

COGNITIVE STRESS IN PEDAGOGICS: GENERAL ANALYSIS

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Abstract. The learning process is always associated with stress. The reason of this may be due to a gradual complication of the material being studied. The transition to new models in the analysis of different processes is frequently associated with the emergence of cognitive stress. In essence, these stresses should be considered a benefit. However, there is always a danger which is associated with the frequency of stressful situations. The emergence of cognitive stress was studied through the analysis of curriculum, monitoring of laboratory reports and in numerous interviews. A new type of cognitive stress which is caused by overloading the student with the same work is described. The second type of cognitive stress which was detected is called the stress of relativism. Some general recommendations for optimization of the time when cognitive stress can occur are investigated. In addition the ways to avoid stress that occurs in the multicultural education environment are also discussed and a few practical recommendations are proposed.

Key words: behaviour, burnout effect, cross-cultural conflicts, educational strategy, microparadigm, optimisation, optimal curriculum, paradigm shift, saturation effect, stress, stress of relativism.

1. Introduction: Instructional Practice and Stress

It was Hahs Selye who studied the stress concept the first in the 1920s after completing his medical training at the University of Montreal. The term “stress” was introduced by him in 1936. He defined it as the “non-specific response of the body to any demand of change” [1; 2]. The word “stress” was taken by him from the theory of solid state where this word describes the behaviours of staff under the action of external forces. In everyday life the term “stress” is widespread. Usually only negative effects of stress are discussed. This understanding differs from the basic interpretation of this term, which was introduced by Selye in his famous book [3]. In fact, stress can have both positive and negative effects on the body. In the negative case, we talk about distress, and the opposite being eustress. The current view suggests that life without stress is really impossible. Since any development is uneven, one can say that our life span is a sequence of stresses of a different nature and power [4]. It is not difficult to understand that learning is also associated with the occurrence of various stresses. Learning is accompanied by several types of stresses. Their nature is different. Many of them were described in a series of psychological issues (see [5; 6]). Yet, there are some specific stresses connected with instructional technologies. On the tertiary level they are never discussed. These specific stresses are the main goal of this presentation. In general they can be denoted as *Cognitive stresses*.

The instructional activity is a single unit. However, in the first approximation, it can be split into two parts. The first one is the acquisition of new knowledge and development of task oriented specific skills. One traditionally says that instructional technologies create and fix competences or Knowledge, Skills, Abilities and some Other characteristics – shortly KSAO. The second part is tied to the creation of competences in the field of team working, personal connections and other behaviour properties of an individual. To build a single theoretical base of this problem, researchers often prefer to talk about the two types of KSAOs namely Technical KSAOs and Behavioural KSAOs [7-9]. In many cases to denote these two types of KSAOs other similar terms may be used. Behavioural KSAOs ensure the implementation of Technical KSAOs. They consist of tolerance, motivation, and team working skills. Therefore, these KSAOs have an individual character. They implement individual competency. In opposite to this, Technical KSAOs enable the realization of competencies. They are referred to as competence. As a result of a number of historical reasons, the Behavioural KSAOs were studied in a more detailed way than the Technical ones. In addition to this until now the causes of the stresses connected with Technical KSAOs has not been investigated. At the same time, as it will be shown without these stresses it is impossible to organize a deep study of different subjects. Moreover, without examination of these problems it is impossible to optimize the curriculum. At the same time, all traditional instructional practices are focused mainly on the process of creating Technical KSAOs. Therefore, the main attention in the starting part of this work is devoted to the stresses tied with Technical KSAOs.

2. Some General Considerations

One of the most important directions in the study of educational stresses is to ensure the comfort of each student. The main direction in following this recommendation is to remove or reduce the factors causing stresses. There are several considerable achievements here. Nevertheless, it is quite obvious that to create an absolutely non-conflict situation in educational practice is impossible. Therefore, the main task to improve the optimal instructional strategy is to try not to avoid all possible obstacles and the source of conflicts. The persons who manage the educational strategy must not kill uncomfortable situations. They should strive to turn the resolution of possible contradictions into a non-conflict form. In addition, they need to develop the skills of the students' correct behaviour in such situations. It is necessary to develop that students should understand that real life conflict free existence is not possible. In addition, it is necessary to consolidate the students' understanding that these contradictions occur not only in the social sphere and everyday practice. Technology and science, in their development, are also associated with overcoming a variety of contradictions and misconceptions. Therefore, during lectures and practical classes every teacher needs to give the necessary examples. In this case the discussion in reciting classes plays a special role. These seemingly simple requirements are actually implemented with great difficulty. At the same time, these problems are typical not only for training. Therefore, we shall pay maximum attention to the problems of special educational stresses.

3. Education and Stresses: Problem of Optimal Curriculum

As evolution in general, an individual development does not always go evenly. Sudden revolutionary changes cause stress in their participants and observers. Accordingly, stress accompanies the process of the personal development and the learning process. Every child experiences stress when he (she) learns of the death of his (her) parents. Another typical stress of growing up can be the discovery that adults do not possess absolute knowledge. Our further attention will be devoted to the Cognitive stresses which are specific for learning on the tertiary level. The learning of the Universe is gradual. This is because Nature is infinitely complex. We can learn it only by using simplifying models. As we move from one level of education to another, all used models of cognition both of Nature and Social life are replaced step by step with new ones. These replacements are frequently unexpected. They are associated with the need to change the individual thesaurus of a student. At its core, this transition may be similar to what Thomas Kuhn called the Scientific Revolution [10]. Using the terminology of this author, one can say that a change in the studied models causes an individual paradigm shift. Of course, what more often happens in instructional practice is that the paradigm shift covers only a small area of knowledge. According to [11] one can speak about shifts of individual paradigms or microparadigms. At the tertiary level, a stress situation is usually complicated by the fact that new models come up in the taught material when students move to new subjects. This, in turn, is accompanied by the appearance of new lecturers and instructors. This frequently can enhance the power of cognitive discomfort.

Gradual complication of the studied models inevitably causes cognitive stress. Careful examination of the curriculum suggests that this phenomenon is inherent in the teaching of all subjects. For this reason, it is impossible to get rid of cognitive stress completely. An experienced instructor usually knows well in which points of the taught material the cognitive problems will come up. These critical points may be shifted within certain limits. Sometimes, it is possible to overcome all cognitive stress by the help of discussions in reciting classes or by special explanations at the lecture time. Yet, very often the problem is more serious. Let us consider two examples. In Physics, which is taught in high schools, they frequently solve the problems about a balance of the two loads hanging on a cord thrown through a block. At the first stage the rotation of the block is neglected. On the next level the students study the main laws of a rotating body. In this case, the solution of the same problem on equilibrium of two loads on the block is different. It is not very difficult to alleviate the discomfort and the attendant stress. This is enough for a short discussion. The second example is connected with teaching of foreign languages. It is well known that the study of a language requires constant expansion of vocabulary. Translation of words into another language is ambiguous. However, at the early stages of learning one can usually focus only on one meaning of the word. As a result, the overwhelming majority of trainees have an impression that there is one-to-one correspondence of

words in different languages. The ambiguity of translation and its dependence on the context is usually surprising. The consequence of this frequently creates cognitive stress. A set of interviews confirmed this suggestion. In contrast to the previous example the stress in this case occurs in different students at different times. This time depends on many individual circumstances. A more careful approach in this case is required as a consequence of overcoming cognitive stress.

It is not difficult to understand that the facts and novelties in instructional technologies, which affect the perception of the new material, are very diverse. In this field much depends on the psychology of a student and of his (her) background. An experienced teacher is usually able to identify these critical moments. They may be called focal points of the instructional program. The most important of them is well known. One example is the transition to the study of quantum phenomena in Physics and Chemistry. These points are available in many academic disciplines. For this reason, the question arises about how to allocate these difficult moments in the General schedule. As a result, the problem arises of optimisation of the schedule. For this point the idea of optimal curriculum can be considered as one of the most important practical problems.

Students can have cognitive stresses in classrooms, lecture halls and elsewhere. Modern education is becoming a more open system in comparison with the previous times. Over the last decades students can find a lot of information from TV, the Internet and popular books. This process is not under serious control. Most students do not have experience in the estimation of the reliability of the found information. Dealing with erroneous and contradictory information often leads to creation of cognitive problems and stresses. To overcome them one needs to organize special trainings in the area of independent work with information flows. Based on our own experience, we can suggest that the best way to solve these problems is by the help of personal training.

4. Students' Mentality and Stresses

Behavioural KSAOs are created under the influence of collective works and under interactions with instructors. Each instructor has an individual style of teaching. Therefore, the instructors' requirements can sometimes vary a little. This occasionally leads to the fact that at the freshmen level students can feel uncomfortable. In such a case one can hear from the students: "This instructor requires one thing, another requires something different". We call the caused stress *The Stress of Relativism*. It is a very dangerous phenomenon. To avoid this temporal stress it is necessary to try some objective methods. One of them is a testing procedure. It is common. The other way is to implement various electronic and Internet programs and methods. Students like this idea, because they consider it more objective than the actions of an instructor. Many instructors also prefer the automation of the education process, especially at the checking operations. In the routine testing strategy a correct answer to a problem is originally introduced into the PC program. It means only one answer is correct. However, there can be a case when students' understanding is not uniform. One frequently does not understand that in some cases a computer assisted system rejects all non-standard and unexpected students' answers as erroneous. The disadvantage here is that rigid standardization of the correct answer eliminates a small number of students with original and creative points of view [12]. In these cases the students feel cognitive stress. If this situation repeats, most creative students will lose their creativity. Moreover, some of them will lose interest in studying.

In addition to the described situation most freshmen and sophomores have stresses due to the lack of teamwork. This type of stress was studied many times. Therefore, we do not review it in detail. A fatigue from monotonous assignments plays a special role in a negative impact on the learning outcomes. During the development of a new material for students, each instructor must meet two main requirements. The first is to provide a comprehensive review of the survey. The completeness of the description of each new serious problem is provided by its repeated consideration from different sides. It is necessary to take into account that each new trial gives less information related to the studied problem. So, over time there comes a kind of saturation. After this it is possible to stop the analysis. The point of saturation may be predicted theoretically [13]. It is not a very exact determination. Therefore, most instructors prefer to extend the research of a new problem as long as possible. However, this can unexpectedly lead to undesirable results. They are connected with the second requirement. It turns out that in the long process of studying the same phenomena the students often overload the same theme. Consequently, they lose interest in the work. This super saturation as a result

of an examination of the same problem creates some negative psychological effects. We call this effect as *Super saturation stress*. In its manifestation it is partially similar to *Burnout effect* [5; 6; 14]. Yet, the source of these two effects of stress creation is absolutely different. Burnout is caused by numerous external influences. The super saturation stress is caused by the lack of a sufficient number of such influences.

Super saturation stress was discovered and at first described by the authors in [13]. In this work the authors studied the creation of new knowledge and skills at the Physics training laboratory. The results were measured by the help of the so called mastering indexes [13; 15]. The time dependence of different averaged mastering indexes P_i in the long term experiments is presented in Fig. 1. It is evident that the value of these indexes rises with the educational time, i.e. hours spent in the laboratory. In [13] it was confirmed that this rise is described as the logarithmic curve [13]. On the left side of Fig.1 the value of the mastering index gradually moves to the saturation region. In the right part of this figure the time dependence of the other mastering index for the same group of students is represented. After entering the saturation region the curve in this part of the figure starts an active fall. This effect can be detected very well by the help of special mathematical treatment of the experimental results. The results of this treatment were described in [13]. Here these results are omitted for simplicity.

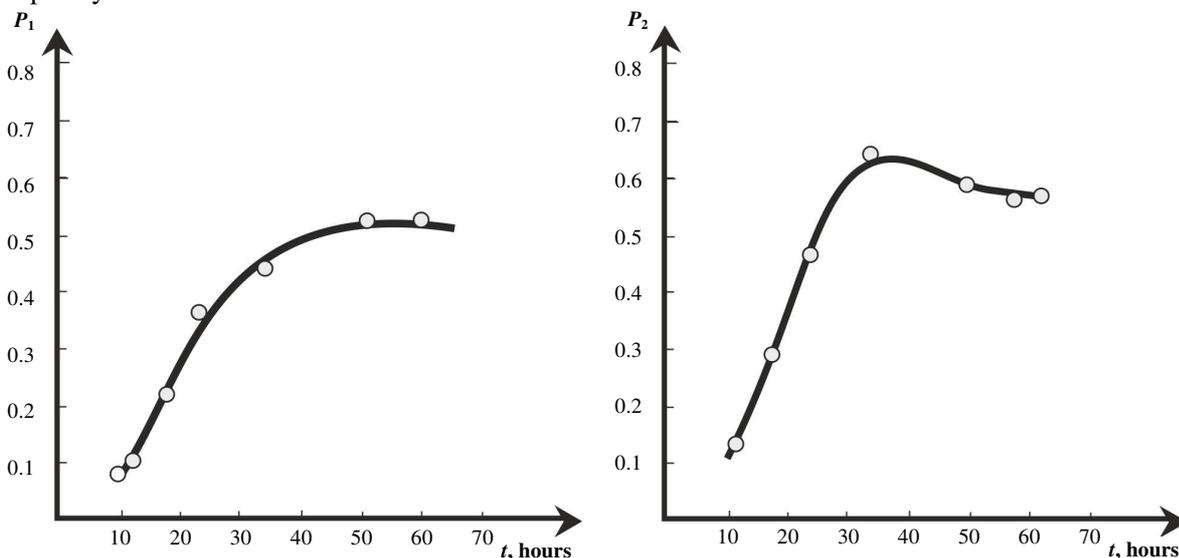


Fig. 1. Time dependence of mastering indexes P_1 and P_2

The data in the right part of Fig. 1 is the result of the Saturation effect, which was caused by the monotony of the long lasting required actions. This effect is manifested under different circumstances. Its negative role is more significant in the cases where the theoretical background and personal abilities of the students vary within wide limits. This effect was confirmed during fifteen years of experiments. They were attended by 800 students.

There is the third specific cognitive stress related to education. Its occurrence is associated with incorrect students' initial ideas about the studied subjects. Many students of high school love humanity subjects like Literature and History. Some of them come to study at the corresponding University departments. They are frequently surprised to learn such unexpected and complicated subjects as, for example, Source studies. In extreme cases the feeling of discomfort in these situations can lead to the desire to stop learning or to different mental disorders. This conclusion is based on numerous conversations with students. They were regularly held in four universities in the period of five years. The results of the interviews were recorded.

5. Some Multicultural Problems

The increased mobility of population in our modern world creates some problems in the field of education. Most of them are closely tied with various stresses. These stresses partially depend on cross cultural contacts in everyday life. They are studied carefully. Yet, there are known stresses, which are directly connected with instructional strategies. First of all, there are three well known principal types

of education strategies: German, English and French [16]. Instructional practice in these systems is different. Therefore, the students, who visited various universities, often need special transition adaptation practice in order to overcome stress. In different countries the same concepts are often referred to and written in different ways. The simplest example is how one writes the decimal fractions. In Germany and Russia one writes: “7,83” and “0,25”. Yet, in England and USA it will be written “7.83” and “.25” consequently. Various discrepancies are well known for mathematical symbols, terms and so on. The teachers must not only explain each case. A much more important learning task is to develop a habit of checking the recording system in all doubtful cases. In the absence of such skills various misconceptions can be observed. For instance, we can recall the story narrated by the Russian champion Igor Ter-Ovanesyan. He recollected how American champion Bob Bimon at the Olympic Games did not realize he had a running jump that set a world record. The source of his lack of understanding was caused by a very simple reason. Bimon did not understand that his result was in meters and centimeters. He did not know that the large part of world media and sportsmen do not use feet. The explanation of this simple example enables the teacher to focus the student’s attention on the validity of some practical problems tied with multicultural problems. The neutral field of world sport competition is convenient for this purpose.

In a multicultural situation it is necessary to provide special training for the teaching staff. Most problems in a multicultural environment are not directly connected with instructional strategies. However, one needs to do some special work to familiarize students with the problems of multiculturalism. In each curriculum there are subjects that can give extensive information about different countries and races. Lectures on ecology can be considered a good example of this subject. For instance, if students discuss with their teachers ecological situations in the Baltic Sea region they must understand that several countries, such as Russia, Finland, Sweden and others, are closely connected together. If the teachers include such examples appropriately, they direct the students’ attention to the surrounding peoples and create tolerant habits as a result. During the period of ecological studies the students have to understand the contributions and needs of different human communities, countries and so on. Such studies are useful for cultivating the students’ understanding of cross cultural interests. Hidden information in such courses creates useful skills and knowledge. This, in turn, helps reduce stressful situations both while studying and in subsequent practice.

It is necessary to have some practical programs to develop these ideas. First, these programs should be connected with the training of the teachers. This training must be accomplished with social testing of the students and appropriate checking procedures. We also need to find some special forms of educational processes. As we will speak about students’ education we must start from the suggestion that it is not efficient or realistic to give special lectures about tolerance, different habits of nations, races and so on. Such lectures are certainly useful. Yet, they cannot solve the main problem of tolerant education. The students’ tolerance may be cultivated as a result of everyday hidden work of all teachers’ staff. There are some methods of such education, of course. Let us discuss the simplest example. There are many foreign students, who are learning in many European universities. There are some objective obstacles, which these students usually meet in their everyday life. These obstacles include language barriers, differences in previous school teaching and other evident factors. Foreign students are usually mixed in with the host students. The authors studied groups of such students which were in several Saint-Petersburg universities. We also compared the situation in these groups with the situation in the groups of foreign students, which were mixed in with the host students groups. We will not discuss pure teaching problems here. Nevertheless, we found that the foreign students separated from the host students have some additional problems in understanding the habits of the host nation, have additional internal conflicts, and other problems. We confirmed this conclusion by discussing the results of the interviews given to us by the students. The host students in this situation also do not have enough information about the foreign students. Therefore, it is necessary to find an optimal strategy of mixing in the foreign students in the host staff. It is also necessary to find additional forms of contacts between the host and foreign students in the period of their free time. Correct organization of such contacts is one of the effective ways of overcoming cross cultural barriers and creating a more tolerant line of the students’ conduct.

6. Results and discussion

The conducted research confirmed the presence of new types of cognitive stress. The most important of them should be considered as The Super Saturation Stress and The Stress of Relativism. The presence of these stresses is confirmed by many years of experiments. The presence of a special type of stress related to learning requires the development of special techniques to overcome it. Some methods were reviewed in this report. However, their further investigation is required.

Along with purely cognitive stress in the learning process, stresses of behavioural type are quite common. There is also a special type of stress which is characteristic of the learning process. This last type of stress is connected with the multicultural situation. Increased in recent decades, the mobility of students requires a more detailed analysis of communication problems of multiculturalism related to the educational process [17]. The first and maybe the most significant result of studying this situation is the conclusion that it does not make sense to avoid different groups of individual interests in the process of education. Had one found any conditions for suppressing any dissimilarity in the environment, a new one would originate. Had one suppressed several sources of conflict and stress, soon the new sources would be produced. So, all students and all educated persons will live in multi-property structures. Multicultural situations can exist in each group of students and teachers as well. So, the main goal of education is not to make attempts to suppress diversity in situations. Each teacher must understand that it is necessary to tune his or her students to live, educate and work in a very diverse and complex environment. So it is necessary to teach students to adapt their conduct to the multicultural world. This means that each person after education must be tolerant enough to different characteristics of their contacts. All persons must understand the necessity of diversification of the customs, confessions, knowledge level, educational background and possible different characteristics of other people. The teachers must understand this situation and they must know how to reduce possible contradictions to the optimal level. They also have to create such individual students' skills which can permit them to transform all frictions and stresses between different cultural classes in a minor form. We mean a minor form of stress between the persons is connected with peaceful and benevolent competitions between the different characteristics of individuals. Contrary to this, the more severe form of stress is connected with quarrel, struggle and other characteristics of intolerance.

7. Conclusions

All ideas mentioned in this report have to be under constant check by special teachers. This staff must have basic preparation and special training. Statistical studies, students' interviews and other similar procedures must go together with the teaching during the entire educational process. Unfortunately, this part of the work is usually not in the best state indeed. Different countries have different problems and experiences in this field. Therefore, a comparative study of this work is a good way for making progress in the field of cross-cultural contacts.

One of the additional ways to diminish possible students' aggressive acts is connected with searching different forms of peaceful competitions. Different mathematical, cultural, and sport competitions held under inconspicuous observation of experienced teachers enable to diminish stresses and turn new stresses into peaceful behaviour. The main idea of such competitions is not to create elite among the top students. The goal of such competitions is not to find several winners. In opposite, this goal is to engage as many students as possible in these competitions and to give as many awards as possible to the participants. New contacts and peaceful situations give positive results in the fields of new contacts between different students belonging to different cultural groups. A compulsory part of such strategy is continuous observation of the students' characteristics. There is a danger that without the teachers' control such competitions can transform into an aggressive form. Conflicts in the football fans' society is an excellent example of such a situation. One of the ways to prevent the transformation of peaceful competitions into an aggressive form is to change the competitions' content periodically and proclaim new forms of competitions. It helps prevent the creation of stable aggressive students' teams in our opinion. The goal of an educational strategy is not to make attempts to avoid differences of contradictions, but to create a spirit. The students have to be explained that contradictions are a constant part of our common life. They must understand that different human properties, confessional differences, race and national habits are the base of a wealthy society. Therefore, students have to check their strategy in everyday contacts in both private and communal life.

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