properties and individual traits that may vary. "Flexibility" implies a greater tolerance to such rules and regulations, the ability to compromise, some middle measures, blur the boundaries that do not correspond to a clear differentiation. This, we assume, can explain the emphasis of a separate factor "flexibility" and categorical abilities.

The results are consistent with [Raven, 2000; Savin, 2002; Sternberg et al., 2002; Kholodnaya, 2002; Chamorro-Premuzic T., Furnham F., 2005]. These results enable the opportunities study manifestations of intellectual competence in childhood. This, in turn, will explore the development of competence in ontogeny and mechanisms for its formation, and will contribute to the development of new methods of diagnosis of intellectual competence.

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