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MEANS OF EXPERIMENTAL EVALUATION TECHNOLOGICAL COMPETENCE OF TEACHERS OF SPECIAL DISCIPLINES

We investigate the level of personal development of technological competence of teachers of special subjects in vocational schools. The evaluation of the development of technological competence was carried out by testing, case studies, observations, surveys, interviews, writing introspection teachers, compiling teaching portfolio and attendance. In order to obtain an objective assessment of the level of technological competence of the teacher of special disciplines is necessary to make a diagnosis on ascertaining and forming stages, and then spend their comparative analysis and to identify changes in growth of technological competence of teachers. Presented in the form of a general structure of any pedagogical experiment and algorithm research. The importance of clear about the direction of modern pedagogical science and society as a whole. And if the content of the discipline often rigidly defined the basic program, the choice of methods of teaching material can be useful modern educational methods and technology.

Key words: technological competence, personality-oriented technology, methodological support, criterion-diagnostic apparatus, ascertaining stage, the stage of the comparative analysis.

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STUDENTS INDEPENDENT WORK IN THE PROCESS OF LABORATORY STUDIES

The article focuses on various types of laboratory work dependent on didactic aims and methods of their achievement. The succession and process of doing the laboratory work for «Material Technology» course are analyzed. The main stages of laboratory works connected with the process of manufacturing semiconducting materials and determining their physical properties proceeding are analyzed. Practical skills every technical engineer working in the sphere of materials engineering are highlighted. The case study of the laboratory work «Semiconducting Materials Floating-Zone Refining» is presented. Its five stages are sequenced as follows: materials refining, original ingot production, measurement of impurities concentration distribution along the ingot by Hall method, floating-zone refining of the material.

The statement that students' independent work accompanying laboratory work is necessary for educational activities results improvement and develops creative skills and abilities, which leads to stable highly professional competencies training in technical sciences is being substantiated.

Key words: laboratory work, independent work, abilities, skills, competencies, materials technology.

Formulation of the problem. The present level of the physical sciences and engineering development, along with traditional methods of solving tasks is also focused on new goals of education, which not only requires modification of curricula, but also requires the search for new forms and methods of the educational process. Now the important thing is not only the use of previously acquired knowledge, but the generation and application of new ideas. The concept of competence-based approach to education implies the effective development of a student evolution, of his opportunity to be prepared for adaptation in modern society.

An analysis of current research. The main objective of higher education is the formation of a creative personality specialist able to self-development, self-education and innovation [1, 2]. Knowledge transfer from the teacher to the student in finished form is not the most effective way of learning, because student in this case is simply a passive consumer. When performing independent assignments the student moves on to the vigorous activity of the creator who knows how to find the correct, optimum and most effective solution of the given problem. The purpose of the educational process is the development of skills and competences in the field of professional orientation. Independent work of students is one of the most important components of the learning process, during which the formation of skills, abilities and knowledge occurs, and further ensure student mastering techniques of cognitive activity, interest in creative work and, ultimately, the ability to solve educational and scientific tasks [3]. The purpose of student's independent work is the development of such qualities of character of the person, as autonomy, that is, the ability to organize and implement their activities without external guidance and assistance [4]. Independent work of a student is an activity in which in a systematic decrease of direct contact with the teacher student performs learning tasks, for example, course projects, reports, essays, reports, etc. For students of technical profile the laboratory work suits in the best way the delivered educational goals because this form of activity is the independent performance of the task.

Purpose of the article. To expand features of the students independent work organization during laboratory works performance at the specialization in the field of professional activity "Engineering and Physics of Semiconductors.

Statement of the basic material. Informative independence of the students is one of the key prerequisites for improving the quality of training in modern society. Let us consider the possibility of independent work of students on an example of laboratory work in technical subjects. The skills resulting in the implementation of laboratory work is the ability to carry out practical action in the field of the subject. Accumulated abilities lead to the formation of skills, in other words, skills become habitual, which allows freely, without errors and uncertainties to perform the experimental task. The skills acquired during laboratory work, form the competence consisting in commitment and readiness to apply existing knowledge to succeed professionally. Thus, the activation of independent work of the students in laboratory work, promotes the formation of professional competencies.

Based on their didactic purposes lab work can be divided into two main types: teaching and experimental; teaching and research ones [5].

The objective of *teaching and experimental* laboratory work is the formation of the student's abilities and skills by using the experimental equipment, industrial plants and other industrial facilities in the profile of professional activities. Execution of laboratory work contributes to the formation of student's ability to apply standard methods and techniques for the study of investigated objects, to measure and record parameters and properties of these objects, which leads to the formation of practical skills of execution of the experiment and application of technical means. In addition, students learn how to process and interpret the experimental results, to use the modern learning programs in the field of information technology. Leading educational purpose of this type of laboratory work is the experimental confirmation and verification of basic physical laws and regularities.

The purpose of *teaching and research* laboratory work is the formation of student's skills and practical competencies of the experiment carrying out, namely, the students learn to plan an experiment [5], if necessary, to collect the measurement setup and conduct experiments. At this the attention is primarily paid to the object of research that contributes to the formation of competencies related to the study of the properties of the material, its structure and parameters. As a rule, the results have elements of novelty and can create an overall picture of the object being studied.

The form of students laboratory work organizing can be different and therefore the proportion of independent work of the student at their performance is also different. The main objective

of the students independent work organizing is to provide psychological and didactic conditions of intellectual initiative and thinking at any form of training sessions.

Depending on the form of their holding all laboratory work are usually divided into three main forms of working: the frontal, group and individual one. [6]

At the *front learning method* of organization, all students perform at the same time the same lab. This technique is most often used when the first laboratory work is carried out by the first-year students. Most often, even the well knowing the issue essence student, loses himself when is the first time to perform laboratory work at the university level. Implementation of the front learning method allows students to get acquainted in the process of laboratory work by organizing his work at every stage, including the calculation of errors of measurement and report design. Teacher in parallel with the students is doing laboratory work and, on his own example, points as is needed to act. However, the student's preparation level is different, so some students can fall behind with the tempo of work. The teacher controls the learning and cognitive activity of the entire group and, at the same time, is organizing the students cooperation and mutual assistance. It is especially important to emphasize that the frontal organization of academic work can be considered as collective one, in which all learners strive to attain knowledge, assist each other directly or indirectly, support and assist in promoting the goal [6]. In addition, at front learning method of study, a teacher is based on the most active students who are asking, answering in their turn the questions of the teacher by being an example to other students in the orientation and analysis of educational material, that allows more widely and thoroughly to learn this stuff. Such co-curricular activity is a collective work in which each student according to the abilities, interests and the amount of knowledge contributes to the common cause. The educational efficiency of the front work depends largely on the ability of the teacher to keep an eye on the entire group, on one hand, and, on the other hand, does not lose from his sight the work of each student. The proportion of independent work in this form of education is generally low, because the work of the student is reduced to almost a repetition of actions of the teacher and peers. However, such laboratory work has undeniable benefits, such as formation of student's stable skills. Student is learning the nature and progress of the laboratory work, which in the future it will facilitate the training and further he will have the opportunity not to think on the necessary actions of the process performing but to on the considered technical problem.

At *group learning method* different laboratory works are carried out by different student subgroups consisting of 2-3 men. Such method is suitable at the study of non-profile discipline when fulfilling scholar-experimental or familiarizing laboratory work. At the *group learning method* during laboratory work fulfilments the teacher is controlling each group separately by passing from one group to another. As a positive moment is the fact that each subgroup is choosing its own working rate and collaboration is realized between the group members. By communicating students have the possibility to discuss the unclear subjects within the group and with the teacher, therefore at *group learning method of* laboratory work carrying out the individual assistance to the student needed, it is increased as on the behalf of the teacher, as well on the behalf of better trained student of the group. The *group learning method* creates more possibilities for the manifestation of each student individual features and abilities moreover the part of independent work is increasing and consequently increases such qualities as initiative, necessity to find the correct choice, self- appreciation and the possibility to find the correct solution of the problem by using the «testing and mistakes» method. At such learning method is better to give to the student the possibility to independently assemble the set up or electrical scheme for carrying out of the experiment. During of such work the students skills of collaboration and communication are more successfully formed and in this case students are acting not only as participants of the mutual control but also as mutual intellectual activity motivation, which provides a considerable enhancement of the cognitive activity efficiency of each participant.

A special variety of group learning method is the differential group work, which proposes to form groups from the students of the same knowledge level, accordingly fixing the laboratory work goals to correspond to the learning possibilities of the group. But in our opinion such learning process organization leads to the even more differentiation of the students skills and competencies.

During the *individual method* of laboratory work the student completely independently realizes his individual task. The basis for independent work is the whole complex of scientific-theoretical knowledge gained in lectures and seminars. Before starting work, students receive a special note on the implementation of laboratory work – where the requirements are defined, specified sources and aids are indicated and the most rational method is recommended. Despite to the annexed to each laboratory work methodical manual, a student must [7]: distinctly formulate the goal of research; outline a plan of work and measurements, thereby drawing in the best shape the table of measured values. The student should perform the necessary measurements which, on one hand, allow the student to become familiar with the measurement units and appliances, and on the other hand – to develop practical skills; carry out the necessary calculations and analyze the result, which is impossible without the knowledge of the theory.

Thus, as a result of going through all the above steps sequentially the student passes from knowledge to understanding, an overall understanding of the essence of the phenomenon, and then to his experimental research, and finally, to its analysis. This complex method of training allows building up of an integrated knowledge, to form the scientific concept of research and to analyze the possibilities of practical application of the studied material.

At such individual activities the process of learning is the most full and complete, and thus represents the highest stage of independent study.

By coming from the nature of the goal, the performed lab exercises can be divided into: trial operation, used to secure fixation of the studied theoretical material; analytical work used to obtain new information and analysis of accumulated theoretical material; creative works, focused on self-selection approach for solving the problem and the use of previously acquired skills.

Laboratory work on special course "Materials Technology", performed as a part of the training of specialists – physicists in the field of professional activity "Engineering and Physics of Semiconductors" (general area of education – "Exact Sciences") corresponds to the third from the above mentioned types of laboratory work. By category all the performed within this discipline laboratory work can be divided into five major groups related to: cleaning of semiconductor materials; synthesis of binary compounds; growing single crystals; obtaining thin layers; treating the semiconductor surface. All laboratory works, except for the technical part, related to obtaining of the necessary material, are obligatorily accompanied by an analysis of the parameters and properties of these materials. Thus, at the majority of labs carrying out the students should have skills in the following areas:

– Work with the glass by using a gas burner that is necessary in the manufacturing of certain form ampoules and so-called "sealing-off" of the evacuated ampoules;
– Work with the chemicals being used in the purification of the produced ampoules, as well as at laboratory work on chemical etching of semiconductor surfaces and the study of processes of photolithography;
– Work on vacuum industrial installations;
– Working on the system using high temperatures, particularly in growing single crystals in furnaces at temperatures reaching 600-650^{o}C;
– Work on installations for the electrical measurements.
– All of these works require safety admittance and special care of the student, so have to be made under the direct supervision of a teacher or a lab assistant if needed.

In fact, laboratory work on " Materials Technology " are among the most complex and bulky to implement, so the duration of each work takes from 6 academic hours (one session) to 12 hours (two sessions), and academic subgroup consists of 6–7 students, no more. A feature of these labs is a necessity for the students to possess not only the theoretical but also practical training which they have to do directly in the laboratory. At the selection of laboratory work content and objective is necessary to consider the complexity of the educational material, interdisciplinary commu-

nication, a place that takes this specific work in conjunction with other laboratory works, practical skills of the students at the given stage of training, as well as its importance for the formation of a holistic understanding of the content of the discipline.

As an example one can consider the scheme of implementation of laboratory work "Refining of semiconductor materials by zone recrystallization". Performing of this operation can be divided into five major steps:

1. Preparatory phase: chemical cleaning, washing and drying of two previously prepared ampoules; filling of ampoule having a smaller diameter with a source material containing impurities; evacuating air from the ampoule to a pressure of ~ 10^{-1}...10^{-2} torr and its sealing.

2. Fabrication of the starting ingot includes: the ampoule is set in a furnace and heated to the melting temperature of the used material (temperature is monitored by a thermocouple); at the melting temperature and constant vibration ampoule containing the needed substance is maintained for 30 minutes, then cooled; the obtained cylindrical ingot of 10...12 cm length is removed from the ampoule.

3. Measurement of the of impurity concentration distribution along the ingot: installation for Hall effect measurements is used; the semiconductor ingot is inserted into the special holder and carrier concentration measurements are carried out in the points by centimetre distance, by assuming that the impurity atoms are fully ionized; the impurity concentration dependence on length is drawn by coming from assumption that the impurity is uniformly distributed.

4. Semiconductor refining by zone melting: the measured ingot is inserted into the second ampoule and the process of air evacuation and sealing is repeated; ampoule is mounted in the installation and, by using a small furnace in the form of a ring, first it melts only the initial portion of the ingot of the length of about 1,5...1 cm; then the furnace is moving very slow along the ingot length and, accordingly, the molten zone is moving; process is repeated three times.

5. Determination of the segregation coefficient: the repeated measurements of impurity concentration along the ingot are conducted; a graph of the impurity distribution along the ingot is drawn and the coefficient of segregation is calculated, according to theory; the report is issued.

When planning the subject and the goal of the laboratory work one should take into account that during assignments performance such actions of the students as: observation, comparison, analysis, establishing dependencies, formulation of conclusions and generalizations, independent management of research, design results, are activated. Thus, a scientific-research skills or, in other words, professional competencies are formed.

Conclusions. Strengthening the role of independent work of students allows a more successful development of the ability to learn, the student develops the capacity for self-development and creative application of the knowledge gained. Independent work completes the task of learning activities by forming abilities, skills and competence of highly qualified specialists..

References:

1. Рекомендации по организации самостоятельной работы студентов [Электронный ресур]. – Режим доступа: http://www.isuct.ru/umo/orgproc10.html
2. Шарипов Ф.В. Педагогика и психология высшей школы / Ф.В. Шарипов. – М. : Логос, 2012. – 446 с.
3. Жиркова З.С. Роль самостоятельной работы студентов в образовательном процессе [Электронный ресурс] / З.С.Жиркова, Н.Н. Новгородова, Н.Г. Бехтюева, Н.Д. Габышева // III Общероссийская студенческая электронная научная конференция «Студенческий научный форум». – Режим доступа: http://www.rae.ru/forum2011/10/719
4. Гуменюк Е.А. Педагогика и психология, теория и методика обучения [Электронный ресур] / Е.А. Гуменюк. – Режим доступа: http://lib.herzen.spb.ru/media/magazines/contents/1/28(63)2/gumenyuk_28_63_2_59 _63.pdf
5. Положение об организации лабораторных работ в УГНТУ [Электронный ресурс]. – Режим доступа: http://www.rusoil.net/pages/14669/Pol_lab_rab.pdf
6. Иванова И.В. Социальные формы организации учебной деятельности как один из факторов формирования профессиональных качеств у студентов технических вузов / И.В. Иванова // Фундаментальные исследования. – 2006. – № 6. – С. 84-85.
7. Никорич В.З. Особенности изучения термоэлектрического эффекта в полупроводниках / В.З. Никорич, О.А. Голбан, О.В. Куликова // Збірник наукових праць Кам'янець-Подільського національного університету ім. Івана Огієнко. Серія педагогічна. – 2010. – Вип. 16. – С. 214-217.

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САМОСТІЙНА РОБОТА СТУДЕНТІВ У ПРОЦЕСІ ВИКОНАННЯ ЛАБОРАТОРНИХ РОБІТ

У статті розглядаються різні типи лабораторних занять залежно від поставлених дидактичних цілей і методів їх досягнення. Аналізується послідовність і процес виконання лабораторних робіт з курсу «Технологія матеріалів». Наводиться аналіз основних етапів виконання робіт, пов'язаних з процесом виготовлення напівпровідникових матеріалів і визначенням їх фізичних параметрів. Вказані практичні навички, якими зобов'язаний володіти інженер-технолог, працює в області технології матеріалів. На прикладі лабораторної роботи «Очищення напівпровідникових матеріалів методом зонної перекристалізації», наведено п'ять основних етапів її виконання, що включають очищення матеріалів, отримання вихідного злитка, вимірювання розподілу концентрації домішок вздовж злитка методом Холла, очищення речовини методом зонної плавки.

Обгрунтовується твердження, що самостійна робота студентів, яка супроводжує виконання лабораторних робіт, необхідна для підвищення результативності навчальної діяльності, розвиває творчі вміння та навички, що призводить до формування компетенцій фахівця високої кваліфікації в галузі технічних наук.

Ключові слова: лабораторна робота, самостійна робота, майстерність, навички, компетентності, технологія матеріалів.

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САМОСТОЯТЕЛЬНАЯ РАБОТА СТУДЕНТОВ В ПРОЦЕССЕ ВЫПОЛНЕНИЯ ЛАБОРАТОРНЫХ РАБОТ

В статье рассматриваются различные типы лабораторных занятий в зависимости от поставленных дидактических целей и методов их достижения. Анализируется последовательность и процесс выполнения лабораторных работ по курсу «Технология материалов». Приводится анализ основных этапов выполнения работ, связанных с процессом изготовления полупроводниковых материалов и определением их физических параметров. Указаны практические навыки, которыми обязан владеть инженер – технолог, работающий в области технологии материалов. На примере лабораторной работы «Очистка полупроводниковых материалов методом зонной перекристаллизации», приведены пять основных этапов её выполнения, включающих очистку материалов, получение исходного слитка, измерение распределения концентрации примесей вдоль слитка методом Холла, очистку вещества методом зонной плавки.

Обосновывается утверждение, что самостоятельная работа студентов, сопутствующая выполнению лабораторных работ, необходима для повышения результативности учебной деятельности и вырабатывает творческие умения и навыки, что приводит к формированию стабильных компетенций специалиста высокой квалификации в области технических наук.

Ключевые слова: лабораторные работы, самостоятельная работа, умение, навыки, компетенции, технология материалов.

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