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Integration of Students' Soft and Hard Skills in Automotive Vocational and Technical Schools

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Abstract

The article presents the author's integrated course, which is directly aimed at the parallel development of students' soft- and hard-skills who master the profession in the automotive industry. Hard skills formation requires the acquisition of professional knowledge and implementation of instructions that can be tested through the exam. In contract, soft skills include general, supra-professional skills (social, intellectual and volitional competencies, sociability, teamwork skills, leadership skills, creativity, punctuality , emotion management skills, etc.). In the coming years, significant changes are forecast in the automotive industry, in the design of heat engines, aimed not only at their improvement in particular, but also at the use of fundamentally new designs and types of engines. Under such conditions, a significant number of specialists will be forced to retrain, in the process of which fundamental training, the formation of soft skills in particular, should be a significant help. It is covered a long time to quantify the effectiveness of the integrated special course, and three leading soft skills (critical thinking, creativity and cognitive flexibility) are identified. It is concluded that the integration of soft and hard skills is an effective means of developing knowledge, skills and thinking, which contributes to improving the professionalism of professionals. The study of the proposed author's course gives positive changes in the professional competence of future automotive professionals.

Keywords: *soft-skills, hard-skills, integration, integrated course, students, vocational school, automotive industry, critical thinking, creativity, cognitive flexibility*

Introduction

Employers of the future will evaluate job applicants mainly not based on academic knowledge, but super-professional skills. Therefore, it is necessary to constantly learn and develop to ensure decent employment in the future. Due to the complexity of the professions of the future, students need a variety of knowledge, skills and combinations, especially soft-skills (communication, leadership, team, creativity, etc.) and hard-skills (professional knowledge and skills) to form hard skills needed to master professional knowledge and follow instructions that can be tested through an exam.

However, now employers of different spheres in the professional field mostly pay attention to soft skills as a set of non-specialised, super-professional skills, which, compared to specialised, do not apply to a specific field of professional activity (Jobs of Tomorrow, 2020). They are sometimes called personal qualities because they depend on human nature and come with personal experience. Soft skills include: social, intellectual and strong-willed competencies, sociability, teamwork skills, leadership skills, creativity, punctuality, emotion management skills etc.

The 21st-century skills are paramount, among which the Jobs of Tomorrow Forum singled out ten top 10 skills: comprehensive problem solving; critical thinking; creativity (implementation of fresh ideas); ability to manage others and interact with them; customer orientation; formation of own opinion and decision-making; negotiation (team management); emotional intelligence (understanding the intentions and motivations of people, directing them in the right direction); flexibility of mind. Teachers have not acquired the appropriate soft skills while studying at universities yet. Because soft skills are an important prerequisite for personality development, „teachers should use an integrated soft skills training module when teaching." (Soft Skills of Excellent Teachers in Diverse South African Schools in the Western Cape).

It is evident that in the next 20-30 years in the automotive industry, particularly in the design of heat engines, there will be significant changes aimed at their improvement and the use of fundamentally new designs and types of engines. Many specialists will be forced to retrain in such conditions, where fundamental general education, particularly the formation of some skills, should be a significant help.

Literature for the Introduction

The literature covers the problems of Soft skills in the context of the fourth industrial revolution (M.Chung, J.Kim, U.Dombrowski, T. Wagner, P.Fisk) and its effects on education (E. Furtak, T.Seidel, H. Iverson, D.Briggs, C.Mougenot, S.Uçar) and others. It is stated that 'Basic skills' are not the same as "key competencies". Most experts usually talk about 'basic' skills when referring to the sub-group of generic or key competencies that are instrumentally essential in a given culture for every person and job, and particularly as we use 'basic' skills to communicate with one another and continue learning. Classic examples of basic skills are: carrying out arithmetical calculations (adding, subtracting, multiplying and dividing), and reading and writing in one's mother tongue.

A detailed description of soft skills is made in the work „The Soft Skills of Special Education Teachers: Evidence from the Literature by Patrícia Raquel da Silva Fernandes, Jacinto Jardim and Maria Celeste de Sousa Lopes, which we refer to for those readers who are interested in a detailed review of the genesis of the problem.

At the same time, the problem of finding effective means of forming and developing skills of the XXI century remains little studied, so we consider it appropriate to present a special course developed by us, which is directly aimed at the development of soft skills.

Soft skills are determined as:

1) communication skills, 2) thinking skills and problem-solving skills, 3) strength of teamwork, 4) lifelong learning and information management, 5) innovative development, 6) ethics and professionalism and 7) leadership skills (Smagina, 2017).

Integrating of technology into learning will be a key focus for teachers who need to master the relevant professional skills to organise a learning according to the students' needs (Furtak, 2012).

At the same time, the problem of finding effective means of forming and developing skills of the XXI century remains little studied, so we consider it appropriate to present a special course developed by us, which is directly aimed at the development of soft skills.

The object of research – is an attempt to solve the problem of forming soft skills in a vocational school on the example of the study of thermal power

The research aims to develop professional integrated courses to develop effective 21st century skills. The expected result is the acquisition of basic knowledge of the course on thermal energy and a group of students' soft skills from studying the course.

The research objective – is to analyse students' level of knowledge and skills before and after reading the integrated professional course on thermal power.

Methods

To develop soft skills, special methods are used. They are finding and mastering effective patterns of behaviour in the process of performing tasks; choosing certain skills for c urrent development; assessing a personal level of mastery of a particular skill; fixing a maximum of two or three skills and a clear understanding of the desired result; choosing at least two or three development tools for each skill; a mandatory combination of skills development methods; considering feedback and introducing new tasks; careful consideration of appropriate developmental actions, or replacement with equivalent ones in case it is impossible to perform them. If the skill is entirely new, it is necessary to find its specific essence in as much detail as possible (using books, trainings, master classes, articles, and blogs). Therefore, other methods of its development can be used.

Research Methodology

Due to the complexity of the professions of the future, they require a variety of knowledge, skills, and combinations of different activities. Therefore, educational models for schoolchildren should be comprehensive.

Several data groups are identified to quantify the effectiveness of the study of the integrated special course. The first group tests the awareness of students' knowledge and its relationship with the level of systematisation and integration in the content of educational material. These data cover a long time and make it possible to simultaneously check the soundness of knowledge, memory of the main elements of the content of educational material, the degree of their forgetting over time, and so on. The five main stages of learning the material in the growing role of integrative-systemic connections are ranked as follows:

I. Assimilation by students of knowledge in physics and special technology during the isolated test of knowledge in these subjects – (general knowledge) 10.

II. Systematising knowledge on the basics of heat energy as a basis for the forming knowledge about the physical foundations of heat energy – (professional knowledge) 20.

III. Integration of students' knowledge of physics and heat energy as a basis for mastering professional knowledge – (integrative knowledge) 50.

IV. Systematically integrated knowledge in standard situations + professional skills – (integrated knowledge and skills) 70.

V. Systematically integrated knowledge in non-standard situations of different levels + professional skills + soft skills (in lessons of industrial training, during industrial practice) – integrated knowledge and soft skills 100.

The formation of soft skills in students involves the qualities presented in Table 1.

Table1. Leading Soft Skills of Students

critical thinking	understanding the logical connections between ideas, building and analysing arguments; detection of discrepancies and omissions in reasoning; systematical problem solving; argumentation of own views; summarising information and formulating conclusions
creativity	readiness and ability to create products of activity or thinking; courage in the face of new experiences, optimisation of the ratio of innovative and traditional views, willingness to absorb new ideas; dynamism and flexibility of thinking
cognitive flexibility	rapid transition from one thought to another, simultaneous consideration of a specific object or complex problem in different aspects, adaptation of thinking when changing the purpose of activities or the emergence of new circumstances, and understanding of possible options and alternatives

The Basis of the Empirical Research and its Sample

The survey is conducted with students of the speciality "Vocational Education (car mechanics)" in Interregional Vocational School of Road Transport and Construction and speciality "Car driver" in State Educational Institution «Higher Vocational School» № 8 in Stryi. The experimental group is taught using the integrative approach. Following the results of written tests and work experience, the students are assessed with the use of the following categories: comprehensive knowledge (10), professional knowledges (20), integrative knowledge (50), integrative knowledge and skills (70), integrative knowledge and professional and soft skills (100).

Results

The author's course which is checked is developed: the short characteristic

During the development of the integrative special course «Thermodynamics with the basics of heat energy» it is expedient to include a comparative analysis of different types of heat engines. The generalised scheme of the object description is of a physical and technical nature and makes it possible to describe a specific heat engine based on general physical principles. The acquired new knowledge is now located in the designated place of the knowledge system, which promotes the development, interaction and creative use of knowledge in professional activities.

Such features of the vocational school as the presence of the general and vocational cycle of subjects, with the integrative-system approach proposed by the authors do not overload students with actual educational material, but strengthen general technical and applied components of physical knowledge.

Studying the integrated special course «Thermodynamics with the basics of heat energy» provides the reconstruction of the content of eiducational material in physics and heat energy. It consists of the gradual systematisation and integration of physical and technical knowledge, making it possible to form a system of students' knowledge of the physical foundations of thermal energy within the current physics course by building a special integrative course based on thermodynamics.

This approach allows to overcome the fragmentation of knowledge, and enhances prognostic, motivational, and personal aspects of learning and special knowledge. At the same time there is a concretisation of physical processes in the study of applied aspects of the educational topic, and learned deep, essential in technological processes and the operation of technical devices.

The main criterion of interaction is the correlation of elements of the content of educational material. Its value is considered zero for completely incompatible concepts that do not intersect in content or methods (for example, wave diffraction and the structure of the internal combustion engine). The maximum correlation value (conventional unit) denotes identical concepts. It applies to the same object, studied in lessons on different subjects (for example, a heat engine). Intermediate values of correlation (from zero to one) relate to compatible concepts (for example, heat engine and diesel engine).

The analysis of theory and practice makes it possible to formulate the main provisions that forms the basis for the developing an integrated course «Physics with the Basics of Thermal Power» in the current physics course for students of vocational schools. In addition to the formation of basic general knowledge and

professional skills, integrated content allows the teacher to form students' soft skills that are extremely important for the profession of motorists in the context of the emergence and rapid spread of fundamentally new types of engines, including electric.

The Results of Experimental Verification

The summary of the research and experimental work results shows the advantages of learning in targeted programmes, which involve integrating students' knowledge about the basis of thermodynamics and heat energy.

The total number of students involved in the experiment is 34 (two groups of 17 students each) and 36 (two groups of 18 students each)in the mentioned schools.

Comparing results in control and experimental groups leads to the conclusion that the experimental groups observed qualitative changes in students' knowledge.

Let us show the confirmation of these findings in specific examples of introduction and testing of the effectiveness of forming students' knowledge about heat engines in the form of an integrated course «Physics with the Basics of Heat Energy». Training in the control group occurred according to traditional methods, and in the experimental group according to the integrated course.

A comprehensive test is conducted at the beginning of the formative experiment to identify the changes in success, which is one of the important indicators of students' readiness for future professional activities. At the stage of diploma design a complex control work is also carried out. Qualitative analysis showed that knowledge acquisition in the control and experimental groups was almost the same at the beginning of the formative experiment.

With the help of a questionnaire, students are interviewed about their attitude to the study of physics, heat and special disciplines in the automotive profile and training in the workplace (in car service).

As shown in Fig. 1, students overestimate the importance of studying disciplines. A survey was conducted at the beginning and end of the study to identify these changes.

At the beginning of the experiment, the greatest importance for students is the production practice, which provides an opportunity to increase the specialist's productivity. However, in the end their importance decreases significantly, as it becomes clear that there is a lack of search skills. The least important discipline is the basics of physics. However, in the end the students' views change. As it turns out, the knowledge of the basics of physics helps develop a quality project the most. The importance of heat energy has increased (by 5%), but special (by 5%) has fallen slightly.

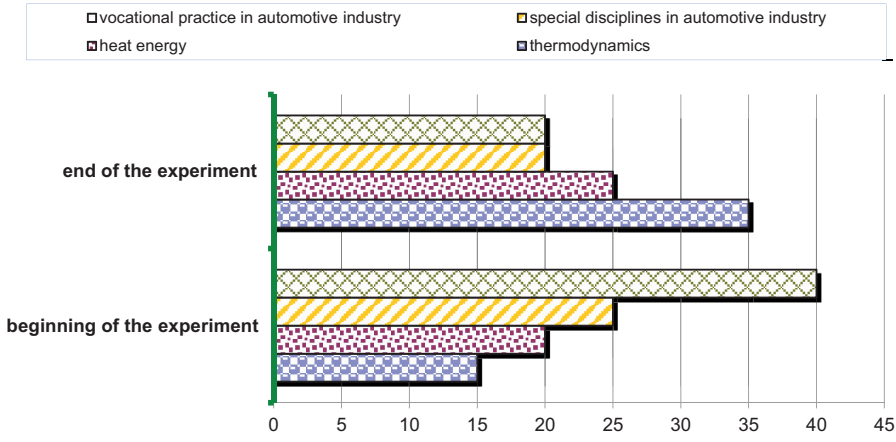

Figure 1. Dynamics of Significance of Educational Disciplines According to the Results of Questionnaires of Students at Different Stages of the Experiment

Interviews were conducted with graduates of previous years to confirm the reliability of the results obtained in relation to the significance of our chosen disciplines. The analysis of their answers shows that the conditions of competition in the market place high demands on the professional competence of specialists. It is an objective factor that needs to be taken very seriously. Accordingly, all gaps in training become an obstacle to the realisation of man as a specialist. In addition, the subjective factor that the student can influence while learning (his attitude to learning, diligence, discipline, etc.) also plays an important role.

The student's creative development is the basis for his professional achievements in future activities. There is a starting threshold for the development of intelligence for each profession, above which the individual limits of creative development already play a role. It is easier for those students who have higher rates. Although, the insufficient level of creativity can be increased due to high efficiency.

Graduates emphasised the importance of soft skills, as they significantly help develop new types of engines and cars in general.

The criterion of formation of abilities and skills is qualitative and defined through levels. The criteria for the forming skills include the composition and quality of operations performed, awareness, completeness and convolution.

Success is an integral indicator that combines the amount of knowledge, the formation of skills, system, stability and generalisation. The amount of knowledge refers to quantitative criteria and is determined by the number of correctly

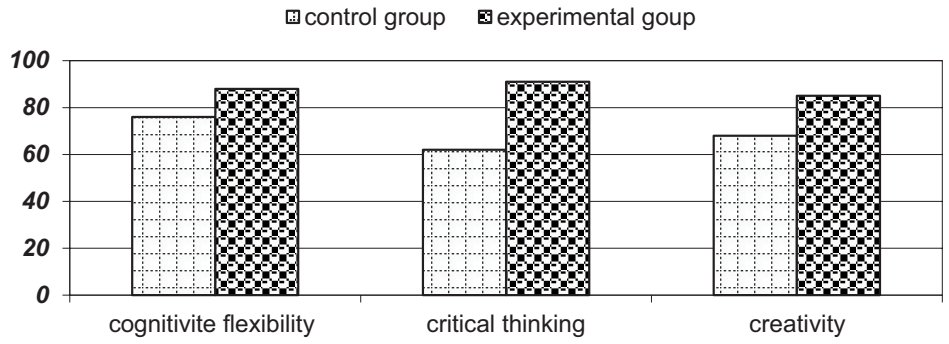

Figure 2. Comparison of Indicators of Mastering Soft Skills in Control and Experimental Groups

performed tasks in the test. We distinguish the following main skills levels: low, medium and high.

At the end of the experiment, as shown in Figure 3, the level of success in the experimental group increased, which is evidence of the effective impact of studying the integrated course «Physics with the Basics of Heat» on the growth of professional competence of students.

In general, in the experimental group, the number of students at the low level at the end of the experiment decreases by 31% vs. 19% in the control, at the middle level – increases by 24% vs. 17% in the control, at the high level – increases by 7% vs. 2% in the control group.

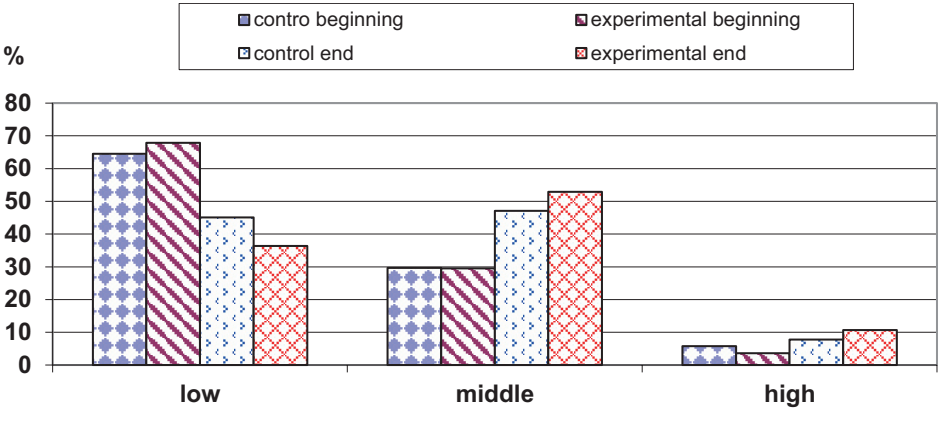

Figure 3. Diagram of the Success of Students in the Control and Experimental Groups at the Beginning and End of the Experiment

Similar results are obtained during the diploma design of students and their practice in car repair shops, repair shops, etc.

Conclusion and Discussion

Thus, the study of physical and technical objects in the form of integrated courses can be used in vocational education institutions. Attention should be focused not only on the formation of purely professional knowledge and skills that age rapidly; but also on the development of soft skills.

Constant improvement and installation for the use of fundamentally new designs and types of engines lead to a significant number of road transport workers being forced to periodically retrain. The integration of knowledge in physics and heat in education helps improve professional knowledge and skills, and serves as a basis for developing students' soft skills. In such conditions, the development of soft skills and their integration with professional skills effectively improves professional competence.

The study of our course allows within the chosen topic in physics (thermodynamics, heat engines) and specialities (heat, heat engines).

The discussion includes the choice of specific soft skills among the top 10 skills (according to other classifications, there are up to 20). It depends on the future profession, but we have chosen critical thinking, creativity and cognitive flexibility as the most important, although the selection of skills may differ in number and skills, depending on the circumstances and requirements.

Thus, in the course of research and experimental work the expediency of forming soft skills knowledge of students about the physical foundations of heat energy based on an integrative approach is proved. It is shown that the study of the basics of physical and technical knowledge about heat engines helps increase the level of general and general technical knowledge of students, elements of professionally significant knowledge and delivers a reliable basis for mastering professional disciplines. The integration combines superprofessional skills, which guarantees of successful future professional activity.

Further research aims to explore the opportunities and roles of other soft skills groups for students of vocational education institutions.

References

Chung, M., & Kim, J. (2016). The Internet Information and Technology Research Directions based on the Fourth Industrial Revolution. *Transactions on Internet and Information Systems, 10*(3).

Dombrowski, U., & Wagner, T. (2014). Mental strain as field of action in the 4th industrial revolution. *Education change in the industry 4.0: candidate science teacher perspective: Conf. On Manufacturing Sys. (Windsor)*. Elsevier. http://doi.org/10.1016/j.procir.2014.01.077

Fisk, P. (2017). *Pedagogical model to train specialists for Industry 4.0 at University. Education 4.0 ... the future of learning will be dramatically different, in school and throughout life*. https://www.thegeniusworks.com/2017/01/future-education-young-everyone-taught-together/

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and Quasi-Experimental Studies of Inquiry-Based Science Teaching. *A Meta-Analysis Educational Research, 82*. https://doi.org/10.3102 /0034654312457206

Jobs of Tomorrow 2020: Platform for Shaping the Future of the New Economy and Society. http://www3.weforum.org/docs/WEF.pdf

Kechagias, K. (2011). Teaching and Assessing Soft Skills. In P. R. da Silva Fernandes (Ed.), *The Soft Skills of Special Education Teachers: Evidence from the Literature* (p. 125). Jacinto Jardim and Maria Celeste de Sousa Lopes Educ. Sci.

Mougenot, C. J. (2016). Japanese higher education in a global context: to make students more innovative. *Engineering education, 64*(5), 64–44. http://doi.org/10.4307/jsee.64.5_39

Smagina, T. M. (2017). Shifting the emphasis from hard skills to soft skills in improving the professional competence of teachers in the system of postgraduate education. Development of professional competence of teachers in the system of postgraduate pedagogical education of the region: collection of conference materials. Zhytomyr. C-21.

Sheikh Abdullah, S. H. (2016). Malaysian Online. *Journal of Educational Technology, 4*, 68–76. https://www.mojet.net/frontend//articles/pdf/ v4i4/v04-i04-05pdf.pdf

Soft Skills of Excellent Teachers in Diverse South African Schools in the Western Cape. https://www.semanticscholar.org/paper/Soft-skills-of-excellent-teachers-in-diverse-South-Fleischmann

Uçar, S. (2015). The use of technology in teaching science to young children. In K. C. Trundle & M. Saçkes (Eds.), *Research in Early Childhood Science Education*. Springer. https://doi.org/10.1007/978-94-017-9505-0