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COMPETENCE FORMING INTERDISCIPLINARY INTEGRATION IN TEACHING TECHNOLOGY

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A B S T R A C T

The study explores the development of interdisciplinary competence in teaching Technology as a school subject, emphasizing its significance within modern educational paradigms. The research provides a scientific analysis of the content of technology education, mechanisms of interdisciplinary integration, didactic foundations of the competence-based approach, and a system of skills formed in learners. The study highlights integrative-module methods, instructional strategies, and cognitive-activity approaches that enhance the effectiveness of interdisciplinary teaching. The results hold scientific and practical value for improving technology curricula and strengthening learners' creativity and problem-solving competencies.

K E Y W O R D S

Technology education, interdisciplinary integration, competence, didactic approach, problem-based learning, creativity.

INTRODUCTION

Competency, which forms interdisciplinary connection in the teaching of technology, is one of the strategic factors of the modern educational process, which requires not only the integration of the content of training subjects on an integrated basis, but also the development of a multicomponent set of knowledge, skills and competencies aimed at solving complex problems in students. In today's conditions of globalization, the effectiveness of the educational process is inextricably linked with interdisciplinary thinking, communicative cooperation, creative and intellectual activity, and technology science is at the center of these processes. Because technology education, by its essence, is naturally integrated with physics, mathematics, engineering, biology, chemistry, economics, art and information technology, forming in students the competence of systematic analysis, design, modeling and practical result creation of real-life processes. In this context, the organization of interdisciplinary interdependence in technology is an important didactic factor that directly influences the innovative development of the general secondary education system, functional literacy and vocational training of students. This study is aimed at determining the theoretical and methodological foundations of interdisciplinary integration in the process of technological education, analyzing the mechanisms of the manifestation of the competency approach in the teaching process, as well as covering effective strategies for the formation of integrative competence in students on the basis of scientific evidence,

and the advanced international experiences, existing pedagogical problems and practical solutions in this direction are studied in depth.

METHODOLOGY

The methodological basis of this study is an integrative approach aimed at the complex study of theoretical, psychological, pedagogical and didactic aspects of competence that form interdisciplinary relationships in teaching technology science. During the study, the methods of systematic analysis, pedagogical diagnostics, comparative, modeling, pedagogical experiment, expert assessment and statistical analysis were used. Through systematic analysis, the content components of technological education, the necessary conditions for interdisciplinary integration and the structural structure of competence have been identified. On the basis of the comparative method, integrative practices in the process of teaching technology in advanced foreign schools—Finland, South Korea, Singapore, Japan, Turkey and Germany—were studied. The pedagogical experiment was organized in three stages: diagnostic preparation, practical implementation and effectiveness assessment, in which students of grades 5-9 of secondary schools took part. During the experiment, modular teaching technologies based on interdisciplinary integration, design and methodological approach, STEAM and cognitive-functional methods were tested. The results were processed by the methods of correlation, dispersion and factor analysis of statistical analysis and the observed changes in the integrative competence of students were scientifically substantiated. At the same time, semi-structured interviews with teachers were conducted, which clarified the difficulties, opportunities and proposals in practice in ensuring interdisciplinary connectivity in technology science. The set of methods used in the study served to ensure the reliability, reproducibility and scientific value of the results.

RESULTS

The results of the study have scientifically demonstrated on the scientific basis that the process of development of competence, which forms interdisciplinary dependence in the teaching of technology science, is a multifactorial, complex and mutually integrated didactic structure; a significant change in students' knowledge, skills and competencies was found to be caused by the use of modular-integrative educational technologies, STEAM approach, design assignments, hands-on and creative activities and cognitive-functional methods used in the experimental process, which were observed by clear indicators at all stages of the learning process; In particular, if at the diagnostic stage the level of understanding of interdisciplinary integration in technology was low, during the process these indicators increased regularly: before the experiment, only 22.7% of students had sufficient competence in identifying, analyzing, and applying interdisciplinary connections, and at the end of the experiment this indicator reached 68.4%; in particular, it was observed that the tasks on design, modeling of problem situations, drawing up technological maps of labor processes, determination of mathematical and physical laws used in production processes, practical modeling of biological and chemical processes sharply activated the ability of students to apply interdisciplinary connections; a significant positive shift was noted in the competence of students in speech, logic, problem and creative thinking — during the experiment, the level of hands-on reasoning of students increased from 31.2 percent to 74.9 percent, and the speed and accuracy of solving problem situations increased from 27.4 percent to 71.3 percent; These indicators indicate an increase in students' ability to think independently on the basis of integrated knowledge, to quickly identify logical connections between

data in different disciplines, to translate theoretical knowledge into practice and to generate new ideas; Also, during the experiment, the effectiveness of students' project activities increased sharply — an analysis of 312 project works completed in grades 5–9 showed that at the beginning of the process, students' design practice was more repetitive, relying on traditional solutions, while from the third stage of the experiment, 61% of project work began to include new technological ideas based on a creative-intellectual approach; This confirms the ability of students to apply not only the basics of technology science, but also the basics of mathematics, physics, chemistry, biology, computer science and economics on an integrated basis; As a result of the cognitive-activity methods used in the educational process, students' ability to independent research, information analysis, modeling and constructive decision-making activity increased markedly; according to follow-up protocols, student engagement in classes rose from 38 percent to 82 percent; The number of Q&As provided during the lessons doubled and the number of alternative solutions put forward by students increased by 4.7 times; Positive dynamics were also observed in the professional competence of teachers to organize interdisciplinary integration — an analysis of the activities of 17 technology teachers showed that the ability to design integrative lessons increased from 41 percent to 83 percent, the ability to develop cognitive-functional tasks from 37 percent to 79 percent; The results of the interviews show that 89% of teachers reported that integrated teaching increased lesson effectiveness, while 76% noted that students' motivation increased; According to the results of the statistical analysis, the performance of the experimental group was higher than that of the control group — dispersion analysis (ANOVA) reliably confirmed the effectiveness of integrative training with a value of $p<0.05$; Correlational analysis showed a positive correlation of $R=0.71$ between the degree of understanding of interdisciplinary relationships and competence in problem solving; These results confirm that the formation of competence based on interdisciplinary integration in the teaching of technology has not only a theoretical basis, but also solid empirical evidence: students have achieved significant advances in systems thinking in practical activities, identifying logical connections between different disciplines, modeling technological processes and developing new ideas; Also, the results of the study form the basis for improving the content of technology in general secondary education, improving the skills of teachers and the introduction of integrative education strategies; The results show that competence based on interdisciplinary relationships significantly increases students' functional literacy, creativity, ability to analyze problem situations and practical efficiency.

DISCUSSION

The results of the study show that the process of formation of interdisciplinary competence in the teaching of technology is inextricably linked not only with pedagogical, but also with psychological, didactic, methodological and social factors; The effective formation of this relationship expands the essence of the knowledge mastered by students, stimulates their understanding in integration with real-life experience and turns educational activity into an active, purposeful, creative process; It is noted in the scientific literature that teaching the subjects in isolation leads to the formation of fragmentary knowledge in students, especially since the science of technology is located at the intersection of different disciplines, and the results of this study confirm these theoretical conclusions in practical terms; The effectiveness of integrative-modular teaching technologies has a significant impact on the cognitive processes of students, in particular the development of attention, memory, logical analysis, problem thinking and creativity, which increases the psychological-didactic value of

interdisciplinary relationships in the educational process; the results obtained are consistent with international best practices, for example, it is noted that STEAM integrated teaching of technology in the education systems of Finland, Japan and South Korea strengthens students' competence in engineering thinking, creative solutions, teamwork and modeling real processes; In this study, these aspects were also confirmed in a practical way — students applied not only theoretical knowledge in the process of performing integrative tasks, but also showed a high activity in the development of new technological ideas, an approach to existing problems from the point of view of various disciplines and practice-oriented creative activities; The results of the pedagogical experiment show that interdisciplinary integration not only enriches the internal logical structure of the educational content, but also develops the competence of students for independent study, research and self-assessment, because in integrative teaching students are forced to work with different sources, work on themselves, summarize knowledge and apply it in real situations; Such a process enhances students' functional literacy and vital competence, which is recognized as a key criterion in the modern educational paradigm; Also, during the study, it was revealed that the professional competence of teachers in the organization of integrative lessons is actively developed — this situation is directly related to the methodological training, creative approach of the teacher personality and the ability to use innovative pedagogical technologies; the results of the interviews show that teachers believe that integrated educational technology increases the effectiveness of the lesson process, encourages students to think actively and strengthens their project-based skills; one of the important points of the study is that the revision of the content of curricula for the effective organization of interdisciplinary interdependence, the multilevel complexity of educational tasks, the introduction of integrative activities in accordance with the young psychological characteristics of students in most cases increase the effectiveness of the study; Also, due to the practical nature of technological science, the use of examples related to real production technologies, modern labor processes, technical systems and digital technologies in the application of interdisciplinary interconnection arouses high motivation in students; The analysis of scientific literature also shows that an integrative approach is the main factor in improving the effectiveness of students' practical activities — especially in constructive design, modeling, conducting experiments, assessing problem situations and developing creative solutions; The scientific novelty of the research results is that on the example of technological science, an integrated model of interdisciplinary relationship was developed, where the integrative structure of didactic units, structural stages of educational activity, logical consistency of methodological processes and indicators of the development of competence were interpreted as a whole system; This model provides a stepwise development of learners' cognitive, practical, creative, problem-based, and communicative competencies; In general, the introduction of interdisciplinary integration in technology significantly increases students' intellectual potential, planning of practical activities, understanding of technical processes, understanding of the essence of production technologies and creativity; Moreover, an integrative approach prepares students for the conscious choice of careers in technical, engineering, and technological fields in the future, which is of importance for the continuity of education and socio-economic development.

CONCLUSION

The results of the above research clearly confirm that the formation of interdisciplinary competence in the teaching of technology is a complex, but incredibly effective educational process requiring a

deep understanding of the scientific-methodological, psychological-didactic and practical and pedagogical foundations of the educational process; in the process of integrative education, when the science of technology is taught in conjunction with different disciplines - mathematics, physics, biology, chemistry, computer science, economics, engineering and art, the scale of knowledge of students expands, their logical thinking, ability to independently find solutions to problem situations increase, and their creativity develops significantly; positive changes in the activities of students, a significant superiority of the indicators of the experimental group over the control group, reliable evidence obtained in statistical analyses scientifically confirm the high efficiency of integrative-modular teaching technologies; the model of competency, which forms interdisciplinary interdependencies, developed during the study, is a systematic structure covering all stages of the educational process, where the concept of stepwise development of students' cognitive, practical, creative, communicative and problem-thinking competence is proposed; This model is a universal methodological direction for technology education and has important scientific and practical value in optimizing curricula, strengthening teachers' professional training, developing the potential of integrative thinking of students; Also, practice has shown that interdisciplinary integration in technology creates an effective learning environment, increases students' motivation, enhances the active learning process and prepares students for the understanding and analysis of real technological processes; The research results show the need to modernize the content of technology in education policy, improve teachers' qualifications, expand integrative educational resources and increase the share of innovative methods in the educational process; According to the general conclusion, teaching technology on the basis of interdisciplinary connection is the decisive factor that significantly increases the functional literacy, intellectual potential, creative thinking and professional guidance of students, and this approach should be recognized as one of the strategic directions of innovative development in the general secondary education system of the republic.

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