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Formation of readiness for professional activity of future dentists on the basis of interdisciplinary integration

Oleksandr A. Kaniura, Natalia V. Stuchynska, Ihor A. Prokhorenko BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE

ABSTRACT

Aim: To present general approaches to designing a model of interdisciplinary integration of the discipline «Biomechanics of the maxillofacial apparatus. Physical foundations of gnathology».

Materials and Methods: To accomplish the tasks set, the following theoretical and empirical methods of scientific research were used: system analysis, comparison and generalization for the theoretical substantiation of approaches to the organization of the educational process of dental students, bibliosemantic method. In order to design the interdisciplinary integration model, the dot textual graph description language as well as the Graphviz open-source toolkit for graph visualization were used.

Results: According to the established valence of vertex p7, was determined that the practical lesson «Methods of diagnosing dento-maxillary anomalies and deformations. Devices for registering and analyzing movements of the lower jaw. Analysis of occlusion in the articulator» is the most integrated with the complex of educational disciplines. Next, the vertex p9 has the lowest degree of valence. The approach we used made it possible to determine the role and place of each topic of practical classes, to adjust the structure of the educational discipline content and the time allocated to the study of each topic.

Conclusions: Establishing interdisciplinary connections based on the principles of designing a mixed graph makes it possible to identify points of contact in the content of academic disciplines, techniques, and methods of mental and educational activity of higher education students, thereby strengthening the foundation for the formation of professional practice-oriented competencies.

KEY WORDS: biomechanics of the maxillofacial apparatus, physical foundations of gnathology, interdisciplinary integration, dental students

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INTRODUCTION

The analysis of statistical data and scientific research shows that a significant proportion of dental diseases and complications is associated with insufficient understanding of the multifunctional connection between elements and tissues of the dentofacial system in normal and pathological conditions, improper use of the knowledge in reconstructive dentistry, diagnostics, and prevention of dental diseases. Developed and implemented for 221 «Dentistry» specialty, the «Biomechanics of the maxillofacial apparatus. Physical foundations of gnathology» academic discipline is aimed at covering this gap.

One of the important tasks in the process of constructing the content of the academic discipline was the primary orientation to the analysis of trends in the development of modern dentistry and approaching the achievements of modern science and practice. While trying to form holistic systemic knowledge among dental students, ensuring interdisciplinary integration of fundamental natural and professionally oriented clinical disciplines, it is crucial to remember of its particular importance.

AIM

The aim of the article is to present general approaches to designing a model of interdisciplinary integration of the discipline «Biomechanics of the maxillofacial apparatus. Physical foundations of gnathology».

MATERIALS AND METHODS

To accomplish the tasks set, the following theoretical and empirical methods of scientific research were used: system analysis, comparison and generalization for the theoretical substantiation of approaches to the organization of the educational process of dental students, bibliosemantic method, interviews with students and teachers. In order to design the interdisciplinary integration model, the dot textual graph description language as well as the Graphviz [1] open-source toolkit for graph visualization were used.

RESULTS

In order to determine the system of interdisciplinary connections of each of the topics of the investigated discipline, the entire complex of academic disciplines studied by students of 221 «Dentistry» specialty was considered. The training system consists of two training cycles: general and professional. The set of disciplines belonging to the specified cycles can be divided into three groups: fundamental professionally oriented, clinical, medical and preventive ones.

The first group includes: Human anatomy, including head and neck anatomy (b1); Histology, cytology, and embryology (b2); Medical biology (b3); Medical and biological physics with the basics of medical informatics (b4); Medical biochemistry, including oral biochemistry (b5); Microbiology, virology, and immunology, including oral microbiology (b6); Physiology, including maxillofacial physiology (b7); Radiology, radiology in dentistry (b8); Pathomorphology, including head and neck pathomorphology (b9); Pathophysiology, including maxillofacial pathophysiology (b10); Pharmacology (b11).

The most numerous group of clinical disciplines consists of: Propaedeutics of internal medicine, including patient care practice in the internal medicine clinic (c1); Preclinical course in pediatric therapeutic dentistry, including nursing practice in dentistry (c2); Prevention of dental diseases, including clinical practice in the prevention of dental diseases (c3); Internal medicine, including endocrinology, epidemiology, infectious diseases, clinical pharmacology (c4); Surgery, including neurosurgery, oncology, patient care practice in the surgical department (c5); General medical training (c6); Orthodontics, including clinical practice in orthodontics (c7); Orthopedic dentistry, including fixed dental prosthetics, removable dental prosthetics, maxillofacial prosthetics, implant prosthetics, clinical practice in orthopedic dentistry (c8); Therapeutic dentistry, including cariesology, endodontics, periodontology, diseases of the oral mucosa, clinical practice in therapeutic dentistry (c9); Surgical dentistry, including tooth extraction, anesthesia and inflammatory diseases of the maxillofacial region, maxillofacial traumatology, maxillofacial oncology, reconstructive maxillofacial surgery, clinical practice in surgical dentistry (c10); Pediatric therapeutic dentistry, including clinical practice in pediatric therapeutic dentistry (c11); Pediatric surgical dentistry, including clinical practice in pediatric surgical dentistry (c12); Emergency and urgent medical care (c13).

Medical and preventive disciplines include Social Medicine, Public health, and fundamentals of evidence-based medicine (d1); Hygiene and ecology (d2).

The abovementioned division of disciplines is conditional, since many of them are closely intertwined in their content. To achieve the set objectives of the research and construction of an interdisciplinary integration model, we will be guided by the mentioned classification of disciplines.

In order to create conditions for the practical application of acquired knowledge, skills and abilities, as well as to provide higher education students with the opportunity to see and evaluate their own results of performing practical tasks, it is necessary to design interdisciplinary connections that would characterize the actual points of contact in the content of disciplines, curricula, and programs. Another aspect here is the common methods formation of intellectual and educational activity of higher education students. To identify the general ideas of the disciplines, it is important to distinguish the essential attributes of the educational elements of each of them. The components of the methodological system of education (goals, methods, forms, means, content of education) of disciplines have their own specific differences; however, for each concept that is common and considered in a particular discipline, it is necessary to highlight a set of common features in accordance with the didactic goals.

To visually represent the model of intersubject connections, a mixed graph was built (Fig. 1), in which:

- -the practical classes cluster (with vertex at V_p) consists of the tuple p1, p2, ..., pn (where p is some practical class), which is connected by oriented edges p1 \rightarrow p2 \rightarrow pn;
- -the lectures cluster (with vertex at V₁) consists of the tuple 11, 12, ..., In (where I is some lecture), which is connected by oriented edges $11 \rightarrow 12 \rightarrow 1n$;
- -the fundamental professionally oriented disciplines cluster (with vertex at Vb) consists of the tuple b1, b2, ..., bn (where b is some fundamental professionally oriented discipline), which is connected by edges $b1 \rightarrow b2 \rightarrow bn$;
- -the clinical disciplines cluster (with vertex at Vc) consists of the tuple c1, c2, ..., cn (where c is some clinical discipline), which is connected by the edges $c1 \rightarrow c2 \rightarrow cn$;
- -the medical and preventive disciplines cluster (with vertex at Vd) consists of the tuple d1, d2, ..., dn (where d is some medical and preventive discipline).

A mixed graph of interdisciplinary integration is a graph in which edges can be both directed and non-directed, G:= (V, A, E), where V is a set of vertices, A is a set of (ordered) pairs of distinct vertices (called edges), E



Fig. 1. The example of a mixed graph of interdisciplinary integration

is a set of (unordered) pairs of distinct vertices (called edges). Separate clusters (p1, p2, ..., pn), (l1, l2, ..., ln), (b1, b2, ..., bn), (c1, c2, ..., cn), (d1, d2, ..., dn) are the associations of homogeneous elements, which are considered as independent units with certain properties. The mentioned associations form a subgraph with vertices $V_a(V_a,V_b), V_{b'}, V_{c'}, V_{d'}$ respectively.

Based on the results of the study of the complex of educational disciplines content [2] and the structure of practical classes in the «Biomechanics of the maxillofacial apparatus. Physical foundations of gnathology» discipline [3], one of the possible graphs of intersubject (integration) connections was designed (Fig. 2).

DISCUSSION

In works [4-6], various aspects of professional training of students of 221 «Dentistry» specialty are considered; in works [7-10] – modern approaches in gnathology and the corresponding principles of diagnostics and treatment, which must be followed in dentistry. Using the conclusions drawn on the basis of the considered scientific sources and our own practical experience, we will suggest possible relationships between the topics of practical classes (designated as vertices of the graph: p1, p2, p3, ..., p9) with fundamental professionally oriented, clinical, medical and preventive disciplines (through the corresponding vertices and edges of the graph). Next, we will present the relationships between the topics of practical classes:

Vertex p1: b1 is a structure of musculoskeletal joints and their classification; b2 is a microstructure of tissue joints; b4 is physical foundations of force, moment of force, and levers; b7 is biomechanics of the dento-maxillary apparatus; c5 is the use of levers during surgical interventions; c7 is the use of mechanical principles in the design of orthodontic appliances, choice of fulcrum in orthodontic treatment; c8 is a balance of loads in prostheses; c9 is the influence of mechanical load on the periodontium; c10 is the influence of pathological joints on jaw functions; d1 is the influence of correct occlusion on general health; d2 is ensuring hygienic care of orthodontic appliances.

Vertex p2: b4 is foundations of deformation mechanics, elasticity measurement, strain gauge analysis of



Fig. 2. An example of one of the possible graphs of intersubject (integration) connections

tissues; b7 is a functional adaptation of tissues; b9 is the changes in bone structure in diseases; b10 is pathological changes in deformations; c8 is the determination of load parameters in prosthetics; c9 is the influence of deformations on periodontal diseases; d2 is prevention of deformations.

Vertex p3: b1 is a structure of the lower jaw joints; b7 is biomechanics of the muscles that control jaw movement; b8 is diagnostics of the TMJ condition and visualization of changes; b10 is the causes and consequences of dysfunctions; c5 is surgical elimination of TMJ pathologies; c7 is the study of the effect of occlusion on the TMJ, correction of TMJ disorders; c9 is conservative treatment of disorders; d1 is the consequences of dysfunctions for psychosocial well-being; d2 is hygienic care for TMJ dysfunctions.

Vertex p4: b3 is muscle microstructure; b4 is the processes of muscle contractions; application of models in research; b7 is the analysis of muscle structure and function in movement; c6 (physical rehabilitation) is the assessment of muscle function in pathologies and recovery from injuries; d1 is effect of physical exertion on general performance.

Vertex p5: b3 is cell action potential; b4 is theoretical modeling of biomechanical processes; b7 is muscle contraction in real conditions, mechanisms of impulse transmission; c1 is physiological basis of diseases of the muscular system; c2 is muscle activity of children during dental treatment; c3 is a control of muscle activity of the maxillofacial region; c4 is correction of muscle pathologies; c5 is modeling of muscle contractions in planning operations; c7 is correction of occlusion and function of the masticatory apparatus; c8 is the design of prostheses that do not disrupt the physiological activity of the muscles; c9 is treatment of periodontal and functional pathologies; c10 is reconstructive surgery and tooth extraction; c11 is treatment of children with muscle dysfunctions; c13 is resuscitation measures and elimination of spasms in emergency conditions; d1 is the approaches to assessing the prevalence of muscle pathologies; d2 is the prevention of muscle function disorders through control of professional, environmental, and hygienic factors.

Vertex p6: b2 is tissue changes in the periodontium under the influence of biomechanical factors and processes of orthodontic tooth movement; b3 is genetic and biological foundations of the formation of the dento-maxillary apparatus anomalies; b4 is physical laws in modeling orthodontic movements, load distribution, and the influence of occlusion; b5 is biochemical processes in periodontal tissues and joints during adaptation to occlusal changes; b7 is adaptation of the dento-maxillary apparatus to load; b8 is visualization of jaw structures; b10 is understanding the mechanisms of development of dento-maxillary apparatus dysfunctions caused by occlusal factors; b11 is the use of drugs to reduce inflammatory processes or relieve pain during correction of occlusal disorders; c1 is care for patients with occlusal disorders; c2 is the influence of occlusion on the development of the dento-maxillary apparatus of children and methods of disorders prevention and correction; c3 is prevention of occlusal anomalies; c5 is surgical treatment of severe occlusal disorders requiring reconstruction or correction of the dento-maxillofacial apparatus; c7 is the influence of occlusion and TMJ dysfunction on the dento-maxillofacial apparatus; c8 is the influence of occlusal relationships on the manufacture of maxillofacial prostheses; c9 is the role of occlusal factors in the development of caries, periodontal diseases, and pathologies of the oral mucosa; c10 is treatment of maxillofacial pathologies caused by or accompanied by occlusion disorders; c11 is early diagnosis and treatment of occlusal anomalies of children; c12 is surgical correction of maxillofacial disorders of children caused by occlusal deformities; c13 is emergency care for injuries of the dento-maxillofacial apparatus that affect occlusion and joint function; d2 is the preventive measures and the influence of environmental factors and hygiene recommendations.

Vertex p7: b1 is the analysis of movements of the lower jaw and occlusal contacts, work with articulators; b2 is the processes occurring in pathologies and anomalies; b3 is biological aspects of growth and development of tissues of the maxillofacial region; b4 is physical principles of operation of devices for recording movements of the lower jaw; b5 is the biochemical processes in tissues of the maxillofacial region; b6 is the role of oral microflora in the formation of anomalies and deformations, the influence of infectious processes on the condition of the dento-maxillofacial system tissues; b7 is physiological mechanisms of movements of the lower jaw, functioning of the TMJ, and occlusion; b8 is the use of radiological methods for diagnosing anomalies and assessing the condition of the maxillofacial region; b9 is morphological changes in tissues in pathologies and deformations; b10 is the analysis of processes underlying dysfunctions of occlusion and movements; b11 is the use of medications for the treatment of maxillofacial pathologies; c1 is identification of systemic diseases that may affect

dentofacial anomalies (for example, endocrine or infectious processes); c2 is the methods for diagnosing anomalies in the development of the dentofacial apparatus of children; c3 is an early detection of dentofacial anomalies at the stage of preventive examinations; c4 is the use of pharmacological agents to correct conditions that complicate diagnosis or treatment; c5 is the diagnosis and treatment of complex anomalies that require surgical correction; c7 is the use of articulators and other devices for occlusion modeling and treatment planning; c8 is the study of the influence of prostheses on the movements of the lower jaw and the state of the TMJ; c9 is identification of changes in the movements of the lower jaw due to diseases; c10 is diagnostics and restoration of functional disorders after injuries or surgical interventions; c12 is detection of anomalies at early stages of development and their correction; d1 is accessibility of modern diagnostic methods for the population; d2 is the safe use of radiation methods in dentistry.

Vertex p8: b1 is understanding the anatomical structures of the head, neck, and maxillofacial region is the basis for interpreting the results of CT, MRI and ultrasound; b2 is understanding the microscopic structure of tissues to assess changes; b4 is physical principles of CT, MRI, ultrasound; b8 is the use of radiological approaches to assess pathologies of teeth, jaws, and TMJ; c5 is the use of CT for planning operations; c7 is the analysis of jaw movements; c8 is articulation in prosthetics; functional assessment; d1 is the development of evidence-based approaches to the prevention of TMJ diseases; d2 is hygienic standards for the use of diagnostic devices, assessment of the impact on the health of patients and doctors when using CT, MRI.

Vertex p9: b4 is the fundamentals of digital data processing, use of virtual reality in dentistry; c7 is the use of 3D technologies for treatment planning; c8 is the use of digital impressions to create prostheses; d1 is an introduction of digital technologies into the healthcare system.

By studying the valence of the vertices of the resulting graph, it was found that the vertex p7 has the highest degree of 23, as evidenced by the number of edges belonging to the vertex. According to the established valence of this vertex, it can be concluded that the practical lesson «Methods of diagnosing dento-maxillary anomalies and deformations. Devices for registering and analyzing movements of the lower jaw. Analysis of occlusion in the articulator» is the most integrated with the complex of educational disciplines. Reliance on the identified relationships is the basis for the formation of systemic knowledge about the structural and functional characteristics of the dento-maxillofacial system. Indeed, the elements of the dento-maxillary system interact through forces, moments of forces, and levers taking into account the points of support, providing biomechanical processes that are important for correct use in therapeutic, preventive, and reconstructive dentistry. Understanding the essence of deformation processes in bone tissues and the features of muscle contraction is the basis for effective treatment in orthodontics. The approach we used made it possible to determine the role and place of each topic of practical classes, to adjust the structure of the educational discipline content and the time allocated to the study of each topic. Based on the results of the study, the changes made to the structure of the educational discipline confirm its effectiveness.

CONCLUSIONS

Establishing interdisciplinary connections based on the principles of designing a mixed graph makes it possible to identify points of contact in the content of academic disciplines, techniques, and methods of mental and educational activity of higher education students, thereby strengthening the foundation for the formation of professional practice-oriented competencies.

Researching the set of relationships between individual topics of an academic discipline with a complex of academic disciplines using the mixed graph method helps to design (or significantly improve) the structure of the content, sequence, and volume of lecture and practical classes of an academic discipline, ensuring a significant effect from the use of an interdisciplinary approach.

REFERENCES

- 1. Graphviz. https://graphviz.org. [Accessed 26 January 2025]
- 2. Osvitno-profesiina prohrama zi spetsialnosti 221 «Stomatolohiia» [Educational and professional program in the specialty 221 «Dentistry»]. https://drive.google.com/drive/folders/1r0HoQ6povdPbin7lcYj199Y6e_aaq6GH. [Accessed 26 January 2025] (Ukrainian)
- 3. Prokhorenko I. Intehratsiia znan z biomekhaniky u profesiinu pidhotovku mahistriv stomatolohii [Integration of biomechanics knowledge in the professional training of masters of dentistry]. Medytsyna i farmatsiya: Navchal'ni dyskursy. 2024;1:45–50. doi:10.32782/ eddiscourses/2024-1-7. (Ukrainian)
- 4. Kaniura OA, Melnyk BM, Mykytenko PV et al. Professional training of masters of dentistry within quarantine restrictions and martial law: a comparative analysis of educational process. Wiad Lek. 2023;76(4):772–777. doi: 10.36740/WLek202304111.
- 5. Kuchyn IL, Vlasenko OM, Melnyk VS et al. Simulation training and virtual patients as a component of classroom training of future doctors under covid-19 conditions. Wiad Lek. 2022;75(5):1118–1123. doi: 10.36740/WLek202205112.
- 6. Kulbashna Y, Skrypnyk I. Profesiina pidhotovka i bezperervnyi profesiinyi rozvytok mahistriv stomatolohii v ekstremalnykh umovakh pandemii SOVID-19 ta viiskovoho stanu v Ukraini [Professional training and continuing professional development of masters in dentistry under the extreme conditions of COVID-19 and martial law in Ukraine]. Zdorov'ya porozhnyny rota ta zahal'nyy stan. 2023;4(2):34–40. doi: 10.22141/ogh.4.2.2023.161. (Ukrainian)
- 7. Minervini G. State-of-the-art in orthodontics and gnathology. Appl. Sci. 2022;12(23):12419. doi: 10.3390/app122312419.
- 8. Fornai C, Oppermann N, Tester I et al. Robert M. Ricketts and Rudolf Slavicek: dentistry by the rules of nature. Angle orthod. 2023;93(5):497–500. doi: 10.2319/050423-323.1.
- 9. Nota A, Pittari L, Monticciolo FM et al. Correlations between mandibular kinematics and electromyography during the masticatory cycle: an observational study by digital analysis. Appl. Sci. 2024;14(21):9996. doi: 10.3390/app14219996. DOI 20
- 10. Zhang ZK. Core position of occlusion, gnathology and related diagnosis and treatment principles that must be followed in stomatology. Chinese journal of stomatology. 2021;56(8):729–733. doi: 10.3760/cma.j.cn112144-20210709-00321. DOI 2010

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CONFLICT OF INTEREST

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CORRESPONDING AUTHOR

Nataliia V. Stuchynska

Bogomolets National Medical University, 34 Prospect Beresteiskyi, 03680 Kyiv, Ukraine e-mail: nvstuchynska@gmail.com

ORCID AND CONTRIBUTIONSHIP

Oleksandr A. Kaniura: 0000-0003-2232-8181 A D E F Natalia V. Stuchynska: 0000-0002-5583-899X A B C D E F Ihor A. Prokhorenko: 0009-0003-6792-8428 B C D

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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