Multilevel continuing professional teaching for vocational education specialists

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Abstract

This article presents a system of multilevel continuing professional teaching for vocational education specialists. The article investigates the basic principles of this process and determines the structure of training for vocational education specialists by analyzing state standards of preparation of graduates in the specialty "Professional education", educational programs, and curricula. The article also includes a comparative analysis of the preparation of graduates in the specializations "Digital technologies" and "Sphere of service (Tourist service)" to form their information culture.

Keywords

multilevel continuing professional teaching, vocational education specialists, digital technologies, sphere of service, information culture

1. Introduction

In the era of pervasive informatization, where computer technologies permeate all facets of human existence, from mundane tasks to intricate problem-solving endeavors, the ability to effectively interact with such systems has become paramount [1]. However, despite the ubiquity of computing devices and applications, the average level of digital literacy among the adult population remains inadequate to meet the burgeoning demands of both the production and service sectors.

The rapidly evolving landscape of the modern labor market, further accelerated by the transformative impact of the recent pandemic, has placed unprecedented emphasis on the

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need for individuals possessing not only specialized domain knowledge but also proficiency in information technology [2, 3, 4, 5]. In today's competitive environment, employers seek out individuals who can seamlessly integrate their professional expertise with technological prowess. Consequently, it is inconceivable for modern educational institutions to produce graduates who are not equipped with the necessary skills to utilize information technology effectively.

The inherent dynamism of computer technologies, characterized by rapid obsolescence and the emergence of novel paradigms, presents a unique challenge for educators. Every few years, the technological landscape undergoes a significant transformation, giving rise to new opportunities for high-speed data access, innovative applications boasting user-friendly interfaces, and unforeseen avenues for leveraging the power of computation [6]. As a result, higher education institutions often find themselves struggling to keep pace with the relentless march of technological progress, leading to a disparity between the skills imparted in the classroom and the demands of the real world [7].

In light of these pressing concerns, it is imperative for computer science educators to devise novel approaches to bridging the gap between the theoretical foundations of computing and the practical realities of its application. By embracing a pedagogy that is both agile and responsive to the ever-changing landscape of information technology, educators can empower their students to become lifelong learners who are capable of adapting to the demands of a rapidly evolving world.

2. Literature review

Note that the training of professionals capable of professional and production-technological activities is a priority area of development of higher education and requires special attention from the state and the proper use of information technology in the educational process has significantly affected the higher education system in general and professional in particular.

Thus, we believe that today it is not enough to form the ICT competence of specialists [8, 9], or "skills of the use of information and communication technologies" [10], or "the ability to search process and analyze information from different sources" [11]. This is not enough for a specialist who will work in the post-industrial information society and such a task cannot be solved by studying one or two computer science disciplines. We need to talk about something much more voluminous in the essence and content – the information culture.

Despite numerous studies of the concept of "information culture", most scientists analyze it from the standpoint of individual sciences, which limits the vision of this phenomenon in modern society. The first attempts to analyze the genesis of information culture, to identify its historical and social conditionality were made by Curry and Moore [12], Khan and Azmi [13], Labouitz and Tamm [14], Leonhardt [15], Lubar [16], Metz [17], Mordue [18], Oliver [19], Porter [20], Rubanov [21], Szecskö [22], Travica [23], Welsch [24], Widén-Wulff [25], Zambare [26]. The formation of information culture at various levels of education were studied by Abitova et al. [27], Almazova et al. [28], Babenko [29], Boamah and Salahshour [30], Ibashova et al. [31], Lauri et al. [32], Lepik and Kannukene [33], Mullins [34], Virkus and Salman [35].

The main components of information culture by Karagodov [36] include:

- information (computer) literacy;
- information competence;
- information value-content component;
- information reflection.

Information competence and information literacy were considered by Karagodov [36] to be key, because they provide a procedural component of human information activities, form a certain value attitude to knowledge, and are the basis for information culture.

According to Kyrychenko [37], "the information culture of the individual is formed in the process of socialization in its broadest sense. Basic competencies that are part of the structure of information culture of the individual are formed under the influence of a wide range of factors of the social environment, not limited to the training process and labor training conditions within specific professions, which until recently were associated with direct functional use of ICT".

Under the "information culture of the educator" Ramsky [38] perceives "an integral indicator of the level of his perfection in the information sphere of activity, which is manifested in the specifics of pedagogical activity and the system of professional qualities". In the information culture of the individual (as well as in the information culture of the educator), he identified the following interrelated components: information and intellectual potential, information worldview, information values, information needs, information and operational activities.

Klimenko [39] identified in the content of the concept of "information culture such important elements as the ability to use information technology, computer literacy; knowledge of information and information environment; ability to work with information; to build their information activities and behavior in a post-industrial society". However, it should be noted that there is a "contradiction in understanding the essence of information culture in pedagogical sciences, which is confirmed by representatives of this field of knowledge, who note that the formation of information culture of future specialists is often considered on the basis of a monodisciplinary approach in such areas: basics of library and bibliographic knowledge; reading culture, basics of rational work with the book; basics of informatics and scientific and technical information; computer technology and basics of computer literacy" [40]. Important components of the information culture of the tutor are: "information knowledge and skills of the user to use a personal computer, peripherals; mastering the skills of working with software, using application programs to search, process and transmit information; information knowledge and skills of the tutor, which include knowledge of sanitary conditions and modes of safe use of computers in the educational process; formation of professional skills in the development and implementation of teaching materials; mastering educational software; ability to education and self-education" [41]. Attempts to overcome such a narrow understanding can be found in theoretical works in the field of pedagogy: for example, Galeta [42] notes: "information culture today is still mainly an indicator not of general culture in its socio-technical aspect, but professional. The ability to work with information technology was often combined, at best, with knowledge of computer science, mathematics and English, scilicet those areas that provide practical human interaction with the technical means of obtaining and providing information. However, when looking at information culture more broadly, it should be noted that general methods of providing knowledge and skills should not be sought only within a computer situation. The real limits of

the application of information culture are much wider; the range of its content is much richer".

Analysis of approaches to the essence of information culture, formed in philosophy, culturology, economics and other fields of knowledge, allowed Belyakov et al. [43] to see that understanding of this phenomenon in different sciences has its differences due to the influence of system-forming categories of these sciences, and the tasks set by the researchers. Common to the above approaches is the understanding of information culture as a component of general culture in society, as well as the recognition of determinative links between the level of information culture and the development of a particular area of professional activity of the individual. Differences in the perception of the studied phenomenon concern the wide or narrow coverage of the features of information culture: from the skills of mastering certain information technologies (computer literacy) to mastering knowledge and skills in almost all areas of human activity. In the first case, we obtain a set of certain characteristics that can be formed by mechanical assimilation of algorithms, without awareness of their direction and value features. In the second case, there is a synthetic combination of categories inherent in different sciences, which greatly complicates the possibility of studying the features of information culture.

In our opinion, information culture is a complex formation of information worldview (system of human views on information), information literacy (system of skills to work with information) and literacy in the field of information and communication technologies (actually, ICT competence).

Levels of manifestation of information culture:

- target – a person's need to receive relevant, reliable information and interest in it;
- cognitive – knowledge and ability to apply them;
- value – evaluation of information, attitude to it, own judgments and interpretations;
- behavioral – a reaction to the received information.

Thus, information culture is a system of material and mental means of realizing the relationship between people, society and the information environment, which was formed in the process of informatization of society.

Information culture in higher education institutions is implemented as a system of multilevel information technology training of future professionals in vocational education, which is based on the principles of continuity, continuity and sufficiency of informatization of the educational process, integration of special and information disciplines, formation of professional information environment and single information space in institution of higher education [44]. Therefore, we can consider it the most important factor in successful professional activity and security of the graduate in the information society.

3. Results

The aim of the work was to analyze the training of future professionals in vocational education in higher education institutions in the context of studying the prospects of forming their information culture.

First of all, let's find out what specializations future specialists in vocational education can acquire and what qualifications to get. According to the order of the Ministry of Education and

Science of Ukraine N292 from 21.03.2016 "On approval of the List of specializations for higher education in specialty 015 Professional education (by specializations)", which is the formation and placement of the state order there were 22 specializations, but after implementation of the order of the Ministry of Education and Science of Ukraine N1223 from 23.09.2019 "On amendments to the order of the Ministry of Education and Science of Ukraine from 21.03.2016 N292" [45] there are only 9 left:

015.31 Construction and welding;
015.32 Electronics, metrology and radio telecommunications;
015.33 Power engineering, electrical engineering and electromechanics;
015.34 Mechanical engineering;
015.35 Mining, processing and transportation of minerals;
015.36 Technology of light industry products;
015.37 Agricultural production, processing of agricultural products and food technologies;
015.38 Transport;
015.39 Digital technologies.

Of course, higher education institutions in the conditions of autonomy have the right to train specialists in other educational programs, but public funding was provided only for these, which accordingly contributes to the professional orientation of entrants and ensuring competition for these specializations.

As for the analysis of the qualification that will be obtained by graduates of these specializations, we turn again to the standards of higher education at the first [10] and second [11] educational levels, we find only the educational qualification "Bachelor / Master of Vocational Education (by specialization)".

The objectives of training in the standard of training of bachelors are specified as training of specialists capable of carrying out educational activities on professional training of technical specialists, skilled workers and workers in trade and services (according to the Classifier of professions 003:2010 [46]) areas according to specialization. The objectives of training in the standard of master's training were defined as follows: training of specialists capable of solving complex problems and problems of specialization of vocational education in professional activities and / or in the learning process, which involves research and / or innovation and uncertainty of conditions and requirements. Also for masters the field of professional activity is more clearly defined, where the graduate of educational programs in the specialty can work according to the Classifier of professions 003:2010 [46] and the International Standard Classification of Occupations 2008 (ISCO-08) [47]: 23 Teachers; 235 Other training professionals; 2351 Professionals in the field of teaching methods; Professionals in the field of relevant specialization.

Given the above information, it becomes clear that a graduate of this specialty at the first (bachelor's) level must be ready to work in institutions of professional, vocational, professional higher and higher education in the following positions:

3340 Other specialists in the education: teacher-trainee; educator; dormitory educator; educator of vocational school; industrial training instructor; instructor of industrial training of workers of mass professions; laboratory assistant; master of industrial training; master of

the training ground; master of the training center; methodologist for vocational rehabilitation; tutor of professional training.

A graduate of this specialty at the second (master's) level must be ready to work in institutions of professional, vocational, higher professional education and higher education in the following positions:

- 2310 Tutors of universities and institutions of higher education: assistant, tutor of higher education;
- 2320 Tutors of general secondary education institutions: tutor of a vocational school, tutor of a vocational institution;
- 2350 Other professionals in the education: tutor (teaching methods), educator-methodologist, methodologist.

As for the engineering component of the educational program and the qualification itself, in terms of current trends in vocational education at all levels and the focus of educational programs on dual training, which provides for coordinated interaction of the educational and industrial spheres for the training of qualified personnel of a certain profile within in organizationally – different forms of training [48], it should be left for this specialty and integrated into the system of training a specialist who is able to work both directly in the workplace and in the educational institution in the relevant positions. After all, unlike the profession of "teacher", which provides for the teaching of fundamental sciences in the content of relevant school subjects at the academic level, "tutor of professional, vocational and technical higher education" must carry out the educational process taking into account the profile of specialties. The person who teach, should provide professionally oriented training of higher education students of such institutions, and therefore its training should be appropriate: both production and pedagogical.

Taking into account the basic principles of higher education development in Ukraine within the Bologna process, as well as the specifics of professional training, we offer a scheme of educational process based on fundamental and psychological-pedagogical training with a dynamic model of professional disciplines (figure 1).

Ensuring quality training of future specialists in vocational education involves the gradual implementation of this scheme. The whole process was divided into separate levels, at each of which the disciplines of certain cycles are studied, according to the principle that at the end of each level the applicant receives a certain amount of basic knowledge with their further expansion and deepening at the next stage.

In our opinion, the content of training of future professionals in vocational education should be based on the following principles:

- formation of information culture of the specialist, appropriate to the current level and prospects of information processes and systems, which is possible only with the integrated using of modern technologies in the educational process of higher education, as a set of three interrelated components – objects of study, tools for professional disciplines and practical training with the use of new educational technologies;
- basics of information technology (office programs: text and spreadsheet editors, programs for creating presentations; graphic editors; Internet technologies; database management

Figure 1: Structural scheme of training future specialists in vocational education.

systems), information systems architecture and system software; elements of programming and the Internet of Things should be studied by applicants for higher education in the form of professionally oriented courses, taking into account the profile of future professional activity;

- in the content of information training should be distinguished invariant part, which includes fundamental methodological knowledge studied in lectures, and a variable, dynamically changing part related to computer software and hardware, and studied in practical and laboratory classes;
- to increase the professional competence of the graduate in the field of information technology in the curriculum it is necessary to introduce disciplines focused on the professional orientation of future professionals in vocational education;
- for the implementation of individual educational trajectories in the curriculum should provide disciplines of the information cycle, taking into account the different levels of computer training of higher education, as well as the area of future professional interests;
- computer-oriented educational technologies used in the educational process should be rationally combined with traditional technologies of higher education and supported by modern technical means.

Thus, the training of future professionals in vocational education involves a combination of knowledge in the field of information technology with the ability of their methodological application in the pedagogical process. Consider the implementation of the developed structural

scheme of training a future specialist in vocational education (figure 1) on the example of subject specialization: “Digital Technology”, where information technology is both a means of learning and a subject of study from the standpoint of the profession.

A feature of the specialization “Digital Technology” is the rapid changes in the content of educational disciplines of professional and practical training, which is associated with the intensive development of computer technology and information technology. Since professional (engineering) training is important in the formation of future professionals in vocational education, we will focus in more detail on the disciplines that determine its professional orientation (figure 2).

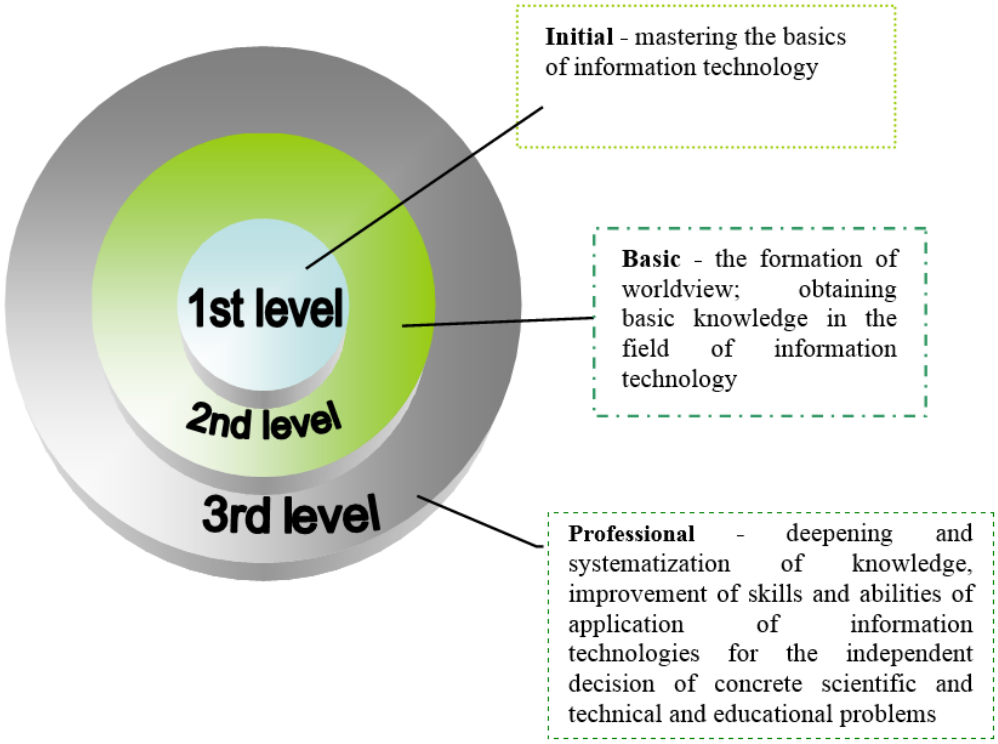

Figure 2: Comparative formation of professional training of future specialists in vocational education.

The first level of training of future professionals in vocational education is based on the study of disciplines of the fundamental cycle, where special emphasis is placed on “Introduction to Informatics – Information and Communication Technologies”, “Higher Mathematics”, “Computer Physics”, ”Software” and forms the basis for the transition to professional training starting from the first semester.

Knowledge of document automation and means of graphical presentation and data editing is required for presenting information using information technology. These tasks are solved in the course “Software”. The course considers the basics of computer data processing using Microsoft Office. In addition, fundamental knowledge of computer layout based on PageMaker and the ability to work with vector and raster graphics (Corel Draw, Photoshop) were formed here.

After completing the first level of training, a significant number of applicants for higher education (over 80%) use the possibilities of information technology in the process of self-study of disciplines of professional and practical training, in particular, in the process of individual research tasks, coursework and more. At the same time, the previously acquired skills of working with applied and tool products, information resources of the Internet find practical application.

The second level involves the study of disciplines: "Application and Web Programming", "Operating Systems and System Programming", "Computer Graphics", "Computer Systems Hardware", "Computer Aided Systems", "Software in Production", the purpose of which is to form professional competencies in understanding and using information technologies. "Application and web programming" involves mastering modern, object-oriented methods of working in Visual Studio, as the most common and universal package of programming environments. The main purpose of the discipline "Operating Systems and System Programming" is to acquire knowledge about modern operating systems Windows and Linux, the principles of their structure, operation and administration. These disciplines form in future professionals in vocational education the ability to design and operate the most common currently operating systems, using elements of programming. This allows integrating the study of computer science, eliminating elements of tautology in the presentation of the material, as well as using information technology to solve applied problems. In addition, knowledge of these subjects was consolidated when solving problems in the Mathcad system, as well as the WinMachine software package.

At the same time, the discipline "Methods of professional training" is studied at the second level. The purpose of the course is to deepen engineering, technical, psychological and pedagogical knowledge and skills and also their integration and provide opportunities for the formation of a holistic phenomenon – information culture, both from the standpoint of engineering and from the standpoint of pedagogical training.

Examples of dynamic integration are the disciplines that form the visual and design basis of engineering training, in particular: "Descriptive Geometry", "Engineering Graphics", "Computer Graphics". Having received at the first level an idea of the image of spatial objects on the plane, at the second level knowledge in the field of geometric, machine-building and construction drawings with the subsequent application of computer technologies (graphic editor Compass-Graph, AutoCAD, SolidWorks, etc.) is formed.

At the third – professional level – training of future specialists in vocational education is differentiated. Depending on the specialization, the profile disciplines were taught, which deepen and systematize the knowledge obtained at the first two levels in relation to the chosen direction of professional activity.

At this level, the formation of skills for independent solution of scientific, technical and educational problems becomes important. That is why a course project was implemented here, which integrates the disciplines of fundamental and professional training and provides for the implementation of tasks that actually appear in the production or management field. Practical classes are held more in the form of discussions and trainings, which also contributes to the formation of a specialist who is able to make independent decisions, work in a team, formulate and convey the necessary knowledge to other individuals.

Given that information technology is rapidly updated and partially modified, at the final level the disciplines that are most dependent on such trends are studied, namely: "Information

security in computer networks", "Intelligent systems and technologies", "Web technologies and web design".

Disciplines of professional orientation are based on mastering the software which is universal from the point of view of studying of the planned educational material and, besides, allows to form design thinking. We are talking about the WinMachine, Matlab and Compass software packages, which are currently the most promising.

As for the processes of formation of information culture of future specialists in vocational education of other specializations, where computer science disciplines are much less, we want to analyze their content on the example of specialization "Service (Tourism)".

The first level of training of future specialists in vocational education specialization "Service (Tourism)" is implemented on the basis of studying the disciplines of the fundamental cycle, with special emphasis on "Introduction to Informatics – Information and Communication Technologies", "Mathematics for Tourism", "Physics", which generally resembles the first level of the previously analyzed specialization "Digital Technologies". After studying these disciplines, higher education students have formed a basis for the further formation of information culture and readiness to use computer technology in the study of other disciplines of professional and practical training.

The second level involves the study of the discipline "Methods of using computer technology in the study of professional disciplines". At the same time, the discipline "Methods of professional training" is studied at the second level, thanks to which it is also possible to form technical and psychological-pedagogical knowledge and skills in an integrated form and to provide preconditions for the formation of information culture.

At the third professional level the discipline "Information systems and technologies in tourism" is studied, the main purpose of which is to form and develop professional competencies in the use of information technology in professional activities. However, it should be noted that tutors of geographical and environmental disciplines regularly use information technology in their classes, which provides a dynamic development of information culture of future professionals in vocational education specialization "Service (Tourist Services)". That is, depending on the specialization, the profile disciplines are taught, which deepen and systematize the knowledge obtained at the first two levels in relation to the chosen direction of professional activity.

During the implementation in the educational process of the proposed method of forming the information culture of future professionals in vocational education to diagnose the level of formation of information culture of future professionals in vocational education in specializations "Digital Technologies" and "Tourist Services" was conducted testing information culture of students at the following levels:

1 – initial (D, E),
2 – basic (B, C),
3 – professional (A).

Lets consider the results of comparing of the two samples (for specializations "Digital Technologies" and "Tourist Services") regarding to the level of formation of their information culture.

The analysis of test results showed that the basic level of information culture of future professionals in vocational education in the specialty "Digital Technologies" only 5.9% higher

Table 1
The level of formation of information culture of future specialists in vocational education.

Groups	Level of academic achievement					
	initial		basic		professional	
	students	in %	students	in %	students	in %
"Tourist Services"	52	28.7	83	45.9	46	25.4
"Digital Technologies"	34	17.1	103	51.8	62	31.1

than the level of students specializing in "Tourist Services" and the professional level – by 5.7%. Figure 3 shows a summary of the results, which indicate that we have developed a method of forming the information culture of future professionals in vocational education in the specialties "Digital Technologies" and "Tourist Services" is within acceptable margin of error.

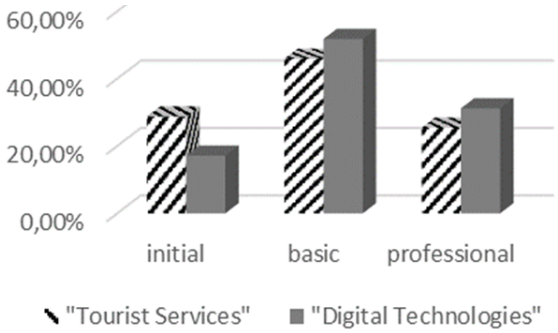

Figure 3: The level of formation of information culture of future professionals in vocational education.

Statistical significance of differences in the levels of student achievement and substantiation of hypotheses, which were put forward to determine the differences between the distributions of students in the control and experimental samples was carried out using the Pearson test (χ^2). The choice of this technique was due to the fact that the criterion χ^2 applies to samples with a large number of respondents and allows on the basis of comparing the values of the calculated χ^2_{exp} and tabular for critical values χ^2_{tab} to conclude a significant or insignificant difference in the distribution of respondents sign (the level of formation of their information culture). The technology of the method assumes that the greater the difference in the values of χ^2_{exp} and χ^2_{tab}, the more significant are the differences between the distributions in the samples. We compare these distributions statistically in order to identify differences in the levels of academic achievement of students in control and experimental groups and determine their statistical reliability.

For the initial and alternative hypotheses we take the following statements:

H_0: the difference in the achieved levels of formation of the information culture of the groups is insignificant and invisible at the level of significance of 0.05;

H_1: the level of formation of information culture of these groups in both cases differs and this difference is statistically significant with a probability of 0.95.

We calculate for each discipline Pearson's criterion χ^2_{exp}, using the formula

$$\chi^2 = \sum_{i=1}^{n} \frac{(x_i - y_i)^2}{y_i}$$

For $P = 0.95$ and $q = 2$ (q is the number of degrees of freedom; $q = n - 1$, where n is the number of evaluation levels – in our case $n = 3$) the critical value $\chi^2_{crit} = 5.99$ (according to the table of critical values).

It turned out that $\chi^2_{exp} = 0.07$ does not exceed the critical, which confirms the effectiveness of the proposed method of forming information culture specialists in vocational education of both samples of specialists in vocational education in the specializations "Digital Technologies" and "Tourist Services".

4. Conclusions

In conclusion, the multilevel system of information technology training in higher education constitutes a unified and integrated complex whose primary objective is the seamless integration of IT into all stages of the academic journey, from the undergraduate level to the pursuit of professional endeavors in vocational education.

The utilization of IT must be grounded in sound scientific principles and underpinned by a robust methodological framework that demonstrably fosters the cultivation of IT proficiency among future professionals in vocational education.

Throughout their learning journey, higher education students must acquire a coherent and comprehensive body of knowledge that transcends the confines of isolated courses. Instead, they must be exposed to integrated disciplines that encompass the various facets of professional training in vocational education.

By achieving these goals, the multilevel system of IT training can effectively prepare students for the challenges and opportunities of a world that is increasingly driven by technology. Graduates who possess a deep understanding of IT and the ability to apply it effectively in their chosen field will be well-positioned to make significant contributions to society.

In addition to the aforementioned conclusions, it is worth noting that the multilevel system of IT training has the potential to foster a number of desirable outcomes, such as:

- Enhanced student engagement and motivation
- Improved learning outcomes
- Increased student confidence in their ability to use IT
- Greater preparedness for the demands of the modern workplace
- Enhanced lifelong learning skills

As the world continues to evolve at an unprecedented pace, the importance of IT literacy will only increase. The multilevel system of IT training is a promising approach to ensuring that future generations of professionals are equipped with the skills and knowledge they need to thrive in a technologically driven world.

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