

Transdisciplinary approach to improving study motivation among university students of engineering specialties

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Abstract

In pedagogy, motivation is considered more important than ability. This study aims to identify, and provide a rationale for, ways to increase of study motivation among the university students of engineering specialties. The creation of conditions for the subject to predict results of his activity, as well as for the manifestation of self-dependence and creativity, contributes to ensuring students' motivation and to the development of their search activity, that is "critical inquiry" of useful information. To implement these conditions, we suggest extending transdisciplinarity in education and integrating it with all forms of the educational process, and establishing more effective contacts (both formal and informal) between teachers and students. Such integration is based on integrity, dialectic method, mental activity and integration of the laws of nature. We see the role of this extension of transdisciplinarity as combining heterogeneous knowledge by content (education) and methods (development) in conjunction with improving the quality of organizational and pedagogical support of training sessions (upbringing).

Keywords: Undergraduate, engineering, Transdisciplinary integration, Achievement motivation, Searching activity, Passive behaviour.

Трансдисциплинарный подход к повышению учебной мотивации студентов технических направлений подготовки вузов

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Аннотация

Целью исследования является выявление и обоснование на основе трансдисциплинарного подхода путей повышения учебной мотивации у студентов высших учебных заведений с техническими направлениями подготовки. В образовательном процессе, где обязателен акцент на самостоятельность и творчество, сложность познавательной деятельности нередко превосходит интеллектуальные и личностные возможности обучаемых. В результате у них снижается мотивация к учебной деятельности. А между тем в педагогике фактор мотивации считается более важным, чем уровень способностей. Возникает проблема: как повысить мотивацию студентов технических направлений подготовки в условиях усложнения учебного материала, как заменить мотивацию избегания неудач (пассивное поведение) положительной мотивацией достижения (поисковой активностью) в сочетании с раскрытием потенциала творческой, эвристической деятельности? Обеспечению мотивации обучаемых, развитию их поисковой активности способствует создание условий для прогнозирования субъектом обучения результатов своей деятельности и для проявления самостоятельности и творчества. Для реализации этих условий мы предлагаем трансдисциплинарность в образовательном процессе, интеграцию всех форм организации учебного процесса, установление более тесных контактов (формальных и неформальных) между преподавателями, например, посредством совместной учебно-методической и научной работы. Такая интеграция основана на идеях целостности, диалектичности законов природы, общества и психической деятельности. Мы видим её роль в объединении разнородных знаний по содержанию (обучение) и методам (развитие) в сочетании с повышением качества организационно-педагогического сопровождения учебных занятий (воспитание). При трансдисциплинарной интеграции компонентов образовательного процесса мотивация избегания неудач заменяется мотивацией достижения благодаря взаимосвязи содержания дисциплин, взаимопроникновению разнородных методов познания, совершенствованию форм обучения на основе ИТ. Разнородные по своей сути гуманитарные и технические знания воспринимаются целостно, без лоскутного деления на отдельные дисциплины. Благодаря взаимообогащению методов, присущих техническим и гуманитарным предметам, совершенствуются умения поисковой деятельности. Более эффективное изучение содержания разнородных дисциплин, развитие эвристических способностей, эмоционально-волевой сферы способствуют формированию

перекрёстных компетенций, общих для группы дисциплин, навыков совместной работы, что позволяет обучаемому выбирать более трудные, но социально значимые цели, связанные с получением профессии.

Ключевые слова: технический бакалавриат, трансдисциплинарная интеграция, мотивация достижения, поисковая деятельность, пассивное поведение.

Introduction

The time in which engineering knowledge evolves is comparable with the length of university study. During this time, the volume and complexity of the educational material to be mastered increase. Therefore, it is desirable and necessary for student to know how to study those or other disciplines – the methods of self-development, and the ways of self-motivation – to improve his/her cognitive activity.

As connections between parts of study material increase, the role of holistic methods of learning and methodological support of the educational process also increase. The methodological culture cannot be transferred in finished form, as it is constantly being changed and reassessed in the process of problem solving (Clausen and Andersson 2019; Tawfik et al. 2019). In this regard, we note the importance of communicative qualities (Hursen 2019), as well as organizational and methodological aspects of the educational process (vanOostveen et al. 2019). Usually universities engineering faculties do not pay sufficient attention to these aspects. However, the students' pragmatic interest in obtaining professional knowledge is helpful; for example, when studying humanities, where Kitova (2018) has investigated the relevance in training highly qualified engineers. Social and humanitarian disciplines in engineering education are necessary, not only to develop students' communicative skills and creative thinking, but also to change the thinking stereotypes for adoption of modern global trends in sustainable development. Engineering faculties' students are, as a rule, interested in humanities, but when faced with the need to make an effort they often push humanitarian subjects to the background. The problem is particularly relevant for Russian engineering education, since for many years the prevailing attitude was that humanitarian knowledge in engineering training was given secondary importance. The complexity of the humanitarian aspects of engineering education lies in the fact that in its implementation it is necessary to establish connection between humanitarian and technical knowledge. This, in our opinion (Gorbunov et al. 2019; Andreev et al. 2017), could be achieved through the ideas of transdisciplinarity. The relevance of a wider interdisciplinary and transdisciplinary approach for educational process with the aim of helping students develop meaningful skills to achieve greater success in the chosen field of professional activity is also actively supported by many researchers (McDonald et al. 2018; Tejedor et al. 2018; Balsiger 2015; Moore et al. 2018; Kudo et al. 2018; Barrera et al. 2018; Pohl et al. 2018).

The development of students' motivation to learning is an essential factor in education. The personal needs the behavioural motives that result from them, are one of the key concepts in psychology and pedagogy. It should be noted that motivation theories in education are very diverse. Motivation regarding achievement is understood as a person's striving to maximize the results of those activities to which evaluations of success or failure can be applied. In this case, achieving something too simple is not regarded as success, and failing to achieve something too complex is not experienced as failure (Heckhausen 1967).

The theory of self-determination is one of the most popular theories of human motivation (Deci and Ryan 2008). It identifies following three basic human needs, which include self-determination (autonomy), competence and relatedness.

According to Gardner and Lambert's psychological studies in second-language acquisition there are four types of motivation (Gardner and Lambert 1959).

1. Intrinsic, linked to the sphere of affections and desires.
2. Extrinsic, linked to external factors such as education.
3. Integrative, that is the motivation of those who wish (intrinsic supplementary motivation) or must (extrinsic supplementary motivation) integrate into culture different from their own.
4. Instrumental, when learning can have positive impact on the educational or professional field.

Similarly, Balboni (2002), traced three fundamental macro-categories, centred on the student's personality related to study motivations:

1. Duty, the obligation to learn, for instance in the school setting, which, if not supported by real interest, produces learning but not acquisition: the contents are stored in the short-term memory and soon forgotten.

2. Need, motivation linked to the left cerebral hemisphere, in which the learner is aware of the need to develop specific knowledge to reach a goal.

3. Pleasure, motivation linked essentially to the right hemisphere, but which can also involve the left, thus becoming very powerful.

Troisi et al. (2018) by means of Big Data analysis investigated heterogeneous and multifaceted factors that shape students' motivations in favour of choosing one university or another for higher education. According to the results obtained, motivations are formed mainly on the basis of training proposals, the material bases, employment prospects, the prestige of the university, the affordability of studies, mutual communication, organizational structure, and environmental sustainability.

Motivation has been investigated by many scientists in various scientific fields (Ryan 2012). Many studies in education are based on the use of a single theory of motivation. Alkaabi et al. (2017) analysed some aspects of simultaneous application of several motivation theories in educational studies.

The use of practice-oriented tasks to increase engineering students' motivation in learning of fundamental scientific disciplines was systematized and summarized by Politsinsky and Demenkova (2015), and Filho et al. (2016). Politsinsky and Demenkova (2015) concluded that a practice-oriented approach helps to increase of learning motivation.

Martínez-Cerdá et al. (2018) explored online learning as a technology that provides lifelong potential for continuous updating of knowledge and new skills. The habits, motivations and technical abilities of students in using mobile devices in the learning process have been investigated by Bogdanović et al. (2014). Arango-López et al. (2019) concluded that the use of pervasive games in higher education acts as means of increasing of student motivation to learn. Bawa et al. (2018), using multiplayer online games, performed comprehensive study of the factors that students consider motivating to master the curriculum. The use of visualization technologies for fundamental concepts of economic and mathematical modelling and the problem of organizing knowledge in successive scenarios of an educational game with the aim of increasing the learning motivation of students was studied by Smeureanu and Isăilă (2017).

The tendency to loneliness in first-year students during the adaptation period in universities in the USA and Canada was studied by Nguyen et al. (2019). It was concluded that these tendencies do not necessarily indicate social discomfort, but are in particular, due to the fact that parents support their children's sense of independence and contribute to its development.

Zhou and Wang (2018) analysed students' motivations to participate in social movements. Dunne (2013) conducted research on students' motivation to voluntarily seek intercultural contacts at a university campus. One of the results of analysis is that students'

intercultural contacts are based on a pragmatically “perceived utility” perspective. Interest in others, the idea of joint future, and the desire to learn other cultures are less significant factors.

Rao (2016) analysed teachers’ motivation in higher education on the basis of McGregor’s X and Y theories (McGregor 1960). Significant factors in motivation terms to achieve goals in the professional activity of university teachers were analysed by Janke and Dickhäuser (2018). The experience of training undergraduate teachers of technical disciplines at the Czech Technical University in Prague was summarized by Andres and Svoboda (2018).

Research problem

Contemporary educational process requires independence and creativity. Furthermore, the difficulties implied in cognitive activity often go beyond the students’ intellectual and personal capabilities. As a result, their motivation for learning activities falls. Meanwhile, high positive motivation can be a compensatory factor in case of insufficiently high abilities. Motivation importance in the educational process is due to the fact that the student must perceive situation as significant, and deserving their attention.

We believe that the phenomenon of achievement motivation contributes to development of individual self-dependence and manifestation of students’ searching activity. In this regard, instead of the more common motivation for avoiding failures, the teacher needs to strive to provide the students with a positive achievement motivation, requiring the expression of volitional qualities. The problem arises: how to increase students’ motivation for learning of engineering subjects in situation of increasing complexity of educational material, and how to replace failure avoidance motivation (passive behaviour) with positive achievement motivation (search activity) in combination with creating of creative and heuristic potential?

Materials and research methods

To identify the level of need for achievements of engineering specialties students the researcher took a basis test dedicated to achievement motivation “Need for goal achieving”, published by Yu.M. Orlov (1978). This test is a proven tool and can be used to assess the motivational characteristics of respondents from different age groups, including in combination with other psycho-diagnostic methods (Slavutskaya and Slavutskii 2018).

1. I think that success in life depends more on chance than on calculation.
2. If I lose my favourite activity, life will lose all meaning for me.
3. For me, in any case, it is not the execution that is more important, but the outcome.
4. I believe that people suffer more from failures at work than from bad relationships with relatives.
5. In my opinion, most people try to reach distant goals, not close ones.
6. In life I have had more success than failures.
7. I like emotional people more than active people.
8. Even in normal work I try to improve some of its elements.
9. Absorbed in thoughts of success, I can forget about safety precautions.
10. My relatives and friends consider me lazy.
11. I think that circumstances are more likely to blame for my failures than I am.
12. Patience in me more than abilities.
13. My parents controlled me too tightly.
14. Laziness, not doubt in success, often forces me to give up my intentions.
15. I think that I am a confident person.

16. For the sake of success, I can take risks, even if the chances of succeeding are slim.
17. I am a hardworking person.
18. When everything goes smoothly, my energy increases.
19. If I were a journalist, I would write more about the original inventions of people than about incidents.
20. My relatives and friends usually do not support my plans.
21. The level of my requirements for life is lower than that of my friends.
22. It seems to me that there is more perseverance in me than abilities.

All questions must be answered “Yes” or “No”. The questionnaire key is:

- “Yes” answers to questions: 2, 6, 7, 8, 14, 16, 18, 19, 21, 22;
- “No” answers to questions: 1, 3, 4, 5, 9, 11, 12, 13, 15, 17, 20.

One point is awarded for each answer, that matches the key, and the total amount of points is calculated. The results are interpreted as follows:

- 0 – 6 points correspond to low motivation in achieving the goal;
- 7 – 9 points correspond to reduced motivation in achieving the goal;
- 10 – 15 points correspond to an average motivation in achieving the goal;
- 16 – 18 points correspond to an increased motivation in achieving the goal;
- 19 – 22 points correspond to high motivation in achieving the goal.

The study was carried out in the faculty of radioelectronics and automation of the Chuvash State University. Undergraduate students of the first year (18 people) and fourth year (9 people), as well as master students (8 people) were tested. A reference, group of teachers (4 full professors and 6 associate professors) was also tested. The average values of the number of key matches for all respondents’ groups were calculated to provide a quantitative interpretation of the test results.

To study the various aspects of motivation learning we used the observation method, understood as purposeful and systematic collection and synthesis of objective scientific information, obtained in conditions that are natural for students participating in the educational process.

This systemic approach considered the entire system of training of engineering specialties students in the form of single complex of interrelated elements. It enabled a movement from classical understanding of transdisciplinary approach to the idea of transdisciplinary integration of all components of the educational process in the engineering bachelor degree program.

Results and discussion

The initial trial testing on a small number of respondents delivered the predicted result: the teachers are most motivated, then master students, and the least motivated were undergraduate students (Table 1a). The results did not show the difference between the first and fourth (final) year undergraduate students. Table 1a shows the number of key matches with the answers given to each question of the questionnaire by respondents in four different groups: “First year undergraduates”, “Fourth year undergraduates”, “Masters”, “University teachers”. The proportions of coincidence of the key with the answers of the respondents in each group are shown in Fig.1 while the distribution of points scored by the respondents of each surveyed groups is presented in Fig. 2. The sample size is small, since generalization of the results for the general population was not the purpose of the study. The survey was conducted anonymously and respondents were selected randomly. The test confirmed its diagnostic capabilities by the fact that when we

re-tested students with high and low training levels, we got results that almost coincided with the initial ones. Then basic testing was conducted on a larger, statistically significant contingent of students. The results are shown in Table 1b.

Table 1a: Number of matches of the tests key with respondents' answers to each question

Test's question number	Number of matches with the test's key			
	First-year undergraduates	Fourth-year undergraduates	Masters	Teachers
1	9	7	3	7
2	3	0	0	6
3	5	7	6	6
4	15	7	7	9
5	7	1	5	5
6	14	5	7	10
7	13	2	5	3
8	14	9	6	9
9	13	7	4	8
10	10	6	6	8
11	17	8	8	8
12	12	4	4	5
13	15	7	7	9
14	8	4	4	5
15	5	6	1	3
16	12	5	6	7
17	4	1	1	3
18	18	9	4	7
19	8	5	6	8
20	12	5	7	6
21	3	0	1	6
22	6	2	6	6
Arithmetic mean	12.3	11.9	13.0	14.4

Table 1b: The basic testing results

Level	Test scores	First year undergraduates (n=62)	Second year undergraduates (n=46)	Third year undergraduates (n=48)	Fourth year undergraduates (n=40)
High	19	-	-	-	1 (2.5%)
	18	-	-	-	-
	17	-	1 (2.2%)	-	1 (2.5%)
	16	2 (3.2%)	3 (6.5%)	3 (6.3%)	3 (7.5%)
Average	15	2 (3.2%)	4 (8.7%)	5 (10.4%)	5 (12.5%)
	14	15 (24.2%)	9 (19.6%)	6 (12.6%)	12 (30%)
	13	20 (32.3%)	7 (15.2%)	11 (22.9%)	7 (17.5%)
	12	11 (17.7%)	9 (19.6%)	5 (10.4%)	4 (10%)

Level	Test scores	First year undergraduates (n=62)	Second year undergraduates (n=46)	Third year undergraduates (n=48)	Fourth year undergraduates (n=40)
Low	11	10 (16.1%)	5 (10.9%)	8 (16.7%)	6 (15%)
	10	-	5 (10.9%)	5 (10.4%)	-
	9	1 (1.6%)	3 (6.5%)	2 (4.2%)	1 (2.5%)
	8	-	-	1 (2.1%)	1 (2.5%)
	7	1 (1.6%)	-	1 (2.1%)	-
	6	-	-	-	-
	5	-	-	1 (2.1%)	-
	Arithmetic mean	11.1	12.7	11.0	13.5

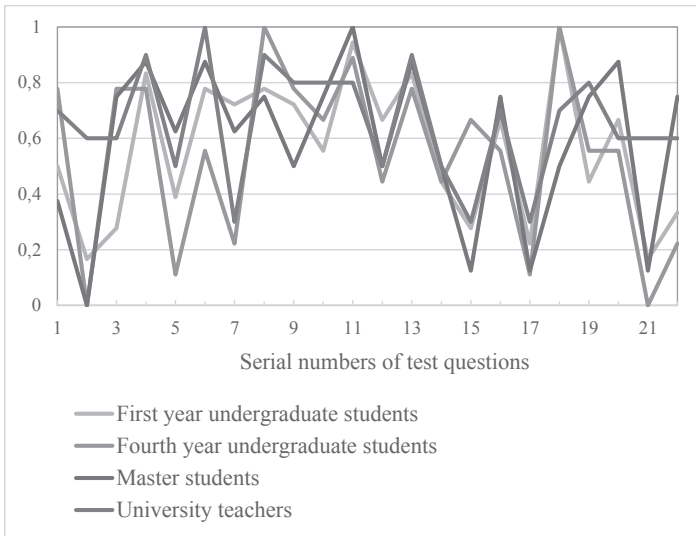


Fig. 1. Dependence on serial number of the test question of ratio of the number of matches with the test's key to total number of respondents in each group

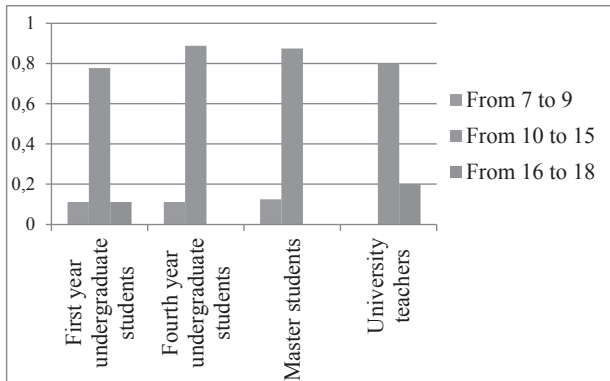


Fig. 2. Distribution of test results in points according to the test's key for all groups of respondents

Most of respondents in all of four groups scored from 10 to 15 points, i.e. had an average motivation to achieve the goal (Fig. 2). There was a small proportion of respondents among first-year undergraduates (11.11%) and among teachers (20%) who scored from 16 to 18 points, i.e. with increased motivation to achieve the goal. There were none in this category among the respondents belonging to groups of fourth-year undergraduates and masters. A small proportion of student scored from 7 to 9 points, i.e. with reduced motivation in goal achieving. The average score obtained by first-year undergraduates was 12.3, by fourth-year students 11.9, by master students 13.0 and by teachers 14.4. There were no significant differences between first- and fourth-year undergraduates in the average level of achievement motivation. This means that the educational process does not develop the need for achievement. On contrary, a small proportion of first-year students (11.11%) with increased motivation to achieve goal “dissolves” towards fourth year (Fig. 2). The test results show that, although there is a noticeable difference in the average indicators of masters, undergraduates and teachers, these variations occur strictly in the interval from 10 to 15 points. Thus, both students and their teachers have an average motivation to achieve their goals.

Correlation coefficients between data shown in Table 1a were calculated giving the following values.

- $R(\text{First year undergraduates, Fourth year undergraduates}) = 0.6944$;
- $R(\text{First year undergraduates, Masters}) = 0.6643$;
- $R(\text{First year undergraduates, Teachers}) = 0.5572$;
- $R(\text{Fourth year undergraduates, Masters}) = 0.5133$;
- $R(\text{Fourth year undergraduates, Teachers}) = 0.5703$;
- $R(\text{Masters, Teachers}) = 0.6000$.

The correlation coefficient between indicators of teachers and students increases as they progress to more advanced years. Thus, the motivation level of students tends to reach the level of teachers. Our conclusion is self-evident: it is necessary, first of all, to increase teachers' achievement motivation, because success-oriented teachers can guide students along the path of learning success.

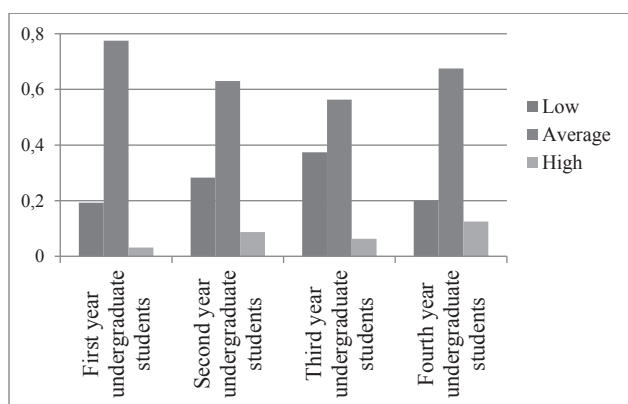


Fig. 3. Distribution of testing results of the basic group of respondents by levels of motivation and training years

The small range of arithmetic means of the test results represented in Table 1b, meant that we were unable to make unambiguous conclusions. Therefore, focused on the distribution of results for the high, average and low levels (Fig. 3). There show that the average level of motivation reduces from the first (0.775) to third (0.563) years of study.

We explain the rise in the fourth year (0.675) as the increased responsibility of students to graduation work, and a significant “dropout” of students unmotivated to study (40 people left). We also note the fact that, from the point of view of the theory of quality management, close values to the left and to the right of the central one indicate, that the investigated phenomenon is “streamlined” and it approaches the normal distribution law. Further, in the most typical range of test results (in average), first-year students (77.5%) have the highest results, therefore, we cannot say that the educational process noticeably changes students' motivation.

Table 2 shows number and percentage of matches with the key for each of the test questions for undergraduates and teachers as the most different categories with respect to test results.

Table 2: Comparison of test results.

Test's question number	Teachers	Undergraduate students	Difference (in %)
1	7 (70%)	16 (59%)	11
2	6 (60%)	3 (11%)	49
3	6 (60%)	12 (44%)	16
4	9 (90%)	22 (81%)	9
5	5 (50%)	8 (30%)	20
6	10 (100%)	19 (70%)	30
7	3(30%)	15 (56%)	-26
8	9 (90%)	23 (85%)	5
9	8 (80%)	22 (81%)	-1
10	8 (80%)	16 (59%)	21
11	8 (80%)	25 (93%)	-13
12	5 (50%)	16 (59%)	-9
13	9 (90%)	22 (81%)	9
14	5 (50%)	12 (44%)	6
15	3 (30%)	11 (41%)	-11
16	7 (70%)	17 (63%)	-7
17	3 (30%)	5 (19%)	11
18	7(70%)	27 (100%)	-30
19	8 (80%)	7 (26%)	54
20	6 (60%)	17 (63%)	-3
21	6 (60%)	3 (11%)	49
22	6 (60%)	8 (30%)	30

We examined more closely the test questions 2, 6, 7, 10, 18, 19, 21, 22 for which surveyed categories of respondents show the greatest differences.

- Question 2 showed a higher level of achievement motivation for teachers (60%) than for undergraduate students (11%). The reason may be that the teachers have a job that they value, but students do not have this yet.

- For question 6 we explain the 30% difference by the fact that students' life and professional experience are too limited as yet.

- In case of question 7 the best result (-26 points) was achieved by the students. Youth and its attitude to life turned out to be more significant than the restrictions and stereotypes formed by years of working life.

- In case of question 10, the older respondents, have more obvious discipline and diligence.

- In case of question 18 we draw attention to the noticeable tendency among students to match the test's key (-30 points). This means that for young people the emotional factor is more important. It follows that it is necessary that the learning process develops on the background of positive emotions: however, as a rule, teachers underestimate this factor.

- In case of question 19 the biggest difference is in favour of seniors (a difference of 54 points). This is apparently due to the lesser professional orientation of young respondents, and, as a result, the easy "switching" of students to information that is far from professional topics.

- In case of question 21 older subjects have a significant advantage here (a difference of 49 points): younger subjects have more complaints and demands for life. It is possible that this is a natural age-related feature as a guarantee of development, but the test does not give evidence for this.

- In case of question 22 the advantage is again in favour of full and associate professors (30 points). They have more perseverance of which they are aware, and skills are considered just as a necessary condition for their professional activity. On the contrary, because of less experience the younger generation believe in their abilities, and do not give due importance to strong-willed qualities, in particular, perseverance.

From the answers to questions 2, 6, 19, 21 we conclude that: due to lesser life and professional experience, students cannot objectively compete with teachers in essence of these questions, i.e. passion for the profession (question 2), the presence of positive experience (question 6), and professional aspiration (question 19).

The conclusion to the answers on questions 10, 22 is the following: the educational process should more intensively develop such personal qualities as industriousness, perseverance, perseverance, will, etc.

From questions 7, 18 we conclude that, to increase students' motivation, more attention should be paid to the emotional factor.

The test for achievement motivation did not reveal differences between the first and the fourth years students. This is an unexpected and revealing result. Thus, the educational process of bachelors training does not instil students with the need for achievements, manifested in the desire for success, perseverance, perseverance in resolving problem situations in the business (educational) sphere, and self-confidence.

Despite the differences of points of view shown in responses of students and teachers to the questionnaire, the survey results imply a certain relationship between the motivations for the success of students and their teachers. In order to teach university students with a high motivation for success in their professional activities, teachers, first of all, must have a no lesser degree of motivation for success than that of students.

The main principles to increase students' motivation, include the need to create conditions (1) for the subject to predict and anticipate learning outcome of the training; (2) for manifestation of self-dependence and creativity. The rationale for this is as follows.

Firstly, it is known from psychology, that the human activity is more effective, the more one strives to carry it out. Simultaneously efficiency depends on strength of these needs and the subjective perception of the possibility of meeting them. The last is carried out consciously and unconsciously by considering ideas about the means available to satisfy an urgent need. The comparison, creates motivating information. The greater forecast uncertainty about an event, the more information will be obtained when implementing this event. Consequently, the subjectively estimated probability of succeeding in a particular activity (for example, the chance of succeeding in an independent task) should not be too

low nor too high. If the forecast is 100% or vice versa, close to zero, then there will be no desire to carry out such activities.

Secondly, self-dependence is characterized by greater tension and less confidence in the results compared to repetitive activities. Consequently, if difficulties overcome the motives of interest, sense of duty and need, motivation for independent work and search activity can decrease. Therefore, we need a gradual transition from rote activity to self-organization based on the one's emotional-volitional sphere. On the other hand, this would develop a search for adaptation in which the vector and intensity are determined by the individual's cultural, intellectual and volitional potential, as well as by the degree of development of the need for self-esteem as a non-reflexive psychological mechanism of personal adaptation.

Thirdly, the basis of creativity – the ability to apply learned activities to different situations, the desire to find a solution and, even better, to find good solutions – lies in a non-reflexive mental activity. It works better for tasks perceived by the subject as the most important. Therefore, learning activities should be not only significant for the subject, but rather dominant. This means that at this stage students should perceive their current activity as the main one. It is argued (Coeckelbergh 2018) that, in order to obtain creative results, “techies”, in addition to logical thinking, need to develop their figurative-emotional sphere and be able to use it. Simultaneously, some of the initial knowledge and skills necessary for obtaining a creative solution should be brought to the level of skills, and this is done through imitative practical activities.

In the neurobiological field motivation to study is defined as a never-ending process of *Stimulus Appraisal*: the students' brain receives inputs from the external world and confronts them with needs, desires and previsions; on these bases input can be assessed positively or negatively, and consequently, it is sent from the working memory to the brain centres assigned to learning, or blocked until the relative memory trace definitively decays (Schumann's Acculturation model and the theory of emotional evaluation of input (Schumann 1999)). In this perspective, a highly motivated learner is neurobiologically more receptive to any kind of input. If then the learner is accurately prepared and calibrated by the teacher based on the learning path already completed (learning prerequisites) and the objectives set, a real “team game” can be established. In the same way, however, the teacher's efforts should be concentrated towards less motivated, or differently motivated, students: acting on the input, and making sure that, as far as possible, this meets their expectations, to stimulate motivation and facilitate learning.

As the degree of self-dependence and creativity increases, the difficulties in cognitive activity often go beyond the student's intellectual and personal resources. This implies that the motivation for such activity decreases. In this case it is important to ration support in resolving problem situations in the form of “friendly interface”, a correctly chosen combination of motives of responsibility and interest. Maintaining the difficulty of educational material at the optimal level for the learner is facilitated by the activity approach and attention to knowledge reliability (for the interrelation of rational and non-reflexive spheres). The dominant aspect of this activity is promoted by taking into account personal orientations, knowledge reliability, and the value of the individual.

The personal value of educational material is realized through individualization of the curricula, as well as the correlation of professional orientation of educational process and its humanitarization. Humanitarian knowledge not only forms spiritual values, but also motivates socially significant activities. Thanks to their methods humanities develop the emotional-volitional sphere, and the learner's ability to form a holistic perception of phenomena. A combination of verbal and figurative forms of information is necessary for

their development. To transform information into knowledge, verbal perception must be supplemented with non-verbal activity (Gorbunov and Evdokimova 2018).

In addition to *Education*, i.e. transforming information into knowledge, the educational process includes *Development* and *Upbringing*. Development is the expansion and enrichment of intellectual and general personal qualities, including search activity as an alternative to passive reception of knowledge. There is a transdisciplinary methodological approach (Fig. 4), which combines heterogeneous knowledge of content and methods, related to the ideas of integrity, dialecticity, integration of the laws of nature, society and mental activity. We believe that transdisciplinarity as holistic methodological approach could be applied not only to combine the content and methods of different disciplines, but also to integrate entire set of components of the educational process (Fig. 5).

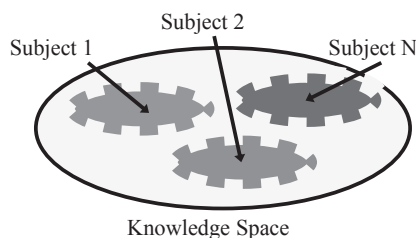


Fig. 4. Transdisciplinary approach in education, implying absence of rigid disciplinary boundaries.

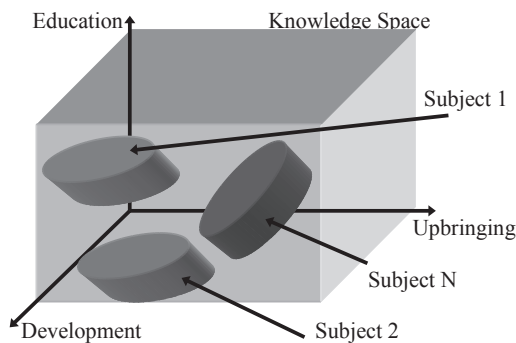


Fig. 5. Transdisciplinary approach in education, expanded integration with all forms of the educational process (*Education, Development, Upbringing*)

Considering the triad “*Education, Development, Upbringing*” we propose to raise the idea of transdisciplinarity to the level of transdisciplinary integration of contents and methods of humanities (philological and psychological-pedagogical disciplines) and technical disciplines and, most importantly, in combination with other components of educational activity, for instance, their behavioural aspects. In other words, transdisciplinarity involves the integration of professional and general cultural education, intellectual qualities and emotional-volitional sphere.

Transdisciplinary integration of the components of the cognitive process is aimed at increasing student's motivation and implies increasing attention to conditions and means of educational process: independent work and research activity, individualization of training programs, professional orientation of the studied educational material, ensuring the dominant value of activity, predicting the results of work, the relationship of logical and figurative thinking, the combination of self-organization with external control (by

the teacher and technological instruments). This also implies the humanization of the educational process. The methods used in the humanities to recreate a holistic picture of different connected phenomena contribute to the development of systemic and figurative thinking, the emotional sphere and creative activity. Our experience shows that consistently taught, Language and Literature, Psychology and Pedagogy actively influence on the development of global abilities and professional thinking, contribute to improvement of intellectual and personal qualities related to academic and then professional activities, communication skills, and the ability to express one's thoughts.

Currently, the teachers' role is shifting towards organizing and providing pedagogical support in the educational process, primarily in the performance of students educational and research work. The last contributes to development of will, perseverance, curiosity, and overcoming a "superficial" attitude to the discipline. The teacher's activity implies increased focus on individualization and professional orientation of training programs, as well as the dominant role of practical activity. This is directed towards the development of the students' need for achievements, their understanding of education as a necessary condition for their success in the professional sphere, increasing their motivation through the consideration of personal and intellectual qualities relevant to the educational process (emotional-volitional sphere, activity, communication skills, erudition, heuristic techniques). Such tutorship should be aimed at diagnosing of causes of difficulties and their elimination, i.e. the support in searching and cognitive activity in the "zone of proximal development". In terms of the external conditions of organization and forms of the educational process, one of the pedagogical means for educating and increasing the student's motivation is the pre-established rules and their careful observance. As they deal with the prestige of the individual, they create the conditions for students to perform the necessary activities. From the point of view of learning theories, this is timely (rather than delayed) "reinforcement".

The individual's awareness of their own responsibility for the outcomes of educational activities develops their self-esteem, self-respect and search activity. In addition, the student's motivation relies significantly on the use of computers, not only as a source of educational information, but also as a means of controlling the cognitive process. Simultaneously, an interactive mode of operation and the practical aspects of this activity contribute to ensuring proper control and accounting and the emergence of independence and creativity.

Conclusion

Transdisciplinary integration of the educational process components increases students study motivation. Simultaneously, the motivation for avoiding failures is replaced by achievement motivation due to the content interrelation of disciplines, the inter-penetration of heterogeneous methods of knowledge, and the improvement of IT-based forms of education. Professional and general cultural training are combined, the intellectual qualities and the emotional-volitional sphere of the personality are developed. Through the mutual enrichment of technical and humanitarian disciplines, both logical and imaginative thinking are used, while heuristic activity skills are improved.

Regarding the forms of educational process organization, we remember the role and worth of the rating system of control, to help predict the results of education. This is a key point. The established rules and their careful observance develop students' self-esteem, self-respect, searching activity skills. Affecting the individual prestige, they confront the learner's need to perform certain necessary activities. Motivation for particular activity depends on the student's interest in it (the strength of needs) and the projected possibility of successfully performing this activity, while the forecast is obtained by comparing (often

unconsciously) one's idea of the means necessary for this with the resources available. Grades must be given for real results. The rating system allows to “digitalize” the education results and take them into account when individualizing education.

Transdisciplinary integration of educational process components contributes to more effective acquisition of different disciplines content, as well as the development of heuristic abilities and emotional-volitional sphere. Cross-competences, that are common for group of disciplines, are developed, as well as skills in integrating formal and informal actions, analysing multifaceted information and joint activities. This allows learners to abandon insignificant activities in favour of more difficult but socially significant goals related to the acquisition of their future profession.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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