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Influence of Knowledge Integration on Students' Professional Competence

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Abstract

Integration of educational processes is fundamental to the modern learning paradigm. It is based on the critical approach to vocational training and gives students an opportunity to prepare well for their future professional life. Ability to solve complex problems is key and knowledge integration is central to the successful development of an independent learner. Research shows that the mastery of a specialist is directly dependent on their ability to solve complex problems. This, in turn, is highly reliant on the ability to apply knowledge to solving interdisciplinary problems. The presented article shows that integrated knowledge is both more encompassing and succinct at the same time. It comprises specific educational problems, the solution of which aids the development of professional competence and optimizes the educational process.

Keywords: *integration, knowledge, professional competence, student, higher education institution*

Introduction

Recently, educational researchers have considered integration of information technology in education (Bandhana, 2012), universal models of integration processes in engineering education (Tuba Pinar Yildirim, 2010), integration processes in teacher training (Richard Keith Rogers, 2011), and simulation of integration processes in education (Jacinta A. Opara, 2011). They all emphasized the importance of the impact of the integration of content, forms, methods and learning tools on successful training of students. More recently, special attention has been paid to integration in the context of the development of professional competence of students (Jucevičiene P., 2017) and teachers (Stranovská E., 2017), as well as the role of integration in higher education (Navickienė V., 2017). According to this research, integration is defined by the ability to approach a problem from different angles, drawing on a variety of knowledge bases. It is based on scientific principles and is considered to be the key factor for preparing students for professional work.

For instance, an engineer will encounter a variety of practical issues, whilst students predominantly focus on theoretical aspects of science and acquire non-integrated knowledge in the process. In our opinion, the problem solving approach provides the best means of knowledge integration. Teaching of individual subjects with a strong focus on sciences forms the basis for the traditional approach. S. Goncharenko (2001) states that, according to the emerging concept of learning, the purpose of professional training is in the acquisition of a complete system of cross-sectional knowledge, which can be achieved through effective integration. Knowledge integration should form the basis for the development of professional competences, professional outlook and the system of moral and professional values of the future specialist.

The above-discussed aspects of the issue of integration of student knowledge are aimed at increasing the effectiveness of vocational training. At the same time, active introduction of knowledge integration eliminates duplication in the content of learning, saves time and prepares students for solving specific problems in the future.

The present research stressed the importance of the relationship between traditional and innovative approaches to embedding integration in education. Thus, the need for further research is acute as it aims to summarise empirical knowledge and ensure logical and seamless transitions from traditional to innovative forms of education.

Relevance of the issue

Many researchers agree on the importance of knowledge integration in vocational training as it is the knowledge itself that provides a solid foundation for the development of key competences. There is a growing body of research focusing on both theoretical and practical aspects of the issue: integrated education (M. Fan, 2004), obstacles to the integration in education (W. Pelgrum, 2001), predictors of technology integration in education (K. Rogers, J. Wallace, 2011), etc.

However, there is limited evidence of multidimensional analysis of the staged influence of knowledge and skills integration on students' competence. It would also be of importance to consider vocational competences expressed through such specific aspects as efficiency, diligence, speed of assimilation, purpose, etc.

The object of the research – aspects of integration of knowledge and skills as means of improving levels of students' professional competence. *The aim of the research* – to establish the relationship between the quality of acquired knowledge, skills and professional competences and the level of knowledge integration following the proposed methodology. *The objective of the research* – to compare qualitative and quantitative aspects of knowledge and skills integration following traditional and proposed methodology with the influence this integration may have on students' skills and professional competences.

Research Methodology

The main focus was placed on the implementation of new methodology that has the reinforcement of knowledge and skills integration as its aim. With this in mind, a completely new methodology was developed. This methodology builds on the problem solving approach, but also takes into account professional aspirations and objectives. Multiple choice tests and written exam results were used to study effect of various factors that either raise or lower the level of students' skills and competences at each stage of their education. The ultimate goal of the research was to determine how knowledge integration influences change in education parameters. Since the relationship between parameters of integrated knowledge is non-linear, the scope of integrated knowledge is smaller than the scope of its components as a result of their interactions with each other. This gives a substantial advantage to the integrative approach especially as there is information overload in the modern learning content.

Methods

Data was collected with the use of a survey and analysis was carried out using descriptive statistics methods. The comparison between control and experimental groups was made using Student's criterion t-test independent by groups (quantitative data) and criterion Pearson test (nominal data) with the view of establishing the effectiveness of applying an integrative approach to the formation of students' professional competences.

The basis of the empirical research and its sample

The survey was conducted with students of the specialty "Vocational Education (Computer Technologies)" in Lviv Polytechnic National University and specialty "IT Education" in the Lublin University of Technology. The experimental group was taught using the integrative approach. Following the results of written tests and work experience, the students were assessed with the use of the following categories: professional knowledge (quantitative 100-point scale), professional skills (qualitative scale: low, medium, high) and professional competence (qualitative scale: absent, partially present, present). The group comprised 214 students.

Research Results

Results indicate that studying each of the subjects in isolation has a minimum effect on the motivation of students or the level of their competency. In most cases, the curricula and programs of higher technical institutions are reliant on building interdisciplinary links, which although effective in improving quality of the student's learning does not lead to the formation of a comprehensive and whole-encompassing system of knowledge. The most common are interdisciplinary relationships between elements of knowledge of different subjects and field-specific education.

Such reliance on intermittent interdisciplinary links does not lead to the formation of a comprehensive system of knowledge, as confirmed by a detailed analysis of lesson plans and lecturers' notes. The survey has shown that the majority does not fully understand the role the fundamental STEM subjects play in the formation of professional knowledge and skills.

Therefore, one of the main drawbacks of the contemporary systems is that they do not lead to the formation of a comprehensive system of knowledge and often admit a violation of the logic of the formation of professionally meaningful concepts. As a result, students often fail to apply their knowledge in specific situations rationally and creatively. Results of the quantitative analysis showed that putting the main focus on learning different subjects without proper assimilative links is unlikely to result in students' increased motivation and raised attainment.

One of the main advantages of utilising problem solving in the learning process is that it promotes the development of creativity in students. It increases motivation and stimulates independent learning.

The main idea of the proposed methodology lies in ensuring correct and effective implementation of the integrative approach as means of the realisation of the problem solving approach, which allows for identifying both positive and negative aspects of the approach to be able to use it as a starting point in the formations of professional competency of students.

This method involves replacing the delivery of theory with specific problems that need solving. This leads to the formation of all-encompassing rather than narrow skills. This in turn leads to the formation of grounding on which to build learning competences on a completely different level. At the same time, this approach leads to the formation of skills that will aid better employability and successful continued professional development of students. The proposed methodology was applied to producing schemes of work for the specialty "Vocational Education (Computer Technologies)" in Lviv Polytechnic National University and "IT Education" in the Lublin University of Technology. 214 students were involved in the experiment. The content of each scheme of work was adapted to reflect the proposed methodology, following a three-stage approach.

First Step – knowledge integration – involves integrated knowledge being incorporated into the learning process. Initially, this is done within the limits of one subject, thus ensuring intra-disciplinary assimilation of knowledge. This newly-acquired knowledge is further assimilated, but now within the inter-disciplinary remit.

This level of assimilation (or integration) of knowledge is the basic level, where the problem solving approach begins to be manifest itself. The proposed methodology also envisages a third level of assimilation of knowledge, this time between whole academic topics. The main objectives of the approach are:

- ensuring the continuity and unity of concepts from different disciplines used in solving a specific problem or task;
- for a block of classes or lectures, such integration allows you to change concepts and elements of content depending on a particular specialty or problem;
- the classical knowledge parameters (completeness, efficiency, thoroughness, systemisation and generalization) are used to check the efficiency of the integration of knowledge.

Below are the results of the analysis of these parameters together with the possible ways of their integration in the professional training of an engineer.

The completeness of knowledge was determined by the number of concepts applied by the student to the number of concepts that needed to be used.

The generalization of knowledge provided the ability to combine specific knowledge with the transition to higher levels of concepts.

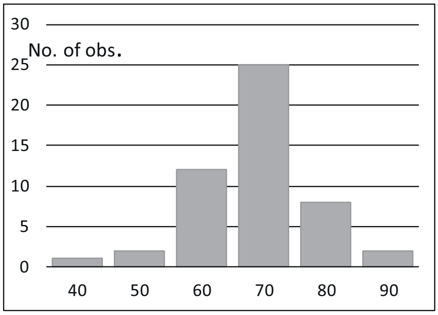
The systemising of knowledge provided the students' ability to generalize and systematize knowledge. The number of students was fixed, from the students of control and experimental groups, who have mastered the appropriate level of systematic and general knowledge.

The depth of knowledge was determined by the student's ability to understand the relationship between knowledge to the number of existing links that need to be made at a given stage.

Completeness coefficients were calculated as a percentage ratio of the amount of knowledge at defined intervals to the knowledge obtained at the moment, which is arbitrarily chosen as zero.

It was found that in most cases, a higher rate of learning in the experimental groups is observed simultaneously with an increase in the coefficient of learning knowledge. In reality, the implementation of the integration of knowledge varied from the didactic approach through the partial integration of knowledge to the problem solving approach. The results showed certain regular differences in the mastery of the students' professional knowledge. The summarized results of the assessment of professional knowledge in the control (Group A) and experimental (Group B) groups as averaged index in the 100-point grading scale, are presented in Figure 1.

a) Professional knowledge – group A
Shapiro-Wilk W=0.975, p=0.36; K-S d=0.122, p>0.2



b) Professional knowledge – group B
Shapiro-Wilk W=0.922, p=0.98; K-S d=0.054, p>0.2

Figure 1. Histogram of the distribution of students' professional knowledge in the control and experimental groups (calculations were carried out using Statistica 10).

According to the performed tests (K-s test and W-test), the frequency distribution of professional knowledge in the control and experimental groups can be considered normal distribution. Mean values in the control (64.2±10.7) and experimental (74.6±9.1) groups differ by approximately 10 points.

To verify the validity of the differences obtained, the T-test independent by groups was used to calculate the critical value and the significance level. As a result of the calculation, the following values were obtained: t-value =-5.26; p = 0.00001. Thus, the hypothesis of a statistically significant difference in the control and experimental groups was proved.

The experimental results showed that the students did not always fit into the norm in the subject-based approach. The efficiency of knowledge was also lower than the norm. At the same time, the groups following the proposed methodology not only corresponded to the norms, but also showed a slight increase.

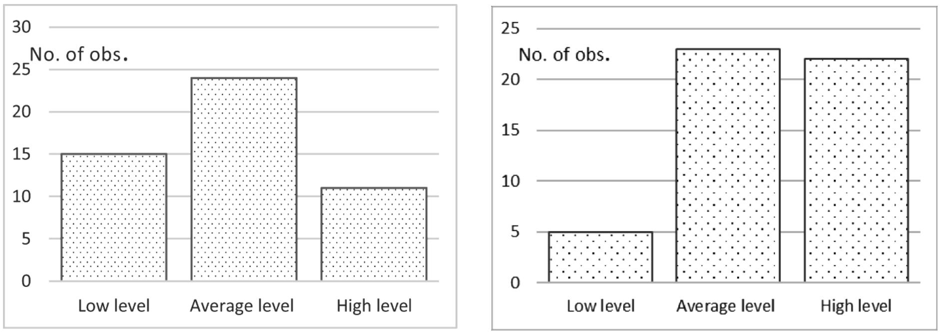
Second Step – integration of skills. The formed base of integrated knowledge allows for forming and consolidating appropriate skills. Proceeding from classical theory learning requirements and problematic approach, we highlight the leading skills as the basis for problem learning in the context of the integration of knowledge:

- to identify and formulate the problem;
- to highlight the essence of the problem;
- to find a new perspective of the problem;
- to find an original, non-standard approach to problem solving;
- to re-structure the elements and links of the studied system;
- to harmonize problem constraints and optimize overall solution.

In order to test the effectiveness of the integration of skills, one purpose of which is to combine different skills (intellectual and practical), automotive traits and creativity, pair parameters were used, which later will be included in professional skills.

The summarized results of the assessment of professional skills in the control (Group A) and the experimental (Group B) groups, as the average index in the ordinal scale (low, medium and high level), are presented in Figure 2.

To verify the authenticity of the results, the Chi-Square Test for Contingency Tables was used and the critical value and significance level were calculated. As a result of the calculation, we ed the following values: Pearson Chi-Square: 8.69; p=0.012. Thus, the hypothesis of a statistically significant difference in the control and experimental groups was proved. This suggests that the introduction of knowledge integration positively influences the formation of professional skills of students.



a) Professional skills – group A b) Professional skills – group B

Figure 2. Histogram of the distribution of students' professional skills by complexity levels in the control and experimental groups (calculations are carried out in the program Statistica 10).

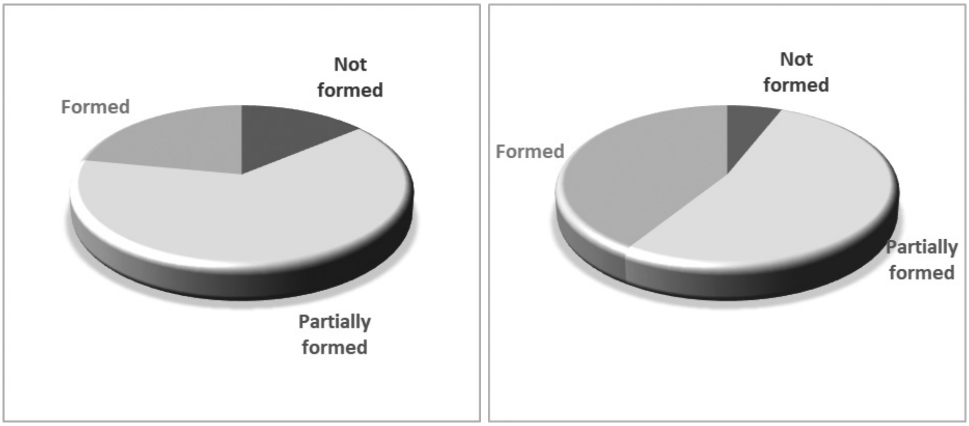
Third step – Integrated professional competence. The final stage of the methodology is the integration of knowledge and skills in the relevant professional competences. We emphasize the latest trends in the development of vocational education, which deepens the professional scope of knowledge and skills and provides the basis for further effective pedagogical activity. The competences obtained within the programme are divided into integrative competence, general competence and professional competence.

Table 1. Professional competence of the students of the specialty "Vocational education"

1	An ability to solve non-standard professional tasks, to think alternatively, to continue professional development
2	An ability to design a functioning pedagogical system, educational process with the use of pedagogical tools, and to create planning documentation
3	An ability to effectively combine information and pedagogical approaches in teaching practice; provide management (direction) of educational processes or labour and formation and development of personality
4	An ability to identify learning objectives of a session taking into account the main principles of vocational education, using educational and planning documentation
5	An ability to develop detailed lesson plans and schemes of learning
6	An ability to organize learning, realizing the basic functions of management in the conditions of the training group of the technical higher education institution

7	An ability to choose methods of vocational education within the meaning of training in theoretical and productive learning using existing forms of organization of learning in a technical higher education institution
8	An ability to apply optimal methods for controlling students' knowledge in terms of theoretical and productive learning, using the method of drawing up tasks to check different levels of assimilation
9	An ability to determine students' professional aptitudes using diagnostic techniques in terms of career guidance, using the methods of the selection of students for studying in vocational education institutions
10	An ability to have a perspective, to be organised and have strong work ethic

A group of experts (teachers and employers) evaluated each professional competence on the following scale: 10 points if competence was formed, 0 points if competence was not formed, from 1 to 9 points in the case of partial competence formation. Overall professional competence was divided into three categories: not formed (0–30 points), partly formed (31–79 points) and formed (80–100 points). Results of assessment of professional competence as a phenomenon (composite index) in the control group (Group A) and the experimental group (Group B) are presented in Figure 3.



a) Group A b) Group B

Figure 3. Pie chart of the students' professional competence by levels of formation in the control and experimental groups (calculations were carried out in the program Statistica 10).

The results of the distribution of the students' professional competence by levels of formation in the control and experimental groups are significantly different. Chi-Square Test for Contingency Tables was used to check the validity of the differences, critical value and significance level were calculated. As a result of the calculations, the following values were obtained: Pearson Chi-Square: 6.02; p=0.04. Thus, the hypothesis of a statistically significant difference in the control and experimental groups was proved. This suggests that the introduction of integrated approaches, a high level of learning and the formation of skills has a positive impact on the formation of professional competence of students of technical higher education institutions.

Discussion

There is a significant problem of improving the quality of professional skills of engineers by integrating their knowledge. It should be noted that the main motive for such integration are the requirements of professional training, which involves a system of integrated subject knowledge.

Students who have best mastered the integrative knowledge showed the highest performance. The analysis of the experimental results showed qualitative changes in all chosen parameters, which were influenced by the variables of the integration of knowledge. The scope of integrated knowledge was thus reduced as a result of qualitative transformation of different elements.

Qualitative parameters also improved, which was confirmed by quantitative analysis. The students from the experimental groups gave more comprehensive answers to questions, made effective interdisciplinary links, showed a deeper understanding of the core fundamental concepts and knew how to apply them in practical situations. The students showed the ability to compare the results of different approaches in considering a certain concept or phenomenon. Understanding the fundamental concepts enabled them to effectively apply knowledge in practice.

Analysis of the tests in core subjects showed an increase in the number of answered questions at a given time, as well as the students' stronger ability to find the optimal way of arriving at a solution. Observations of graduates who are studying further or working, confirmed that they achieved higher levels of mastery in core subjects.

Conclusions

Qualitative research showed that the integration of knowledge makes it more systematic and more comprehensive, which in turn has a positive effect on professional skills of an individual.

Experimental analysis showed that it is necessary to provide teachers with special training concerning implementation of the integrative approach. They should:

- understand the concept of the integrative approach in order to understand specific plans and schemes of work;
- be motivated to integrate knowledge at the methodological level;
- be psychologically prepared to ensure integration into the learning process.

It should also be noted that with increased costs of professional training (either to the state or to an individual), the problem of increasing the quality of acquired knowledge and skills is increasingly more relevant in the current financial climate. Further training and professional development in the workplace proves to be even more costly as well-qualified workers are scarce and there is a significant gap in the employment market.

In the future, such concepts as professional values should also be taken into consideration. This is vital for the formation of comprehensive integral competences for which the described integrated knowledge and skills will serve as a springboard.

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