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The Relationships of Mental States and Intellectual Processes in the Learning Activities of Students

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Investigation of the interaction of mental states and cognitive processes in the classroom allows us to solve the problem of increasing the effectiveness of training by activating cognitive processes and management of students' mental states. This article is concerned with the most general patterns of interaction between mental state and intellectual processes in students' academic activity. On the basis of the structural-dynamic approach two forms of influence on the intellectual process by current mental state have been identified. The first type of influence is on the transformation of the form of the process, reducing its resilience and degree of organisation as increasingly becomes integrated into the contingent mental state. The second type of influence is associated with the positive, neutral or negative dynamic of the productivity of separate indicators of the cognitive processes. The obtained results may be of interest for investigators studying the problem of mental states as well as for teachers and students concerned with the psychological aspects of training.

Keywords: learning activity, students, mental state, intellectual processes

INTRODUCTION

The problem of the interaction of psychological states and cognitive processes has become the subject of intense scientific research since the end of the twentieth century.

At present a series of authoritative journals are being published such as *Emotion, Cognition and Emotion* and *Emotion Review.* On their pages can be found active discussion of different aspects of this problem. The high level of this research and the newness of the results allows us to speak of the formation of cognitive-affective science as a new interdisciplinary area in psychology (Frijda, 2005; Izard, 1977; Lewis, 2005).

The interaction of the cognitive sphere and psychological state is at the centre of attention in the study of styles and strategies for coping with difficult life situations, since the social mechanism of coping behaviour is based on the constant interaction of cognitive processes, emotional state and coping activities (Lazarus, 1994). Using

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this approach, it has been shown that the influence of negative emotional states reduces the capability to understand aspects of a situation which must be adequately taken into account in order to manage behaviour. In connection to this, study of the system of Cognitive Processes and Psychological State has paramount significance since the correct functioning of this system leads to more highly organized cognitive processes, and, as a consequence, a deeper understanding of difficult situations.

In the area of the students' academic activity, the problem of the interaction of state and cognitive processes is acquiring particular topicality. This is connected to the tendency of young university students' academic activity to be characterized peaks of intellectual activity in combination with an intensive series of dramatic emotional experiences. This means that the discovery of mechanisms of interaction between mental state and the students' cognitive processes is becoming an important task.

The main cognitive process which constitutes a base to successful study is thinking. Thinking provides the process for recognizing and understanding what is happening. In the information processing system, thinking serves as the 'process of processes' since it allows the analysis of information received from other cognitive processes. On the other hand, the dynamic of cognitive activity causes functional changes in the processes of perception, attention, memory etc. The highest original level of cognitive processes is conceptual thinking, which includes all the lower levels of cognitive structures, acquiring "the form of the integral work of the intellect" (Vekker, 1976, 280).

The place and role of mental states in the functioning of students' thinking and other cognitive processes is still insufficiently studied in experimental psychology. However the results of research carried out demonstrates the close interaction between emotions and information processing. In particular, Isen et al. (1987) showed that positive emotional states influenced the cognitive process. The experimental data collected testifies that experiencing positive mental states facilitates increased cognitive productivity, improved comprehension of complex situations and heightened productivity of verbal associations.

Similar results were obtained by Fredrickson (2001). A positive mental state (among which the author includes calm, pleasure, joy, interest, serenity etc.) favorably influences cognition. The repertoire of cognitive actions increases, understanding of complex tasks increases and scores in creativity and comprehension tests rise. On the basis of experimental research Fredrickson (1998) developed *The Broaden-and-Build Theory of Positive Emotions*, according to which a complex of positive emotional states significantly increases cognitive potential. Consequentially, the physical, intellectual and social resources of the individual grow.

Analogous results were obtained in research on memory. Positive emotional states raise the productivity of associative processes. Subjects in these states more easily find links between different events, thoughts and ideas than those experiencing negative states (Worth, 1987).

The research examined supports the view that mental state and cognitive processes are in a mutually dependent coordination. In other words, they form an interactive system. Knowledge of the mechanisms at play in this system has practical application, especially in the context of an individual's self-regulation. For example, cognitive processes and intensive states of jealousy, fear, aggression etc. interact by the principle of mutual induction. The psychological content (a mental representation of the situation), created in the processes of cognition, imagination and memory, heightens the emotional states experienced, which in turn, facilitate even greater mental fixation on one or other aspect of a situation which is important for the subject. In this way the system acquires the aspect of a "vicious circle", which can be escaped either by cognitive regulation (by shifting attention to other matters, or by positive thinking etc.), or by emotional discharge which lowers the intensity of the mental state experienced.

Purpose and research question

The main aim of this research is to discover a mechanism governing the interaction between mental state and cognitive processes during real academic activity. To do this it is necessary to answer the question of how the dynamic of productivity and the resilience of cognitive processes are dependent on the mental state which arises during study.

METHODS

Participants

Mathematics and physics students between the ages of 19 and 20 took part in the study. Their average age was 19.7. There was a total of 118 subjects, 53 men and 65 women.

Instruments

The Amthauer Intelligenz-Struktur-Test (IST) was used to research cognitive processes (Amthauer, 1970). Its (GE) II subtest was applied to measure abstraction and the ability to generalize thought; the III (AN) subtest – for researching cognition by analogy; the IV (KL) test – to research the ability to classify concepts; and the VI (ZR) subtest to evaluate logical thought.

Assessment of the vividness of mental imagery was conducted with the help of the Betts questionnaire, (QMI) (Sheehan, 1972). Nonverbal creativity was measured using the techniques of the Torrance Test of Creative Thinking, (TTCT) (Incomplete figures task subtest) (Torrance, 1974). This was used as an indicator of originality.

Verbal creativity was measured using the Remote Associates Test, (RAT) (Mednick, 1967). The main psychometric indicator of cognitive processes was productivity.

From the exercises included in these tests, three parallel sets of exercises were put together. This was done using various forms of tests, such IST (A, B, C), TTCT (A, B) and by divided stimulus material into parts. Completing each of these prepared sets of exercises took no more that 8-10 minutes.

To measure mental states a special method was developed, based on the semantic differential technique (Snider, 1969). Using this method, measurements were taken of the intensively of manifestations of the characteristics of psychological states: experience, physiological processes and behaviour (18 characteristics in all).

Procedures

The interaction of cognitive processes and mental states is dynamic. For this reason, in order to study patterns of interaction at a given time, it is necessary to take a diagnostic snapshot. This allows research not only of the dynamics of separate indicators, but also of change in the subsystem of cognitive processes. Accordingly, at the start, in the middle and at the end of the session, the academic activity of the students was interrupted for 10-12 minutes with the aim of measuring indicators of cognitive processes and mental states.

All the research was carried out during seminar sessions which, as usual, took place under the supervision of a professor. The sessions lasted 90 minutes.

Date analysis

Statistical processing of the data was carried out with the help of Pearson's correlation analysis.

The following statistical indicators were used during analysis of the data.

The determination coefficient (R^2), showing to what extent variation of one feature is determined by variation of another.

The variation coefficient (V), which is a relative measure of the scattering of results differing from the arithmetical mean. The variation coefficients have been used as indicators of instability.

The stability coefficient (S) of structures and their interconnections, defined as the relation of the quantity of correlations at the significance level $p < .01$ and $p < .001$ to the general quantity of statistically attested connections (at the level $p < .05$).

For identification of the leading indicators of interaction the *statistical scale method* was used. Correlations at the statistically significant level of $p < .05$ were registered – 1, $p < .01$ – 2 and $p < .001$ – 3. The indicators with the highest score in all statistically significant connections were considered the leaders as defined by the structure of the cognitive processes formed.

RESULTS AND DISCUSSION

At the *beginning of the session* medium intensity states prevailed – calm and interest (31%). There were 5 correlative links in the structure of the cognitive processes: classifying – generalization (.333; $p < .001$), classifying – analogy (.307; $p < .001$), generalization - analogy (.458; $p < .001$), generalization – verbal creativity (.214; $p < .05$) and analogy – verbal creativity (.314; $p < .001$). The leading elements in the cognitive process subsystem were *generalization and analogy* processes.

The structure of interconnections between indicators of states (inter correlated links) form 11 correlations (4 of which are negative). The strongest links were: classifying – autonomic perception (.301; $p < .01$), inference by analogy – purposiveness of behavior (.243; $p < .01$). The leading interactivity indicators were the *analogy* process and the *behavioral* subsystem.

In the *middle of the session*, high and medium intensity states had the highest frequency of occurrence. High intensity states included joviality and excitement, (15.3%) and medium intensity states included calm and interest (27.2%). In the structure of the cognitive processes, there were 4 statistically significant links: classifying – analogy (.324; $p < .001$), classifying verbal creativity (.217; $p < .05$), analogy – generalization (.289; $p < .01$), analogy – verbal creativity (.287; $p < .01$). The leading *element* in the structure of the cognitive processes in this stage was analogy.

The interconnection between states consisted of 29 positive correlations. The leading parameters of interaction were, on the part of the cognitive processes, *logical thought* and *non-verbal creativity* and, on the part of the states the *physiological processes* subsystem. The greatest extent of correlation was observed in variables of logical thought – activity of the cardiovascular system (.295; $p < .01$), and non-verbal activity – emotional inhibition (.294; $p < .01$).

At *the end on the session*, the greatest integration of cognitive processes into the structure of mental states was observed. The interconnections found were distinguished by their high stability. The dominant state was fatigue (36.4%). There were 7 interconnections in the structure of the cognitive processes. The strongest were: classifying- analogy: (.247; $p < .01$), analogy – generalizations (.396; $p < .001$), classifying – verbal creativity (.263; p < .01), analogy – verbal creativity (.213; p < .05). Leading indicators were *analogy, classification* and *generalization.*

At this stage of the session the intensity of the interconnections between cognitive process and states substantially increased (49 positive correlations in all). The central line of interaction went through the indicators of *logical thought*, the *experience* subsystem and *behavior*.

The following correlations showed the greatest extent: non-verbal creativity – confident behavior (.313; p < .001), logical thought – emotional activity (.312; p < .001), logical thought – emotional vivacity (.311; p < .001), logical thought – emotional inhibition (.310; p < .001).

In order to identify statistical differences in productivity parameters The Friedman test was used (also a great number of comparisons using the Wilcoxon signed-rank test were employed). The results of statistical analysis have shown that the average productivity of cognitive processes over the course of the study session remained unchanged. At the same time, certain specific changes in the productivity dynamic of individual cognitive processes were recorded.

The *analogy* process was the leading element in the cognitive processes subsystem. The productivity of this process increased over the course of the session and achieved its maximum values against a background of low intensively behavior – fatigue, drowsiness etc. (Chi Sqr. (N = 118, df = 2) = 36.321; p < .000). The *mental imagery* indicator demonstrated a similar dynamic. (Chi Sqr. (N = 118, df = 2) = 12.448; p < .0019). It is clear that in these cases a developmental effect of the training session was manifesting itself, since the basis of the instruction was the repetition of certain activities.

A high degree of the leading element, *logical thought*, was noted in the structure of the intercorrelated links. This was expressed by its maximum variability in comparison to other cognitive processes. However, statistically reliable changes in the productivity of logical thought were not recorded (Chi Sqr. (N = 118, df = 2) = 5.541; p < .062). In this way the process showed its relative neutrality in interaction with states.

A fall in productivity of *nonverbal creativity* was observed from the beginning to the end of the study session. (Chi Sqr. (N = 118, df = 2) = 43.318; p < .000) The *classifying* process also fell in productivity (Chi Sqr. (N = 118,df = 2) = 40.637; p < .000). The drop in the indicators is evidence of complications in the processing of verbal information which arise in the final stages of the session.

One of the most informative stages of empirical research is analysis of macro-indicators of the cognitive process subsystem and their interrelation with states (figure 1). Firstly, from the beginning to the end of the session, the stability coefficient of cognitive substructures fell by more than 50%, which reflects the reduced degree of interdependence of the processes and their reduced combined involvement in solving academic exercises. This is also indicated by the declining dynamic of the average determination coefficient of the cognitive process subsystem. Secondly, as the internal autonomy of the cognitive processes grows, a tendency is observed towards stronger dependence on current mental states. This is expressed by a growing dynamic of stability coefficients and determination of the structure of intercorrelated links.

In this way, the influence of mental states not only affects the productivity of separate cognitive process parameters, but also the transformation of the degree of organization or integration of the cognitive process subsystem as a whole.

The presence of invariant links in the structure of cognitive processes is an interesting factor. These links are preserved for the duration of the whole session of academic activity (figure 2). The organization of these links reflects the fact that a key role in cognitive activity of students is played by the *induction by analogy* thought process. It should be mentioned that analogy is not only a form of cognition but also a method for learning new knowledge (the metacognitive procedure).

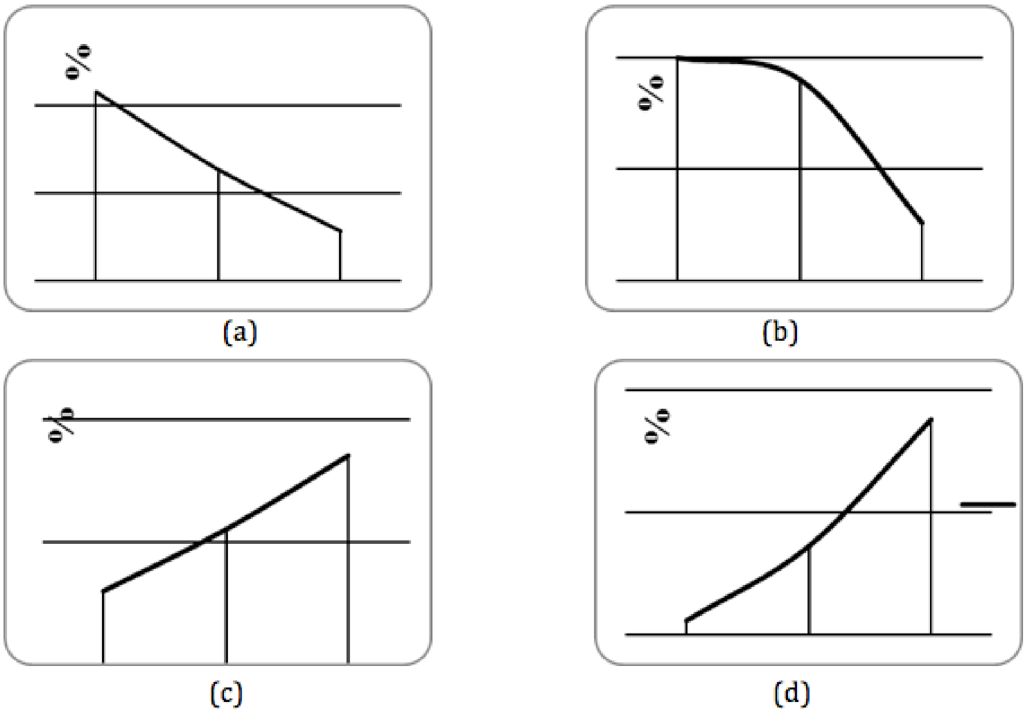

Figure 1. Dynamic of determination and stability coefficients of cognitive process subsystems and intercorelated links. (a) The determination coefficient dynamic (the cognitive processes structure); (b) the stability coefficient dynamic (the cognitive processes structure); (c) the determination coefficient dynamic (the intercorrelationary links structure); (d) the stability coefficient dynamic (the intercorrelationary links structure).

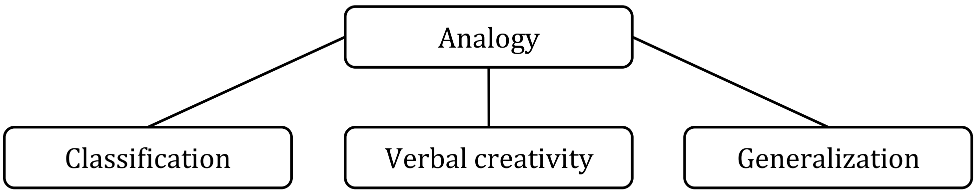

Figure 2. Invariant links in the structure of cognitive processes during the academic activity of students.

CONCLUSION

The results of the research carried out show that the interaction between cognitive processes and mental states is accompanied by variations in the stability of cognitive processes over time. At the same time, despite the changes in structure, it has an invariable feature, the preservation of the functional connections between several parameters of cognitive processes. The systematic element of these interconnections is *deduction by analogy*. This supports the view of the cognitive subsystem as relatively autonomous and resilient to changes in the course of interaction with the mental state.

Each of the indicators of cognitive processes which have been observed was connected to the ‘background’ state in different ways. This is expresses by the cognitive process having a different productivity dynamic and by the indicators’ interconnection with the constituent mental states over the course of the study process. The most resilient in their interaction with the mental state are *logical thought*, *general understanding* and *verbal expression*. It may be supposed that the resilience of these indicators to interaction with states is due to their high significance to the successful realization of the students' academic activity, which was concerned with not only the memorizing, retention and reproduction of information, but also on the alignment of logical connections between academic material, synthesis and understanding the contents of academic disciplines.

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