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**METHODOLOGICAL APPROACH
FOR IMPLEMENTATION OF COMPETENCY-BASED TRAINING
IN THE PROFESSION "APPLIED PROGRAMMER"**

ABSTRACT

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The Ph D thesis consists of 168 pages, of which 138 in the main part containing: Introduction, 3 chapters, 16 pages of references and 3 appendices in total of 14 pages. References include 184 articles and book titles and 47 Internet sources. Cited articles and books are 77 in Cyrillic and 107 in Latin. Internet sources are 21 in Cyrillic and 26 in Latin.

The list of author publications consists of 8 titles, 6 of which are in Web of Science. The publications were cited 11 times - 4 in foreign and 7 in Bulgarian articles.

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GENERAL CHARACTERISTICS OF THE THESIS

Relevance of the researched problem. A basic requirement for job applicants in the modern labor market is that they have developed their digital competencies at a high level, which are a kind of second literacy, as many researchers define it. With many times greater force, this applies to job candidates in the information and communication technology (ICT) sector, where the subject of activity is the creation of ICT products. It is expected that in the period 2020 - 2025, the software sector will create over 32,000 new jobs, and the share of the sector in the gross domestic product will increase from 3.8% to over 7% for the same period [50]. At the same time, interest in careers and profiles related to programming in secondary schools is growing.

Although there is experience in training specialists with secondary education in software development, it is rather an exception in a few schools and this good practice is not multiplied. It also needs to be updated in sync with the modern paradigm of the competency approach (CA), on which the State Educational Standard (SES) [52] for the new profession "Applied Programmer" (PAP) is based in our educational system. In the methodological literature, there are a number of studies on the application of CA in higher education in a number of specialties and professions, but there are no such studies in relation to secondary vocational education and training (VET). There is a need to develop and research methodological approaches for the application of competence-based training (CBT) in the field of vocational education and training.

The successful implementation of such training will lead to an increase in the quality of personnel training, which will satisfy the requirements of the IT sector. The CBT on PAP can be used as an example in a large part of training in professions related to Software Engineering (SE), Computer Science (CS) and the "Software and Hardware Sciences" profile. Last but not least, confidence in the education system that it is capable of preparing quality personnel for the industry will increase.

The purpose of the research is to develop and approve a methodological approach for competency-based training of students in the profession of "Applied Programmer", including a suitable toolkit for developing and diagnosing the professional competencies in software development included in the curriculum.

Tasks of the research:

1. To study and analyze the foreign and national experience in training in CS and SE, including the recommendations of the industry associations on a global and national scale for training in SE, in order to determine the specific competence framework on which to base the methodological approach for application of the CBT under PAP.

2. To develop an appropriate methodological approach to learning about PAP in order to improve learning outcomes, based on:

- a developed set of tasks for developing (and evaluating) the selected specific competencies in connection with the application of the developed methodological approach;
- a suitable form for collaborative blended learning with more than one learner with the possibility of distance collaboration in an electronic environment.

3. To develop a toolkit for diagnosis and assessment of the level of specific and key competences acquired by students (tests, practical tasks, assessment cards and self-assessment of students) and to conduct a diagnostic procedure to establish the level of knowledge and developed competences through proposals methodological approach, including:

- two-stage evaluation of specific knowledge, skills and competence tasks;

- self-assessment test of specific and key competencies of the trainees;

expert assessment of trainees for writing quality programming code using a competency scorecard.

Object of the study: The object of the study is the training of students in the profession of "Applied Programmer" in modules of the profession related to the development of competence in algorithms and data structures and programming paradigms.

Subject of the study: The subject of the study is the process of formation of specific competencies among students in the profession of "Applied Programmer" by using a methodological approach for competency-based training and a toolkit for its implementation and diagnosis of the results of its application.

Research hypothesis: By applying the methodological approach developed by the author for competence-based training in the modules of the "Applied programmer" profession, a higher degree of assimilation of knowledge and skills is achieved, as well as specific competences in the profession are more successfully formed in comparison with traditional context-based learning

Research methods:

A. Methods of working with information - analysis, synthesis, classification of normative documents, scientific literature on the problem and scientific literature dedicated to pedagogical research.

B. Methods for conducting scientific research - pedagogical experiment; competency self-assessment survey; partially structures Expert evaluation; diagnostic test; criterion-referenced test; practical task; methodical approach for CBT.

C. Mathematical-statistical methods for data processing - analysis, synthesis, comparison and summary of the results of the conducted empirical research.

Structure and volume of the dissertation:

The dissertation consists of 168 pages, of which 138 in the main part, containing: Introduction, 3 chapters, 16 pages of references and 3 appendices in the amount of 14 pages.

The introduction presents the topicality of the problem, the choice of topic, the subject, the object, the objectives of the research and the structure of the dissertation work.

Chapter I presents an overview of the study of software engineering in a global and national context and the concepts of CA in education. A resulting framework of required competencies for software developers is derived.

In Chapter II, the methodical approach developed by the author for CBT in the profession of "Applied Programmer" is presented using a partial modification of the classic ADDIE training model. The proposed model for collaborative blended distance learning in an electronic environment is discussed. Didactic training materials developed by the author (Sample set of tasks (ST) for development (and assessment) of the selected specific competences in PAP and a sample project for project-based learning per study module are also presented.

Chapter III presents the organization, results, analysis and conclusions of the study. The analysis is based on the results of a two-stage assessment of professional competences in the field of Algorithms and Data Structures (ADS), self-assessment and expert assessment of learners.

In the Appendices, a preliminary test used for training and assessment and sample solutions to the tasks for the development of professional competences are presented.

BRIEF CONTENTS OF THE THESIS

CHAPTER I. SOFTWARE ENGINEERING – TRENDS, TRAINING. PROFESSION "APPLICATED PROGRAMMER"

1. Global trends in software engineering education. Association for Computing Machinery classification of computer education.

Under the auspices of the Association for Computing Machinery (ACM), representing a global scientific and educational organization dedicated to the development of science, engineering and the application of computers, recommended curricula [56] for SE and CS have been created. For the purposes of this work, the principles underlying the SE program GSwE2009 [61], as well as the proposed ACM recommended standard for CS for CSTA K-12 high school graduates are of interest [57].

The rapid rate of development of SE requires a constant revision of the curricula, and it is recommended that such a revision be carried out every 3-4 years [18]. GSwE2009 reflects changes in technology and practice and is aligned with the development of pedagogy and the principle of lifelong learning (LLL) enshrined in the EQF (European Qualifications Framework) [60].

ACM recommends that learning content should focus on gaining hands-on experience that will aid both a comprehensive understanding of the specifics of a particular type of software and the methodology for its creation. Expected Learning Outcomes (LO) are a goal and an integral part of curricula. ACM uses Bloom's taxonomy in describing learning activities. The association recommends that students form and develop the following basic and specific skills, which in CA terminology cover the competencies: in-depth knowledge, ethical competencies, teamwork competencies, effective communication skills, leadership in at least one of the areas - project development, management of projects, requirements analysis, architecture, construction or quality assurance of the software product; problem solving skills; perspective - understanding and assessment of project feasibility, negotiation skills with stakeholders in a typical software development environment; effective work habits, technological and leadership qualities; learning ability.

According to the latest 2017 revision of the CSTA K-12 CS standard, the ACM articulates the following goals: to introduce students from an early age to basic CS concepts; introduction of informatics as equal to other subjects at school; encouragement to further study of the CS and preparation for the labor market or the next degree of education; to ensure access to high-quality CS education for all students.

2. Contemporary trends in the study of computer science in Europe

The work analyzed the results of research in the European Union (EU), coordinated with the ACM, on the study of ICT and its application in education [55]. The apparent lack of compulsory or at least optional informatics courses in schools across Europe shows that informatics is not recognized as a separate discipline [62], while learning to acquire digital competences starts very early. According to the survey, over 75% of students never or almost never did programming at school. To solve these problems, the EU promotes strategies, projects and research to improve their level [58]. The goal is to develop the skills of the 21st century - skills for programming, problem solving and analytical thinking.

The EU recognizes as crucial the role of VET in the field of SE to overcome the challenges related to the lack of software developers. According to the EU, VET is able to increase enterprise

efficiency, competitiveness, research and innovation. VET is influenced by a number of labor market factors: Short life cycle of qualifications; New technologies and new professions; Abandonment of existing occupations; An economy based on knowledge, ideas and innovation. The challenges faced by VET are: LLL; Flexibility through modular training and diverse development paths; New professions and specialties; Creating a personal culture of learning; Electronic learning platforms.

Modern VET in the field of SE in Bulgaria is carried out in the professions "Programmer", "Applied programmer" and "System programmer", for which SES has been created in recent years [34].

3. Training in computer science and software engineering in our country.

A major component in the review of the state of the study of SE and CS is the study of national experience. According to the brief review, it is clear that Bulgaria is among the pioneers in the world in introducing CS in secondary school [16]. At the beginning, they were studied as optional in several mathematics high schools, and rich traditions were built, which we consider strategically important to be multiplied.

In parallel with educational traditions, the experience of preparing skillful students [16] [29] and the development of programming skills, algorithmic thinking [23] [36] [40] [48] and personal qualities necessary for developers have been studied and analyzed. of software. The VET experience in programming at OMG "Kiril Popov" Plovdiv was studied and analyzed, which is upgraded, multiplied and borrowed in the modern training in PAP [38].

4. The constructive basis of competence-based learning.

From the overview and subsequent analysis, we assume that effective training in PAP, it should be aimed at the development of basic and professional competences, known as CBT, whose ideas are rooted in the philosophy of constructivism [2] [15] [26]. According to the constructivist theory, in the center of the learning process is the learner with his interests, motivation, conscious activity in expanding his abilities to solve problems, responsible attitude in performing the activities. The learning process should be aimed at supporting the development of reflection. All knowledge should be acquired through an experience that leaves lasting traces in the mind.

The dissertation analyzed the differences between traditional context-based learning and the one based on the principles of constructivism CBT [10].

5. Competency approach in the selection of personnel in the industry.

To clarify the concept of CBT, a brief historical overview of the development of ideas about CA in the selection and training of personnel for industry is made. The evolution [44] of the concepts of competence and competence is analyzed, the concepts of different schools are presented. The difference between skills and competence is clarified. Various variations of definitions and interpretations of the concepts have been given [8] [12] [25] [33].

Competence include several different dimensions – knowledge, skills, attitudes, values and attitudes. We accept as successful the "iceberg" metaphor, according to which competence consists of a visible part - behavior and an invisible part (knowledge, skills, values, attitudes, motives, personal characteristics). The invisible part has the strongest influence on behavior that is "visible" on the surface.

We adopt the following definitions based on those given in the literature:

- Competency - set of expected knowledge, skills, attitude, ability to act effectively, independently or in a team to achieve given goals in an acceptable time, at an acceptable price, i.e.

competence is standard.

- Competence - an integral quality of the personality, a set of acquired competencies; it is found in demonstrated behaviors when solving a given problem.

The main classifications of competencies based on different principles have been studied and analyzed. Armstrong [4] distinguishes between Behavioral (soft skills) and Technical (hard skills) competencies. Hamel and Prahalad [28] divide them into 3 types: General, Core competencies in the organization and Functional (specific) competencies. Chantov [12] distinguishes the competencies of 2 large groups: general and professional, each of which he divides into subgroups. Spencer [33] divides them according to the degree of productivity: Basic competences and Distinctive competences. Zuell [49] classifies competencies into 3 groups: Distinctive, for the excellent; Core, Mid-Performance and Transformational Competencies that, if improved, will lead to better performance. Khutorski [21] proposes a hierarchical model of competencies in education, where some of them are more general or more significant than others. It lists three levels: key, general and subject competencies. Debrecen [14] classified them as: portable and specific.

For the purposes of this project, we will adopt Khutorski's approach. Without limiting the community of our research, we will combine general and subject competencies into one, as professional or specific. Similar is the classification in the SES for PAP, in which they are divided into general, sectoral and specific.

The concepts of "competency model" (CM) for an economic sector or organization, "competency profile" for a position, as well as the meaning of the term "competency catalog" to achieve transparency and comparability in the typology and definition of competencies with other ones have been clarified. The approaches to the development of CM have been clarified [12].

6. Transition to competency-based learning

The CBT paradigm places the student at the center of the educational process. The training is aimed at the overall development of the learner as a person. In it, the student is a researcher and actively seeks knowledge himself, learns by doing and experiencing. In this pedagogical interaction, the teacher plays the role of an assistant whose goal is to facilitate the student in cases where, due to the lack of sufficient experience, the student is unable to cope on his own. Mistakes during learning are not considered failure, but the teacher uses them to shape the student into valuable life experience. Thus, students learn to construct meaningful hypotheses and prove them. The training is tailored to the personal characteristics of the student, it is approached in a multidisciplinary way, working in a team. Assessment does not aim at quantitative evaluations, but serves to adjust the pedagogical interaction to improve learning outcomes. The aim of the training is to form competences, with the criteria for the expected LO. Indicators of the achieved LO are the demonstrated behaviors during the successful performance of the activity.

7. Competency frameworks related to the profession "Application Programmer".

For the implementation of the experimental CBE on PAP, the competence frameworks related to the profession were analyzed, as well as "hard" [6] and "soft" [7] skills essential for software developers. The thread of such frameworks leads from the most general to the most specific competencies that an application programmer should possess. These are: EQR, the National Qualification Framework (NQF) [53], the Framework for Citizens' Digital Competences DigComp 2.2 [45], the recommendations in the Strategic Requirements of the Software Industry for the Introduction of CA in Education [54], the Qualification Framework for IT professionals the e-CF sector [59].

After the analysis and synthesis of the listed frameworks, a resulting framework was formed, representing a tree-like structure of general and PAP-specific digital competencies. The purpose of the framework constructed in this way is to clearly define the objectives of the training on PAP, and not to present the overall picture of the competence development of the personality, in which the other listed competence frameworks are also reflected. Through it, an approach to structuring learning goals is presented, which can be used to facilitate goal setting in other professions as well.

In general, the framework is based on EQF, a core part of which is digital competences. These in turn include the competence "Creation of digital content", the subject of which is the e-CF IT workforce digital competence framework. For software developers, the most important competency in e-CF is "Programming". Specific to software developers are its components a) "Planning" - with the competence "Design" and b) "Building" - with the competences "Development of software", "Testing" and "Documentation", which are the objective of CBT on PAP.

8. Vision of the existing problem and its solution

- After the study of the world and national experience and the currently existing practices in CS and SE training and taking into account the recommendations of the above-mentioned world and European leaders for computer education such as ACM, CECE-ACM, we can synthesize the main ideas and vision for solving of the tasks we have set ourselves to achieve the goal of the research:

- There is a need to change the traditional paradigm to one for LLL. We recognize that the rapid progress of ICT is confronting educational systems with the serious challenge of increasingly rapidly developing professions. This leads to a serious problem in the preparation of teachers. In a preliminary survey carried out by us among the teachers in Bulgaria in PAP and CS in secondary education, the teachers share about the need for a more flexible and regular updating of their technological training.

- We share the idea that modern training in SE on PAP should be aligned with the latest requirements of specific and industry-specific training, for which ACM recommends educational programs and standards with relevant competency models. Given that CA in training is enshrined in the laws related to education and SES, it is found that for the successful implementation of CBT in CS, SE and in particular PAP, it is necessary to develop methodological approaches and educational content, which are currently lacking or quite sparse.

- We believe that for effective training in PAP we can use the good traditions of the Bulgarian education system in the training of informatics and competitive programming, which mainly develops computational and algorithmic thinking, which are key to mastering professional competencies in the field of PAP.

- We share the understanding that the implementation of CBT on PAP will help to increase the quality of human resources with secondary education offered on the labor market. At the same time, the application of the CBT principle of continuity between secondary vocational and higher education will increase the interest in continuing higher education in the field of ICT, which would lead to a better supply of ICT specialists with higher education on the labor market afterwards .

- We accept that competence is an integral characteristic of the personality and its unequivocal and complete research and development is impossible. Each individual component of general competence must necessarily be seen in some meaningful overall context. We accept that out of context, we can only talk about a specific skill, not a competence.

- We arrive at the idea that successful training in PAP can be realized with an appropriate

methodological approach based on the principles of CBT, the objectives of which are satisfied by the SES for PAP and the proposed outcome framework.

We will use a two-stage assessment of LO linked to Units of Learning Outcomes (ULO) from the SES for PAP to check the achieved LO. In order to obtain a more comprehensive picture of the results achieved through the new methodological approach, the application of specific evaluation methods for CBT, such as self-evaluation and expert evaluation, is planned.

The questions in the self-assessment survey aim to find out how the personal assessment of the achieved LO is compared to the SES expected LO. Given that the Software Developer Competency Profiles are more specific and updated more frequently than the SES, the question of the extent to which learners are able to perform their primary activity, according to this profile – to write quality programming code – is of interest. For this, we suggest the use of another main tool, which is expert evaluation.

9. Results and conclusions of Chapter I

The demands of the industry to the modern educational system require a transformation of the traditional context-based learning to CBT, aiming at achieving LO, in the center of which is the learner.

On the basis of the analysis and synthesis of competence frameworks, an integrated resulting competence framework is presented, concerning general and professional competences that a successful software developer must possess, and the same will be used as a basis for implementing a methodological approach for CBT on PAP.

CHAPTER II. A METHODOLOGICAL APPROACH FOR COMPETENCE-BASED TRAINING

Chapter II examines the theoretical basis and construction of a methodological approach for the application of CBT on PAP, for the successful formation and development of basic (key) and professional (specific) competences in the education of students participating in the National Program "IT Career Training" (NPITCT) on PAP in groups of OMGs. Acad. Kiril Popov" - Plovdiv, PGEE "Konstantin Fotinov" Burgas and SU "Hristo Botev" - Chepintsi village, Smolyan region.

1. Theoretical foundations and concept of the approach to competence-based training in the profession "Applied programmer".

To clarify the proposed methodological approach, the definitions of concepts, training, training method [1] [22], training approach, model, technological model [9] were used. In the present work, we will use the following definition: "Education is a purposeful process of interaction between the teacher and the students, during which knowledge, skills are transferred and assimilated, competences are formed and developed." Under the concept of a learning approach, we will understand a set of ways and means of approaching a certain problem and, more specifically, to learning. According to Andreev [1], training methods "build the procedural side of the training technology, give it life, largely determine its appearance and, together with the content, are its core...". According to Boykova [9], the use of technologies in the educational process provides new opportunities for: predicting the results of the management of the pedagogical process with a high degree of accuracy; establishing a scientific basis for the analysis and organization of the educational activity; choosing effective methods for solving educational problems; personal development of the trainees and trainers.

The development of the approach goes through several levels. The first of these is to understand the concept of CA in recruiting in industry and specifically in the ICT sector. Visually, it is a circular chain, all elements of which influence the preparation and successful professional realization of specialists. They are: Labor market => Standards => Training => Assessment => Labor market.

For training design, we propose a partial modification of the classic ADDIE (Analyze, Design, Develop, Implement, Evaluate) model [47]. Although it was created for designing training, it is also suitable for conducting it. The application of ADDIE as an iterative model, both at the module level and at the unit level, is known in the scientific literature as the "flexible" Successive Approximation Model (SAM) [63]. At the end of each of its iterations, there is a feedback about the student's learning results and possibly - difficulties. It includes information, both to the teacher and reflexively to the student himself, based on the quantitative or qualitative assessment of the achieved LO. With each iteration, the student reaches, supposedly, a better position to the goal (Successive Approximation), which is set in the training - the achievement of certain LOs. According to Peterson [27], using the ADDIE model in developing a program or course can help developers introduce a learner-centered approach rather than a teacher-centered approach, making the program more applicable and meaningful to learners.

Given the summaries and clarifications made, we will present the methodological approach for CBT. The main phases in its implementation are: Analyzing the learning objectives, learners and the learning environment; Designing appropriate learning content and teaching methodology; Development of learning content; Implementation (implementation) of training; Evaluation of learning outcomes.

2. Implementation of the approach for competency-based training in the "Applied Programmer" profession.

After superposition of the CA models for the selection and evaluation of personnel and the adapted "flexible" ADDIE model, the resulting technological educational model, according to which the methodical approach will be implemented, takes on a finished form. In addition to the fact that the process is cyclical, it is necessary to take into account the fact that an increase in the competence of the learners is expected after each completed module, as well as that at the end of the training the demands of the labor market will probably be higher, given the elapsed period of learning in which technology evolves. Therefore, we suggest that the process should be considered not only as a cycle, but as a 3-dimensional spiral developing over time, the development of which is represented in the form of a "ladder".

In detail, we will present the functioning of the approach through the technological educational model depicted in Figure 1:

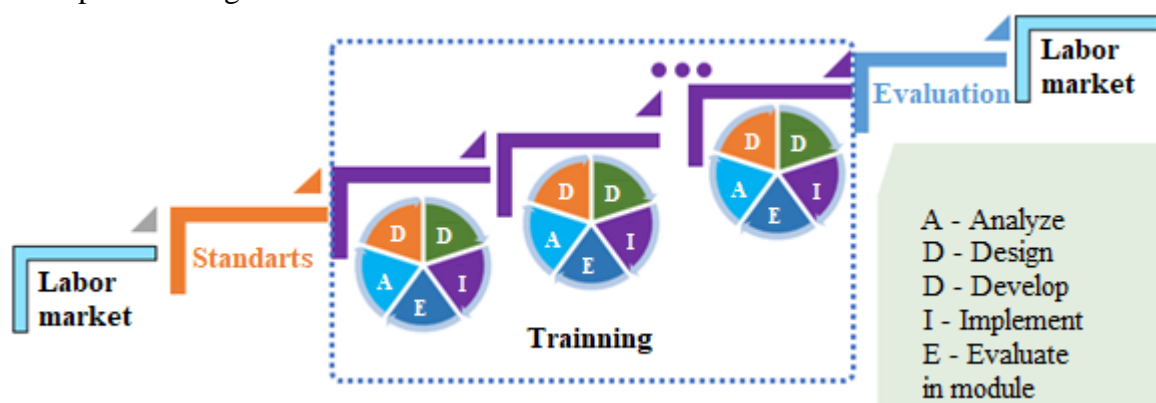


Figure 1 Technology education model

2.1. Labor market

The market is the starting point where it is determined what abilities of candidates are in demand at a given time for the economy. In the labor market, the business sets its requirements in the form of job characteristics, which the candidates for a given position must satisfy in order to successfully deal with its inherent professional activities. Training according to the model is effective only if it satisfies the requirements set in it. In the proposed model, representatives of the IT sector actively participate in meetings with the trainees by teaching, participate in committees for evaluating the trainees' projects, consult teachers and students on specific topics, present their subject of activity and emphasize the competence profile of each of the roles, for who are looking for candidates to implement their future projects. Thus, the IT industry receives feedback at the various stages of the candidates' training. At the same time, employers gain insight into real training, trainees build authentic self-assessment, and trainers adapt training to improve LO.

2.2. Standards

On the basis of analyzes of job characteristics, the ICT sector develops and updates KM and profiles for individual positions and roles in software development teams, and from them also SES for PAP. The SES specifies both the purpose of the training and the criteria for successful mastery of the profession, presented in a list of 14 ULOs. Each ULO contains several LOs. Each LO is decomposed into knowledge, skills and operationalized competences. The means, conditions and criteria for evaluation are specified for each ULO. The criteria are presented in a list of exemplary behaviors that the learner demonstrates as evidence of achieving LO. In the PAP SES, the concept of "competence" is considered as a requirement, i.e. it is used as a synonym for "competence". Competences correspond to level 4 of the EQR and NQR with a corresponding degree of independence and responsibility in carrying out the activity.

Given that SES sets a framework for what to do, not how to do it, we will use KM and SE profiles. We assume they are more current than the SES. These profiles detail "How professionals perform the specific activities for a given team role?". We will also examine the degree of readiness to take responsibility when performing independent or team work, as well as the transferability of competences in an unfamiliar problem situation.

2.3. Training

To describe the training, we will use the proposed ADDIE model. In addition to his characteristic analyzes of the goals, the learners and the environment, an analysis of the trainers is also offered. They are characterized by appropriate professional competence and role in the model. Trainers can be: a) teachers and professors of CS and SE in secondary schools and vocational high schools; b) teachers of CS and SE in higher schools and c) software engineers with teaching skills. It is essential to note that the three different types of teachers have 3 different profiles of professional experience and can make a specific unique contribution to the training, which with appropriate planning of their joint activity can be realized. The thesis describes in detail the desired profile of the teacher, in accordance with the ideas of CBT and recommended qualification [18], in accordance with the DigCompEdu framework for digital competences of teachers.

The analysis also includes a description of the desired role for the learners to play in the model. In the proposed model, the learner is at the center of learning. He participates in it through active learning, forming and developing holistically his key (basic) digital and professional [59] competencies. The learner develops his professional competence, related to the acquisition of knowledge and skills from the general, sectoral and specific training for PAPs, which contribute to

the formation of attitudes, relationships and willingness to take responsibility in independent work and/or in team work when solving practical tasks related to the job requirements for the PPE practitioners. The level of competence that is aimed to be achieved is indicated in the SES for PAPs and corresponds to Level 4 of the NQR and EQR. Learners develop their mathematical literacy, creative thinking skills, critical analysis and teamwork.

The next component in the presented analysis is the learning environment. The analysis took into account the recommendations of the DigCompOrg framework for school organizations, good dispatches for Distance Training in an Electronic Environment (DTEE) [24] . The concept is considered in several aspects: (1) mixing the possible interactions "trainer-learner" and "learner-learner"; (2) mixing the forms of learning - face-to-face and distance. Collaborative Blended Distance Training in an Electronic Environment (CBDTEE) is offered and developed for several groups. The trainees in each of them consists of one part participating on the spot and another, which participates simultaneously (synchronously) in DTEE conditions. CBDTEE offers improved real-time teacher support and assistance; development of knowledge sharing practices; increasing the diversity of learning resources; creating the opportunity for feedback that is key to the learning process. About CBDTEE - students who would otherwise not be able to meet in a learning environment in one physical place have the opportunity to exchange experiences with each other. The class becomes larger and thus there is an opportunity to overcome the problems associated with small groups in terms of the possibility of comparing the personal abilities of the learner with others.

By "collaborative" it should be understood that more than one teacher and more than one group of students participate in the learning process. It is not necessary for one teacher to participate remotely. It is an advantage if both teachers are present on site. The remote participation of the teacher should be considered as an opportunity that allows the realization of the training when: 1) it is impossible for him to be present on site; 2) everyone participates with their group, which teaches in person at the given moment; 3) when other professors, software engineers or professors from higher schools are included as referents in given cases, in which their professional competence will help the teacher-pedagogue.

When there are two or more teachers, they work in a team – one teacher monitors the work of the other and provides support in teaching, as well as looking for mistakes in the teacher's presentation to correct at an appropriate time. Collaborative teamwork between teachers is a real opportunity for teaching at CBDTEE, which is not typical of traditional education. Teachers share experiences by observing each other. This experience is offered to learners who in addition have a visual example of teamwork. It is recommended that the trainer, who is not currently leading the training, monitors the feedback channel and intervenes at appropriate times by answering the questions so as to facilitate the process of understanding the taught material.

Along with the flexibility that such a form and environment of learning offers, there are also specific limitations and challenges that determine the success of such learning. The main difficulties are:

- a) the need for additional preliminary activity to carry out the analysis and planning of the study work, which are labor-intensive and time-consuming;
- b) availability of serviceable means of communication for the implementation of such a form of mixed education.

In addition to the software provision of DTEE based on cloud services, the presented approach relies on innovations in several aspects:

A) regarding the pedagogical interaction between trainers and trainees, it is proposed:

- conducting synchronous and asynchronous training in a mixed environment - part of the trainees are present, and the other online, if it is impossible to train them on site;
- joint training between several groups (in this study there are 2 groups);
- teaching by a team of teachers, ensuring the need for: adaptability and personalization of the learning material; scientific justification and innovations in the field of SI; as well as practical professional competence to create software;

B) regarding didactic materials:

- addition of self-training support systems for individual modules;
- storing video recordings of the conducted sessions;
- save solutions to a cloud-based version control system such as GitHub.

The CBDTEE proposed in Figure 2 builds on the training platform created for NPITCT. The existing platform is represented in yellow, and its modification in blue:

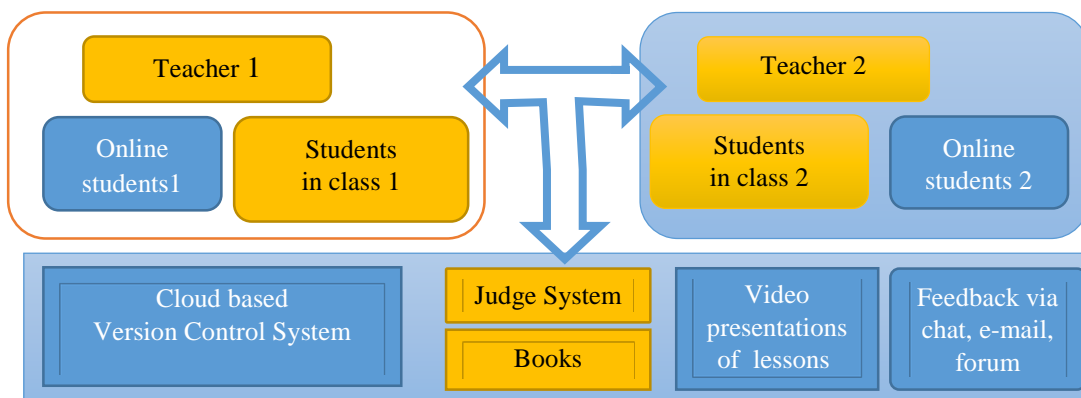


Figure 2 CBDTEE - Collaborative blended distance learning in an electronic environment

Designing the learning content. The study programs for the modules provide learning content with which to cover the expected LOs laid down in the SES. The design is carried out at several levels: SES level - a curriculum is drawn up; Module level – a curriculum is drawn up with specific study units for it; Level Study unit of the curriculum - includes theoretical knowledge and tasks for their assimilation, applied tasks for skill development and practical tasks for formation and development of competences. The design of SES level and Module level was done in advance, according to the curriculum of NPITCT. For the purposes of the research, the curricula created and approved by the Ministry of Education and Culture and their corresponding programs by subjects and modules for all types of training were used. The interest in the research is directed to the Unit level of the curriculum, where teachers can apply methodological approaches to achieve the objectives of CBT.

It is recommended that the learning content, tasks and learning resources be personalized by adapting them [3] to the specifics of the learners to facilitate the achievement of the requirements in SES, depending on the level of preparation and interests of the learners. The goal is, as much as possible, for the training to be motivating, so as to achieve a better commitment of the learners. This is a prerequisite for achieving a state of "flow" [13] in the learner, in which he actively participates.

A decomposition (operationalization) of competencies (ULO) is proposed as) [2], including relevant knowledge, skills, attitudes and attitudes. Thus, each complex competence is analyzed to its component operationalized competences. The latter represent a series of skills. The mastery of

any operationalized competence is proven through demonstrated behavior by the learner through successful solving of appropriate applied and practical tasks.

Given the content of each ULO and the impossibility of studying them sequentially, a significant part of the modules of the NPITCT curriculum are organized into two parts - an introductory and an advanced module. The curriculum created in this way offers a good basis for organizing the learning content in the modules, respecting the principles of its stepwise and spiral learning. The modules cover all or parts of the ULO.

Development of learning content.

Taking into account the recommendations for the design of learning content, in the following points we will present a methodology for creating a ST for several of the modules related to the study. In the development of educational content, educational materials of NPITCT were used, and the ADDIE (SAM) model was applied to them, including the relevant toolkit for classifying tasks using the framework with requirements for the types of tasks created for the purpose and a methodology for creating ST. The tasks are pre-selected and adapted according to the concept of CA and Bloom's taxonomy. Included are tasks for acquiring knowledge, mastering skills and developing professional and key competencies.

Conducting the training. Given that training is a combination of teaching and learning, emphasis is placed on the learning process, which puts the learner at the center of the training. He plays an active role, which in turn does not exempt the teacher, quite the opposite. The teacher should guide the learner to achieve the expected LO by adapting his teaching activity to motivate the learner to be a researcher.

Kolb's constructivist theory of active learning is explained in the dissertation. With it, students solve real problems from the world around us, even with their inherent contradiction that exists within them. The most significant is the method: Learning by doing. The highest degree of implementation of learning by doing is achieved through the development of practical projects, known as project-based learning (PBL). Throughout the training, the learner develops a project (for example, a web application based on the Model-View-Controller pattern) that is tailored to his interests. The teacher provides appropriate context for the application, as well as dividing the application into stages of development across all the modules studied in the curriculum. This work on the preparation of individual projects is tailored in the Analysis stage of the proposed model, apart from the learning objectives and personal cognitive characteristics, attitudes and interests. The learner reflects their work on the project to the GitHub repository daily. Given its importance in both the learning process and evaluation, we will focus on using GitHub, but it is necessary to specify that there are many alternatives.

Taking into account the recommendations of the IT industry, we have paid special attention to the GitHub tool for storing the version history of the projects on which the learner has worked. The idea is based on the fact that software companies look for proven experience and skills when hiring young developers, and it is appropriate to demonstrate such through their own GitHub profile, as well as to use it for assessing competencies. It is recommended that it be developed from the very beginning of the training.

Evaluation of learning outcomes.

This is the stage at which LOs are certified according to the SES, along with the requirements specified in the Standards (KM and profiles for the ICT sector). It is an ongoing process, based on

feedback from learners [1], to form ICT sector-specific competencies [11].

Depending on the specific goals to be achieved with the evaluation, 3 levels of it are classified. The meaning and role of each of them is clarified: *Level 1* – Formative assessment (FA); *Level 2* – Summative and *Level 3* – “External” assessment. The evaluation methods specific to CBT have been analyzed.

Level 1 - FA is the regular feedback with a subsequent analysis of the difficulties that each student encounters in the acquisition of knowledge, skills and abilities. Automated Judge Systems (AJS) are suitable for such evaluation [46]. Analyzed and proposed for application in *Level 1* assessment are the typical CBT assessment methods such as self-assessment [17] [35] and peer review, also called “peer assessment” [31] or “mutual assessment” [17].

Level 2 – summative assessment. It is applied to the evaluation of competences at the ULO level in module exams, with means, conditions and evaluation criteria determined for the specific ULO by the SES. AJS are suitable for this purpose. It is suggested that they be used in combination with the Expert Evaluation method. The expert assessment is made by a committee that includes teachers and experts from the SE branch.

Level 3 – represents the assessment considered in the final phase of the model. The aim is to verify the extent to which the professional and basic competencies laid down in the Standards have been achieved. The validation of competences at this stage is fully consistent with the SES for PAP, KM for SE and the competence profile of the "Software Developer" role. Evaluation is done by a team of software development professionals. We will also call such assessment "external", not as a synonym for state exams, but because it is carried out by specialists external to the educational system. State exams are one example of such assessment, but they do not exhaust the content and meaning of the concept.

Taking into account the ideas of CA in training, we believe that the conditions under which the assessment is carried out should maximally recreate those of the real work environment. A number of methods specific to CA and in particular CBT are suitable for this purpose, such as Peer verification and Expert evaluation, but no longer so adapted to facilitate learning, but closer to the real work environment.

Given that competences are assessed in a given context, there is a limitation regarding the assessment of specific competences in the short time of the job application procedure. For this, we propose to include in the model the tool noted in Chapter I as the most preferred by the representatives of the ICT sector - GitHub [51]. The projects previously developed by the job applicant stored in it represent a kind of portfolio. From these, assessors can draw artifacts to place an authentic expert assessment of the competence of the graduates.

2.4. Didactic tools used in developing the learning content

A Task Types Requirement Framework (TTRF). When creating the tasks, it is necessary to classify them from the point of view of their purpose in the learning process. Bloom's taxonomy for educational purposes is suitable for this purpose. The TTRF was created for the proposed methodological approach. In it, the tasks are divided into 3 main groups: for acquiring knowledge; to acquire skills; for the formation and development of competences. For each of the groups of tasks, the following are indicated: their goals and purpose, a category from Bloom's taxonomy, the expected results that learners must achieve when solving them; the behavior they are expected to demonstrate after their successful mastery. TTRF is a qualitative framework and serves as a basis for determining specific quantitative evaluation scales with which to evaluate the achieved results.

Variations of the scales allow flexibility to apply FA during learning in a particular module. According to the specific needs in the learning process, it is suggested that the tasks are arranged according to the specific features of the lesson, adapted to the respective learner. They can be classified as those for: updating old knowledge, skills and abilities, for introducing new knowledge, skills and abilities, for consolidating knowledge and skills, as well as those for forming abilities, through generalization, analysis and synthesis. Adaptable e-learning technologies and tools [5] [30] [39] [41] [42] [43] are suitable for this purpose.

Methodology for creating a set of tasks. In view of the established TTRF, a methodology is proposed for the creation of STs, representing an algorithm by which they will be developed for the various modules, shown in Figure 3:

For each module
For each ULO included in the module (Module Section)
For each LO of the specific ULO:
Create according to TTRF ST , including tasks for:
Knowledge; Skills; Competencies.
If this competence has also been developed in previous modules, include in the ST such tasks that build on it in accordance with the new aspect of learning.

Figure 3 Methodology for creating a set of tasks

The teaching methodology aims to develop competences in each module, illustrated in Figure 4:

For each module
For each topic of the syllabus in the module
define the subset of ULOs that are studied
For each ULO, determine the subset of LOs to be studied
For every student
Analyze the student
Adapt (design and develop) a suitable custom ST
Apply ST
Evaluate the LOs achieved
until the student's expected LO is achieved
for this ULO
for this topic
for this module

Figure 4 Teaching methodology

3. Selection of target LOs from SES, whose formation and development will be studied

After the analysis of the structure and content of SES, a set of target knowledge, skills and competences G (goals) have been defined, which will be investigated in the experimental training. These are ULO 9 ADS from SES and ULO 10 - "Programming Paradigms".

4. A set of tasks and assignments for project-based learning

In the dissertation work, 4 sample versions of ST and one proposal for PBL are presented, with which the goals defined in G can be achieved. Sample solutions of the tasks are given in Appendix 2. The proposed STs were implemented in teaching as well as in assessment in the conducted experiment. They illustrate, but do not exhaust, the necessary minimum of such for the overall development of professional competences in PAP. Each set of tasks includes questions, tasks for

knowledge, for skills and one or more applied tasks, which develop professional competences from G. Each of the tasks corresponds to the requirements in the TTRF.

ST for the module "Introduction to programming", Study unit "Checks". 4 tasks are selected from the materials of the NPITCT in it. The ST is aimed at a gradual upgrading of knowledge, skills and the formation of competences for creating branched algorithms. In addition to mastering the use of the full and short form of a conditional operator, students are introduced to good algorithm design practices.

ST for Introduction to Algorithms and Data Structures module and Algorithms and Data Structures Module, Dictionaries Unit. The methodological toolkit consists of three parts: A. Test with selectable and free answers; B. Practical task 1; C. Practical task 2. The purpose of the proposed test is to develop (check) knowledge and skills, and with the practical task to develop competencies for manipulation and algorithms on the data structure Associative Array, known in the C# language as Dictionary. The materials are author's except for one practical task. The two practice tasks are chosen so that they appear to be different. They are selected from different areas of life, but the same mathematical and informational model can be used for their solution. The goal is to develop the competence to use the Associative Array (Dictionary) data structure through appropriate algorithms on it. To develop this competence, the emphasis is on the durability of knowledge (given that Practical Task 2 is given after some time) and the key ability of students to transfer their skills to solve real problems from another domain (the algorithm for solving is the same, although that the task is from another real situation).

ST for development of competences related to ULO "Programming models" - OOP. Modules Introduction to OOP and OOP, Unit "Principles of OOP".

The proposed set of tasks is composed of 4 author's tasks, intended for the development of the competence to use object-oriented programming (OOP) and a basic level of functional programming style (FPS) in the students in the training of the OOP and OOP modules. The tasks illustrate in a compact form a spiral upgrade of learning the principles of OOP - Abstraction, Encapsulation, Inheritance and Polymorphism [32].

ST includes 4 tasks applied in different study units in both modules. To solve each subsequent task, the knowledge and skills acquired from the previous tasks are used. Competencies for using the List data structure built in the System.Collections.Generic library in the C# programming language are developed, skills for using the LINQ library used in the Programming module are developed. Students thoroughly learn the basic principles of encapsulation, inheritance, abstraction, and polymorphism, along with good practices for their analysis, design, and implementation [19]. In the last task, all the competencies from the curricula of the two modules are demonstrated.

ST for Module Functional Programming - for development of competences related to ULO 10. "Programming models" - Functional style of programming. All assignments are author's. The main problem that arises for the learners in the Functional Programming Module is related to the new style of programming, which is different from known so far [20]. The proposed ST is a tool for overcoming the learning challenges that students encounter when learning specific competencies related to FPS. The goal is to facilitate the learning of FPS, as well as to realize the differences compared to other known paradigms (imperative, procedural, object-oriented and logical). Problem solving is proposed to include: (1) Problem solving using a procedural style; (2) Using procedural-style recursion where possible both in describing the algorithm and in describing complex data structures; (3) Replacing procedural style with declarative and using pure functions

and recursion; (4) Proposing a solution that is close to logic programming.

After presenting and analyzing various sample solutions to the tasks, students are provided with several tasks to check the acquired knowledge and skills related to FPS. The last part of the FPS proficiency test is an assignment in which students have to propose practical problems and their solutions through the FPS.

PBL for the HSE Module. Given that the competence of the application programmer is a complex formation, including in itself both industry and specific professional competences, as well as communicative ones for successful teamwork, a sample assignment for PBL for the EMS Module is offered. In it, students develop "hard" [6] skills for programming embedded systems in an Arduino environment and "soft" skills [7] such as teamwork, communication skills, conflict management, expression skills and assertiveness, non-standard thinking [54], problem solving [37]. The aim of the training is: to form competencies for programming embedded systems. At the end of the module learning, students present a real working system or robot composed of Arduino based components. Learning tools: web-based simulation environments, embedded systems programming environment; systems for configuring virtual machine operating systems; Hardware: development boards for embedded systems, kits of electronic components for building circuits. The training was conducted as an DTEE. Rules for team participation and evaluation criteria are specified. It is evaluated through a presentation by the students, as well as a review of the development and the code by a committee (Peer review), as part of an expert evaluation.

5. Results and conclusions of Chapter II

A theoretically justified methodological approach for CBL under PAP. The structure and functionality of the model is described, including TTRF, methods for creating didactic materials and teaching through ST for the development of professional competences laid down in the SES for PAP.

A new design of training is proposed - CBDTEE and an environment in which it can be implemented, allowing: a) inclusion of teachers with a different profile of professional competence (teachers and scientists from higher schools, as well as professionals from the ICT sector); b) to teach several groups of students together, which enriches both learners and teachers with experience in at least two directions: enrichment of ideas and approaches to solving tasks, and also expanding the basis for comparing the achievements of each of the learners against the rest; c) to be stored, reused and shared in the independent training, the valuable teaching and formative experience of the students demonstrated during the joint work in the form of electronic resources (artifacts - program code, educational video materials from the training process); d) to improve the joint teamwork of teachers; f) effective implementation of FO, as a main component in CBL.

The proposed approach imposes requirements for additional preparatory work by the teachers at CBDTEE, Internet connectivity, serviceability of AJS and GitHub.

A methodology for teaching through ST has been created to achieve the objectives of CBL.

For a complete diagnosis of the achieved LO, it is necessary to use specific forms of assessment for CBT, such as self-assessment and expert assessment. For this purpose, it is planned to carry out such evaluations within the framework of the experiment.

CHAPTER III. ORGANIZATION AND CONDUCT OF PEDAGOGICAL RESEARCH

The purpose of the empirical research is to establish the veracity of the hypothesis that the proposed methodological approach for CBT in the profession "Applied Programmer", implemented in the training of students in the groups of OMG "Acad. Kiril Popov" - the city of Plovdiv, PGEE "Konstantin Fotinov" - the city of Burgas and SU "Hristo Botev" - the village of Chepintsi, Smolyan region, participating in NPITCT achieve a higher degree of assimilation of knowledge, skills, as well as form -successful profession-specific competencies (compared to traditional context-based learning).

1. Organization of the study

In May 2019, a methodical meeting was held with the teachers from the specified schools teaching in the NPITCT groups and teachers teaching in the regular form of education in the same schools. The purpose of the meeting was for the teachers to familiarize themselves with the concept and preliminary plan of the study. It describes chronologically the tasks that are planned for its implementation. The deadline for conducting the research is November 2020 - January 2022.

Main stages of the research. The study is aligned with the third task of the dissertation and the types of assessments presented in Chapter II. It is divided into three stages: a two-time examination of the competence on ADS, self-assessment and expert assessment of the competence of the trainees.

Study plan and course. In the course of the study, the intended plan was implemented, including the following steps:

- 1) Conducting a preliminary test to establish the level of the groups
- 2) Application of the developed methodical approach for the CBT of the students of NPITCT and training of the students in regular form according to the traditional approach;
- 3) Solving a test to check knowledge and skills and a practical task to check competence with students in both forms of education after studying the study unit "Dictionaries" from the "Programming" module.
- 4) Training on the modules related to ADS, OOP and FPS in the studied groups;
- 5) Solving a second practical task to check the acquired competences related to ADS
- 6) Conducting a student self-assessment survey;
- 7) Conducting observation by the teachers on the overall work of the learners and placing an expert assessment using a Competency Assessment Card (CAC) on the skills and abilities of the learners to write quality programming code

2. First stage: Study of the development of specific professional competences in the field of Algorithms and data structures

The first stage is aimed at evaluating the acquired knowledge, skills and competences in the field of ADS, laid down in ULO 9 of the SES on PAP.

Goal of the first stage. The purpose of the first stage is to compare the results of applying two different approaches to the training of the "Applied Programmer" profession in Bulgaria: a methodical approach for CBT on PAP and the traditional training approach applied in vocational

high schools offering training in the same profession. Because of the large volume of the studied material, the research is to LO from a study unit concerning a basic data structure such as Dictionary, known in programming languages as an associative array, associative list, Hash Table and Map.

Working hypothesis. The application of the described methodical approach for the CBT on PAP in the selected modules in the profession "Applied programmer" achieves a higher degree of assimilation of knowledge, skills, and specific competences in the profession are formed more successfully (compared to traditional context-based learning).

Learning objectives. The learning objectives are related to the formation and development of professional competences in the field of ADS, laid down in the SES on PAP, some of which are:

- acquiring knowledge and skills for using basic data structures: arrays, lists and dictionaries,
- acquiring skills to detect and debug program code,
- acquiring skills for solving specific tasks independently,
- solving practical tasks with dictionaries and nested dictionaries to establish the level of acquired competences.

Research methodology. A representative sample of:

- 124 students who are divided into 2 groups of 62 students each from NPITCT and a regular form of education in the same schools - when conducting the knowledge and skills test,
- 80 students, divided into 2 groups of 40 for each of the forms of training in the implementation of the practical task 1 and task 2.

An ascertaining experiment was carried out, the results of which allow the conclusion that the start of the training takes place with equal opportunities for the participating students. For this purpose, a test with a priori analysis was used.

The first stage covers LO 9.5 ("Dictionaries") and is divided into two parts:

Part 1: a) a test to check the acquired knowledge with multiple-choice and free-response questions, as well as an applied code correction task on the study unit "Dictionaries" to check the acquired skills; b) verification of formed competences through a practical task.

Part 2: practical task to assess vocabulary competence.

The idea of the chosen evaluation format has several features:

- assessment of competence includes verification of acquired knowledge. skills and ability to solve practical tasks through an appropriate set of knowledge and related skills,
- the practical task from Part 2 is done at a later stage.
- Even the same code can be used to solve problems from Part 1 and Part 2. Constructed in this way, the tasks aim to check to what extent the learners have permanently mastered the competence (one of its characteristics according to Khutorski), as well as its transferability to new life situations.

Given the time span of conducting this stage of the research, a partial evaluation of the ULO 9 ADS of the SES for PAP, covering the expected LO for work with dictionaries, has also been implemented. Other ULOs related to OOP and FPS are partially included in the study.

Processing of the results of the first stage of the research.

Two groups are distinguished:

- control (noIT) – 62 students from a regular form of education - the standard methodology, characteristic of the traditional approach to teaching in vocational high schools, based on traditional contextual learning, is used,
- experimental (IT) – 62 students studying at NPITCT - uses a methodical approach, including the ADDIE model for CBT.

Criteria and indicators for evaluation of test questions and practical tasks are indicated in the dissertation work.

Test results. The mean value of the two independent groups is presented in Table 2:

Table 2 The average value by groups

Group	N	Average value
controls	62	15.89
experimental	62	21.40

The tables show that the difference in mean score is 5.51 in favor of the experimental group. The results of checking for normal distribution of the empirical data of the two formed groups show the following:

- the Shapiro-Wilk test applied to the control (noIT) and experimental (IT) groups and designed for small samples returns a value for Sig. (significance level) below 0.05 (noIT-0.001; IT-0.000), which is a sufficient condition to reject the null hypothesis (for a normally distributed sample) in favor of the alternative hypothesis for the non-normal distribution of test results.

The conclusion follows the need to use a non-parametric method to compare the results of the two independent populations. For this purpose, the comparative analysis was made with the Mann-Whitney U-test (Mann-Whitney Test), which returns a result of .000 for Asymp.Sig.(2-tailed). Based on this result (significance level <0.05), it can be concluded that the difference between the two measurements is not due to chance, but is a result of the applied methodology. In other words, the confirmation of our hypothesis is not accidental.

Results of practical tasks. The practical tasks are aimed at establishing lasting competences according to the criteria mentioned below. The results obtained allow a comparison to be made between the results of the same group performing both tasks over a certain period of time. The successful completion of the specified criteria set in both tasks allows a conclusion to be drawn about successfully acquired competences.

Mean values for the two independent groups for the individual tasks are presented in *table 3 and table 4*:

Table 3 The mean value by group for task 1

Group	Number	Value
Controls	40	17.00
Experimental	40	24.40

Table 4 The mean value by group for task 2

Group	Number	Value
Control	40	18.83
Experimental	40	24.40

From the tables, it can be seen that the average score of the experimental group remained at a high

level, which indicates a permanent assimilation of knowledge and skills and their transformation into competencies. In the control group, we have a slight growth of the indicator, which guarantees that the acquired knowledge and skills of the successful students of this group have been formed as competencies. The difference in the average score between the individual groups is significant - 5.57 in favor of the experimental group.

Conclusions from the First Stage: A pedagogical study was conducted on 124 students to test knowledge and skills and 80 students to perform two similar practical tasks testing the same competencies over time;

1. The obtained results were processed through the IBM SPSS software, for the analysis of research results, using the Mann-Whitney U-test for two independent samples to reject the assumption of random nature of the result;

2. On the basis of the above actions and obtained results, the following conclusions can be drawn:

2.1. The results of the knowledge and skills test show a difference between the two groups, which is not due to chance and proves the working hypothesis that the application of the proposed methodology for CBT on PAP in the selected modules of the "Applied Programmer" profession achieves a higher degree of assimilation of knowledge, skills, and profession-specific competencies are formed more successfully (compared to traditional context-based learning).

2.2. The results of the two practical tasks show permanent assimilation of knowledge and skills and their transformation into competencies, regardless of the methodical approach applied.

3. Second stage: Self-assessment of students

For greater completeness of the research related to CBT, we conducted a study of the self-assessment of learners.

Objective of the study in the second stage. To establish the level of self-assessment of learners for developed specific competencies based on the applied methodological approach for CBT and to compare it with the self-assessment for the same competencies of learners using the traditional approach.

Materials and tools. For the purpose of the study, a survey was created with questions selected based on the expected LOs contained in the SES for PAPs, as well as the expected skills for writing quality programming code described in the competency models and profiles. Each competence (competency according to the terminology of SES for PPE) is described by behavioral indicators – verbs from Bloom's taxonomy suitable for carrying out the activity, which the learner performs during his work.

The other dimensions of competence refer to the degree of taking responsibility and independence. They include learning and communication competence.

Study progress. Students are divided into 2 groups:

- Experimental group (EG) - 53 students, trained at the Plovdiv and Burgas centers of the NPITCT, for whom a methodical approach for CBT was applied;
- Control group (CG) – 116 students from the regular form of education, in which traditional education was used in the same schools.

After training in half of the PAP modules in both groups, a survey was conducted for self-assessment of the achieved LO of the students using the Google Forms tool. The questions explore key and specific competencies related to ADS, FPS, OOP and skills for writing quality programming code. For each question, learners indicate the degree of mastery of the specific competence in 5 possible degrees - from the lowest first level - 1, to the highest fifth level - 5. Each of the levels is described in advance what it means by corresponding indicators of its mastery and behavior, which learners demonstrate in solving problems concerning the competence. Each level after the first includes as mastered competencies the previous levels. The criteria for self-assessment of professional competences are given in the dissertation.

The result of the Second Stage study shows that there is a statistically significant difference at the 0.05 level of significance in favor of the experimental group between the level of self-esteem of the students of the two groups.

4. Third stage: Expert assessment with a competency assessment card

Objective of the study in Stage Three. To check whether the used methodological approach for CBL has a positive effect on the results of the expert assessment of the learners.

Materials and tools. For the purpose of the study, a competency assessment card was created. It includes questions selected based on the expected LOs contained in the SES for PAPs, as well as the expected skills for writing quality programming code described in the competency models and profiles. Each competence (competency according to the terminology of the SES for PPE) is described by behavioral indicators, suitable for carrying out the activity verbs from Bloom's taxonomy, which the learner performs during his work.

Study progress. Students are divided into 2 groups:

- Experimental group (EG) - 42 students, trained at the Plovdiv and Burgas centers of the NPITCT, for whom a methodological approach for CBT was applied, of the expert evaluation will help for better reflection in the learners. Thus, they will have a truer view of their own skills and confidence in their abilities. In reality, this is the better scenario, compared to the opposite case of inflated self-esteem, which would present a significant didactic problem.

5. Conclusions from Chapter III

The objective information obtained from the processing of the results of the three stages of the conducted pedagogical research (assessment of competences for ADS, self-assessment and expert assessment) confirm the hypothesis that the applied methodological approach for competence-based learning, as part of competence-based education, in the center of which is the learner, leads to better LOs compared to traditional context-based learning.

CONCLUSION

From the research done, the conclusion is forced that for the successful integration of the personality in the modern society and economy based on knowledge, a complete transformation of the traditional education system, oriented towards the assimilation of knowledge, to one oriented towards learning results, at the center of which is necessary is the learner with his personal interests and specifics. The purpose of such training and education is the development of competences - general and professional, which the person develops not only during secondary and higher education, but also throughout life.

The main driving force of the development of both the economy and education are ICTs, which can be successfully implemented as a toolkit in an adequate education oriented towards the development of key and professional competences, such as CBL. With even greater credibility, this also applies to professional education and, in particular, to ICT-related professions such as the "Applied Programmer" profession.

Despite the laid foundation of CA in education, the implementation of such training is still not possible to be implemented in its entirety. Both because of insufficiently developed approaches and because of the lack of curricula and learning content that would allow a personalized approach to the learner. An approach in which learning content and activities are adapted to the personal attitudes, interests and obstacles that each learner has in their learning process.

With regard to CBL, as can be seen from the description of the stages in the ADDIE model, a large amount of additional preliminary work is required. Furthermore, from the survey of teachers' digital competences presented in the appendices, it can be concluded that few teachers are willing to implement it, but it is clear from the research presented that the results are encouraging.

The conducted research allows us to summarize that the proposed methodical approach for CBL on PEP, carried out in secondary vocational education, achieves the training goals set out in the SES for the profession. The proposed methodological approach to learning based on our modified ADDIE model allows learners to successfully develop their key and professional competencies. The proposed methods for creating sets of tasks and for training with them offer a constructive approach for implementing such training under the new PAP educational system.

The methodological approach offers an innovative organization of co-teaching, in which teachers in secondary and higher education participate, including representatives of the software production industry. The proposed innovations also include a flexible learning environment, such as that offered by the author of the CBDTEE dissertation. It facilitates the inclusion of different categories of teachers in synchronous learning, as well as the participation of more than one group of students learning in a mixed environment - learning on-site and in the conditions of DTEE

The usefulness of the proposed methodological approach for CBL is in several directions.

In terms of achievements:

A) Training is aimed at developing competence, not focusing solely on knowledge and skills. Learners are given challenges from real software production, where it often happens that the task giver has not made specifications, but only wants to solve a real problem using applied software.

B) Both professional and basic competencies are developed - application programmers interact with colleagues in teams, with customers, which requires mastery of "soft" skills. They also develop their basic, "transferable", competences specific to other professions, specified in the SES for ULO from the general and sectoral professional training.

Regarding the organization of the learning process:

A) Implementation of team teaching

B) Use of a mixed environment for teaching and learning (one part is trained on site, and another part can participate in parallel in DTEE conditions)

In the conducted experiment of CBL on PAP, different forms of assessment of learners were implemented and the results confirm the hypothesis.

Such training is a challenge for teachers with a view to preparing the teaching content

Contributions from the dissertation

The hypothesis thus established was confirmed after the research was carried out. All productions provided for the realization of the dissertation have been completed. The main scientific and applied contributions of the dissertation work are:

1. Methodical approach for CBT - An integrated resulting competence framework is presented for PAP. A methodological approach for CBT for VET in secondary vocational education was proposed and approved, based on the ADDIE model with appropriately developed sets of tasks for the development of competences, according to a defined framework with requirements for the types of tasks to achieve the set goals in the various ULOs expected results and proposed methodology for their creation and use.

2. CBDTEE – An adaptation of the learning environment - CBDTEE was proposed and approved, allowing: 1) mixed synchronous and asynchronous training on site and in an electronic environment; 2) training by a team of teachers (teachers, professors from higher schools and representatives of the ICT sector); 3) joined DTEE of more than one group.

3. Methodical toolkit for evaluation - A methodical toolkit has been developed and approved for: 1) diagnosis and evaluation of the level of professional competences acquired by learners in the LOs "Dictionaries" of the ULO ADS; 2) self-assessment of professional and basic competencies of students; 3) expert assessment, representing the assessment of skills for writing quality program code through an established KOC based on the recommendations of specialists.

The relationships between the contributions, the tasks of the research, the place of description in the dissertation work and the publications made on the topic of the research are shown in Table 5:

Table 5 Contributions, tasks, publications and their place in the dissertation work

Contribution	Tasks	Chapters	Articles	Reports
1. Methodical approach for CBT	1, 2	I, II	2, 4, 5, 6, 7	1, 2
2. CBDTEE	2	II	1, 3	2
3. Methodical approach for evaluation	3	I, III	2, 4, 7, 8	

Prospects for the development

For the overall implementation of the approach, it is necessary to create ST for all ULOs from SES, as well as for each of them to have enough options with which the training can be adapted both to the interests of the learners, their psychological attitudes and stereotypes of learning, and directed to solving the problems they encounter in mastering the profession.

The paradigm of CA in education and even more so in the professional one is that it should be aimed at achieving LO, in which the learner follows his own learning path. Therefore, the education system should be arranged so that each learner follows his own learning path. Each stage from which to pass only and only with successfully mastered competencies, demonstrated as a result of learning through appropriate behavior, and not after the expiration of a certain period of training.

The successful implementation of CBT can serve as an example for other professions in which this approach should be applied. This can most easily be implemented for the "Programmer" and

"System Programmer" professions, as well as in the profiled training in "Software and Hardware Sciences".

The ideas of CBT are related to the maximum effectiveness of what is learned in practice. Therefore, any innovative practice that enables new ways of facilitating the acquisition of professional skills, as well as new ways of measuring achievement in practice, will make sense to also be used as approaches and means of assessing achievement in learning. Every innovation leading to improvement of work results should also be meaningfully investigated for its benefit in occupational health and safety in the relevant profession.

CBDTEE can also be implemented in other professions, both in terms of cooperation between teachers and professionals, and in terms of pedagogical interaction in the mixed learning environment - on-site and DTEE.

It is recommended to emphasize the digital competences of teachers (DigCompEdu) in all its 6 aspects, which will improve their work.

The education of the future including vocational education and training, is related to the development of abilities to make effective decisions about atypical challenges, which requires out-of-the-box thinking, which is a highly valued personality ability.

Publications on the subject of the dissertation

1. Mollov, M., 2019. Google Classroom – An Innovative Approach To a more Efficient Organization of learning. *Mathematics and Informatics*, 62(5), 509–516, ISSN 1314–8532 (Online).
2. Mollov, M., Stoitsov, G., 2020. The Challenge – National Program “Training In IT Career”. *Mathematics and Informatics*, 63(2), 167 – 178. ISSN 1310–2230
3. Mollov, M., Stoitsov, G., Koleva, G., 2020. Development Of Stem Competencies In Virtual Environment For Occupation “Application Programmer”. Anniversary International Scientific Conference “Synergetics and Reflection in Mathematics Education”, 16-18 October 2020, Pamporovo, Bulgaria, ISBN: 978-619-202-595-3.
4. Mollov, M., 2020. Development Of Competencies During The Education In The Module “Introduction In Programming” As A Part Of The Degree “Application Programmer” Of The National Program “Education For It Career” Of The Ministry Of Education. Anniversary International Scientific Conference “Synergetics and Reflection in Mathematics Education”, 16-18 October 2020, Pamporovo, Bulgaria. ISBN: 978-619-202-595-3.
5. Mollov, M., Stoitsov, G., 2021. Competency Development in the Object-oriented Programming Style Education. *TEM Journal*, 10(4), 1938-1944. ISSN: 2217-8309
6. Mollov, M., Petrov, P., 2022. Developing Problem Solving Competency Using Functional Programming Style. *Mathematics and Informatics*, 65(1), 30–44. ISSN 1310–2230 (Print), ISSN 1314–8532 (Online). <https://doi.org/10.53656/math2022-1-3-dev>
7. Staribratov, I., Mollov, M., Valchev, R., Petrov, P., 2022. Self-Assessment – a Component of the Competence-Based Training in the Profession „Applied Programmer”, Strategies for Policy in Science and Education - Strategii na Obrazovatelnata i Nauchnata Politika, 30(5), 512-525, ISSN 1310–0270 (Print) <https://doi.org/10.53656/str2022-5-5-sel>

8. Mollov, M., Stoitsov, G., 2022. Results of Competence Based Training in the Modules Related to „Algorithms and Data Structures“ in the Profession of „Application Programmer“. *TEM Journal*, 11(4),1606-1611. ISSN:2217-8309 DOI: 10.18421/TEM114-22

Reports: Reports on Paper 3 and Paper 4 were presented at the same conference.

Part of publications have been cited 11 times – 4 citations in foreign and 7 times in Bulgarian articles specified in the dissertation.

Approval

Part of the results obtained in the research have been tested in the following projects:

1. Scientific project MU21-FMI-011 at PU "Paisiy Hilendarski", 2021, topic: "Machine vision in an intelligent environment and organization of work in a learning environment - experimental approaches in the education of students and students", (participant)
2. Scientific project MU21-FMI-004 "Support for conducting scientific research at the School of ICT Innovations", financed by the "Scientific Research" Fund at Plovdiv University "Paisiy Hilendarski", (participant)
3. National program "Training for an IT career" of the Ministry of Education and Culture 2019-2022, (trainer)

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