ABSTRACTS of PUBLICATIONS

of d-r Dzhendo Atanasov Dzhendov

submitted for participation in a competition for an academic position

"Docent" in the field of higher education 7. Health care and sports, professional direction 7.2 Dental medicine, specialty "Prosthetic dental medicine"

I. PUBLICATIONS INCLUDED IN A REFERENCE ACCORDING TO A MODEL PROVING COMPLIANCE WITH THE MINIMUM REQUIREMENTS FOR OCCUPYING THE ACADEMIC POSITION "DOCENT", ACCORDING TO THE LAW ON THE DEVELOPMENT OF THE ACADEMIC STAFF IN THE REPUBLIC OF BULGARIA, 2018.

CRITERION A

INDICATOR 1. PhD thesis

1. **Dzhendo Atanasov Dzhendov**, Non-removable prosthetic structures from Co-Cr alloys, made by technologies with material addition, 2017,161, Medical University - Varna.

In the dissertation is made a comparative characterization of non-removable prosthetic structures made of Co-Cr alloys according to three technologies: 1) classical - casting from a hand-made wax model; 2) casting from a 3D printed model and 3) selective laser melting. Standard specimens of Co-Cr alloys were tested for tensile strength. The geometrical accuracy of the 4-member Co-Cr bridges produced by TIDM was investigated and compared with the classical technology regarding dimensional accuracy, adjustment accuracy and surface roughness. Also were investigated density, microstructure, mechanical properties - hardness, tensile strength, yield strength and modulus of elasticity. The adhesion strength of porcelain to Co-Cr alloy was also investigated. Clinical and laboratory protocols have been developed for treatment with non-removable prosthetic structures made using multi-jet printing and selective laser melting.

CRITERION B

INDICATOR 3. Published habilitation thesis - monograph

1. **Dzhendo Atanasov Dzhendov**, The virtual patient in dental education, Second updated edition, 2023, 155, Varna, STENO Publishing House, ISBN 978-619-241-260-9.

In the present work has been done a thorough investigation of the types of virtual simulators for training in dental medicine. The applications of simulators in the various fields of dentistry are reviewed. Information is presented on the connections that can be made between simulators and paraclinical research tools such as intraoral, facial and cone beam scanners. The ways of teaching the students with the help of these means are analyzed. Possibilities to ease the work of left-handed students in the simulation centers and halls were considered. Issues related to the design of work areas and instrumentation are explored, and education issues relate to aspects of teaching and learning. An analysis was made of the advantages and disadvantages of the previous simulation system with the current one in the Faculty of Dental Medicine. Student opinion on online dental

education was investigated in 20 questions and relevant conclusions were drawn. Attention is drawn to 5G and the possibilities of application in dental education.

CRITERION G

INDICATOR 7. Publications in scientific journals referenced and indexed in world-famous databases with scientific information **(Scopus, Web of Science).**

1. Ts Dikova, **Dzh Dzhendov**, Iv Katreva, D Pavlova, Accuracy of polymeric dental bridges manufactured by stereolythography, Archives of Materials Science and Engineering 2016; 78(1):29-36, **Scopus**

Purpose: Purpose of this paper is to investigate the accuracy of dental bridges produced via digital light projection stereolithography process.
Design/methodology/approach: 3D printer Rapidshape D30 was used for manufacturing of two groups of samples – temporary four-part bridges and cast patterns for permanent bridges. The temporary bridges were made of NextDent C+B polymer, while the cast patterns - of NextDent Cast. The samples were manufactured with different layer's thickness (0.035 mm and 0.050 mm). The geometrical and adjusting accuracy were investigated by measuring of the samples' dimensions and silicone probe, while the surface roughness was studied out by profile meter and optical microscopy.
Findings: It was established that the dimensions of the temporary bridges and the cast patterns, printed with layer thickness 50 μm, are larger than that of the virtual 3D model with 0.1-0.3 mm. Decreasing the layer thickness to 35 μm leads to 0.29%-1.10% smaller sizes of dental bridges and cast patterns in comparison to that of the virtual 3D model. The average roughness deviation Ra of the 3D printed temporary bridges and cast patterns is larger than that of the initial model. As the surface roughness depends on the layer's thickness, the samples with 0.035 mm layer characterize with lower Ra values. The silicone probe shows that the temporary bridges as well as the cast patterns need additional adjusting in the dental office or corrections during design of the virtual 3D model and 3D printing process in the dental laboratory.
Practical implications: The stereolithography as part of CAD/CAM manufacturing process characterizes with high accuracy as a whole. But present study reveals that additional adjusting or preliminary corrections of the design of 3D printing process are needed for dental constructions produced by SLA.
Originality/value: The geometrical and fitting accuracy as well as the surface roughness of dental bridges, produced by stereolithography were evaluated. The data, shown in the present study, will help dentists and dental technicians to precise the manufacturing regimes for production of dental constructions with high accuracy.

2. **Dzhendo Dzhendov**, Tsanka Dikova, Application of selective laser melting in manufacturing of fixed dental prostheses, J of IMAB. 2016 Oct-Dec; 22(4): 1414-1417, **WOS, Scopus**

The additive technologies characterize with the building of one layer at a time from a powder or liquid that is bonded by means of melting, fusing or polymerization. They offer a number of advantages over traditional methods: production of complex personalized objects without the need of complex machinery; manufacturing of parts with dense as well as the porous structure and predetermined surface roughness; controllable, easy and relatively quick process. The methods,

mostly used in prosthetic dentistry, include stereolithography, selective laser sintering, and selective laser melting. The aim of the present paper is to reviewthe features of the Selective Laser Melting (SLM) process and the possibilities of its application for production of fixed dental prostheses. The features of the SLM process, the microstructure and mechanical characteristics of dental alloys as well as the properties of fixed dental prostheses, fabricated via SLM, were discussed. It was revealed that the SLM Co-Cr dental alloys possess higher mechanical and tribo-corrosion properties, comparatively good fitting ability and higher adhesion strength of the porcelain comparing to the cast alloys. All this is a good precondition for successful application of the SLM process in the production of fixed dental prostheses, mainly of frameworks for metal-ceramic and constructions covered with polymer/composite, intended for areas with high loading.

3. Tsanka Dikova, Tihomir Vasilev, **Dzhendo Dzhendov**, Elisaveta Ivanova, Investigation the fitting accuracy of cast and SLM Co-Cr dental bridges using CAD software, Journal of IMAB, 2017/9/25, 23, 3, 1688-1696, **WOS**

The aim of the present paper is to investigate the fitting accuracy of Co-Cr dental bridges, manufactured by three technologies, with the newly developed method using CAD software. The four-part dental bridges of Co-Cr alloys were produced by conventional casting of wax models, casting with 3D printed patterns and selective laser melting. The marginal and internal fit of dental bridges was studied out by two methods – silicone replica test and CAD software. As the silicone replica test characterizes with comparatively low accuracy, a new methodology for investigating the fitting accuracy of dental bridges was developed based on the SolidWorks CAD software. The newly developed method allows the study of the marginal and internal adaptation in unlimited directions and high accuracy. Investigation the marginal fit and internal adaptation of Co-Cr four-part dental bridges by the two methods show that the technological process strongly influences the fitting accuracy of dental restorations. The fitting accuracy of the bridges, cast with 3D printed patterns, is the highest, followed by the SLM and conventionally cast bridges. The marginal fit of the three groups of bridges is in the clinically acceptable range. The internal gap values vary in different regions – it is highest on the occlusal surfaces, followed by that in the marginal and axial areas. The higher fitting accuracy of the bridges, manufactured by casting with 3D printed patterns and SLM, compared to the conventionally cast bridges is a good precondition for their successful implementation in the dental offices and laboratories.

4. Ts Dikova, **Dzh Dzhendov**, Iv Katreva, Ts Tonchev, Study the precision of fixed partial dentures of Co-Cr alloys cast over 3D printed prototypes, Archives of Materials Science and Engineering, 2018; 90(1): 25-32, **Scopus**

Purpose: of this paper is to investigate the accuracy of Co-Cr dental bridges, manufactured using 3D printed cast patterns.
Design/methodology/approach: Four-unit dental bridges are fabricated from the alloys i-Alloy and Biosil-f by lost-wax process. The polymeric cast patterns are 3D printed with different layer's thickness (13 μm, 35 μm and 50 μm). Two 3D printers are used: stereolithographic "Rapidshape D30" and ink-jet "Solidscape 66+". The geometrical and fitting accuracy as well as the surface roughness are investigated.
Findings: It is established that Co-Cr bridges, casted from 3D printed patterns with 50 μm layer thickness, characterize with the largest dimensions – 3.30%-9.14% larger than those of the base model. Decreasing the layer thickness leads to dimensional reduction. The dimensions of the

bridges, casted on patterns with 13 μm layer thickness, are 0.17%-2.86% smaller compared to the primary model. The average roughness deviation Ra of the surface of Co-Cr bridges, manufactured using 3D printed patterns, is 3-4 times higher in comparison to the bridge-base model. The greater the layer thickness of the patterns, the higher Ra of the bridges. The silicone replica test shows 0.1-0.2 mm irregular gap between the bridge retainers and abutments of the cast patterns and Co-Cr bridges.
Research limitations/implications: Highly precise prosthetic constructions, casted from 3D printed patterns, can be produced only if the specific features of the 3D printed objects are taken in consideration.
Practical implications: Present research has shown that the lower the thickness of the printed layer of cast patterns, the higher the dimensional accuracy and the lower the surface roughness.
Originality/value: The findings in this study will help specialist in dental clinics and laboratories to choose the right equipment and optimal technological regimes for production of cast patterns with high accuracy and low surface roughness for casting of precise dental constructions.

5. **Dzh Dzhendov**, Iv Katreva, Ts Dikova, Prosthetic treatment protocol with fixed dental constructions made on 3D printed cast patterns, Archives of Materials Science and Engineering, 2018; 90(1): 33-40, **Scopus**

Purpose: of the present paper is to develop prosthetic treatment protocol for fixed partial dentures made of 3D printed cast patterns.
Design/methodology/approach: The clinical and laboratory protocols for manufacturing of fixed prosthetic constructions upon 3D cast patterns are developed on the basis of the literature review and our previous experimental investigations. Comparison between the conventional technique and innovative approach is made.
Findings: The terms "semi-digital treatment plan" and "fully digital treatment plan" are defined according to the way of obtaining data for the virtual 3D model and the production method of the fixed prostheses. A classification of treatment protocols with non-removable partial dentures produced by additive technology is developed. Protocols for "semi" and "fully" digitized treatment plans with fixed partial dentures made by casting with 3D printed models are created.
Research limitations/implications: Implementation of the fully digitized protocol for manufacturing of fixed prosthetic constructions via 3D printed prototypes requires specific equipment in the dental office and dental technician laboratory – intraoral scanner and CAD/ CAM system with 3D printing machine.
Practical implications: Establishing of systematic clinical and laboratory protocols helps dental specialists to implement the innovative working approach in their practice with no risk of neglecting or omitting of some important procedures which increases the quality and long lasting effect of the dental constructions.
Originality/value: Following the developed protocols reduces the role of the subjective factor in production technology of fixed prosthetic constructions while saving labour and time.

6. **Dzh Dzhendov**, Iv Katreva, Ts Dikova, Development of treatment protocol with selective laser melted fixed partial dentures, Archives of Materials Science and Engineering, 2018; 90(2): 68-73, **Scopus**

Purpose: of the present paper is to offer treatment protocol with fixed partial dentures, produced by selective laser melting, including clinical and laboratory parts.
Design/methodology/approach: The treatment protocols with selective laser melted fixed partial dentures was developed on the basis of literature survey and our previous research about accuracy and mechanical properties of dental bridges, manufactured by additive technologies.
Findings: The treatment protocol with fixed partial dentures, produced by selective laser melting, consisting of clinical and laboratory parts, was developed. The treatment procedures with FPD made by SLM were classified as semi-digital when working with extraoral scanner and fully-digital – with intraoral scanner.
Research limitations/implications: The introduction of the proposed treatment protocol into the clinical and laboratory practice would lead to a systematic approach and working optimization for prosthodontists and dental technicians when using selective laser melting.
Practical implications: Due to the elimination of multiple manual manipulations and technological operations, treatment protocols with FPD, produced by SLM, ensure higher accuracy and quality of the constructions and shorter time for their manufacturing compared to the conventional procedure.
Originality/value: The developed clinical and laboratory protocols for the treatment and manufacturing of FPD through SLM clearly show the benefits of the new technology in dentistry and dental technician field.

7. TD Dikova, **DA Dzhendov**, I Ivanov, K Bliznakova, Dimensional accuracy and surface roughness of polymeric dental bridges produced by different 3D printing processes, Archives of Materials Science and Engineering, 2018; 94(2): 65-75, **Scopus**

Purpose: To compare the dimensions accuracy and surface roughness of polymeric dental bridges produced by different 3D printers.
Design/methodology/approach: Four-part dental bridges were manufactured by three printing systems working on the basis of digital light projection (DLP) stereolithography (SLA), laser-assisted SLA and fused deposition modeling (FDM). The materials used from SLA printers are liquid methacrylate photopolymer resins, while FDM printer use thin wire plastic polylactic acid. The accuracy of the external dimensions of dental bridges was evaluated and the surface roughness was measured.
Findings: It was found that compared to the base model, the dimensions of the SLA printed bridges are bigger with 1.25%-6.21%, while the corresponding dimensions of the samples, made by FDM are smaller by 1.07%-4.71%, regardless the position of the object towards the substrate. The samples, produced by FDM, are characterized with the highest roughness. The average roughness deviation (Ra) values for DLP SLA and lase-assisted SLA are 2.40 μm and 2.97 μm, respectively.
Research limitations/implications: For production of high quality polymeric dental constructions next research should be targeted to investigation of the polymerization degree, stresses and deformations.
Practical implications: Our study shows that 3D printers, based on laser-assisted and DLP SLA, can be successfully used for manufacturing of polymeric dental bridges – temporary restorations or cast patterns, while FDM system is more suitable for training models. The results will help the dentists to make right choice of the most suitable 3D printer.
Originality/value: One of the largest fixed partial dentures – four-part bridges, produced by three different commercial 3D printing systems, were investigated by comparative analysis. The paper

will attract readers' interest in the field of biomedical materials and application of new technologies in dentistry.

INDICATOR 8. Publications in journals with scientific review, not referenced in world-famous databases of scientific information.

1. NA Dolgov, T Dikova, **D Dzhendov**, D Pavlova, M Simov, Mechanical properties of dental Co-Cr alloys fabricated via casting and selective laser melting, International Journal "Materials Science. Non-Equilibrium Phase Transformations", 2016; 2(3): 3-7

The aim of the present paper is to investigate the mechanical properties (hardness and tensile strength) of dental Co-Cr alloys fabricated via casting and selective laser melting (SLM). Two groups of metallic specimens (four-part dental bridges and standard tensile test specimens) made of Co-Cr dental alloys were produced by lost-wax casting and SLM processes. Vickers hardness distribution along the depth of the dental bridges as well as the Rockwell hardness and tensile strength of the samples were studied out. The hardness of Co-Cr dental alloys are dependent on the manufacturing technique employed. It was established that the average Vickers hardness of the samples, produced by SLM, was higher than that of the cast samples 3S2 HV and 335 HV respectively. The nearly even hardness distribution in the bridges, produced by SLM, and fluctuations of the hardness values along the depth of the cast bridges were observed. The Rockwell measurements confirmed the higher hardness of the SLM samples - 39 HRC in comparison with that of the cast ones - 33 HRC. The tensile strength is in good agreement with the hardness values. Due to the unique microstructure, the yield strength and tensile strength for the SLM samples were higher than those of the as-cast alloy.

2. H Atapek, T Dikova, G Aktaş, Ş Polat, **D Dzhendov**, D Pavlova, Tribo-corrosion behavior of cast and selective laser melted Co-Cr alloy for dental applications, Int. Journal "Machines, Technologies, Materials", 2016; 10(12): 61-64

Cobalt-chromium based alloys are widely used in dental applications due to their excellent mechanical properties, high corrosion resistance and good biocompatibility. Although they are generally fabricated by casting for dental restorations, recently selective laser melting (SLM) has become an attractive production method since it allows complex geometries. Recent studies revealed that Co-Cr alloys formed by SLM, provided better corrosion resistance as well. In this study, tribo-corrosion behavior of a Co-Cr-Mo alloy produced by casting (Biosil-Degudent) was compared with the one (Co212-f ASTM F75) produced by SLM. The wear properties were investigated by tribo-corrosion tests in a Fusayama-Meyer artificial saliva solution using a "ball-on-disc" type tribometer. Polished surfaces were tested against zirconia balls at the same sliding speed, distance and load. Friction coefficient values were determined and the worn surfaces were evaluated using microscopes to compare the wear and tribo-corrosion resistance through wear tracks. SLM proved to be a promising manufacturing method for dental applications.

3. T Dikova, **D Dzhendov**, K Bliznakova, D Ivanov, Application of 3D printing in manufacturing of cast patterns, VII-th International Metallurgical Congress, 9-12.06.2016,

Ohrid, Macedonia; edited by Sveto Cvetkovski & Goran Načevski.- Skopje: Macedonian union of metallurgists, 2016. - CD-ROM (pp. 9-12)

The aim of the present paper is to review the application of 3D printing technologies for manufacturing of patterns for investment and sand casting. The additive technologies are characterized with building the object by addition of the material layer by layer. They offer a number of advantages over the traditional methods: easy, controllable and relatively quick process; manufacturing of objects with complex geometry; no need of complex tooling equipment; the desired shape, dimensions and properties can be obtained. The possibilities of stereolithography (SLA), fused deposition modelling (FDM), multi jet modeling (MJM) and selective laser sintering (SLS) for manufacturing of polymer patterns for investment and sand casting are discussed. The advantages and the disadvantages of different printing processes are summarized. The geometrical accuracy and the surface quality of cast patterns, fabricated by different technologies, are compared. It was observed, that the dimensions of all samples printed within the study were smaller than that of the virtual 3D models, irrespective of the printer technology used. Concerning the surface quality - the largest is the surface roughness of the sample created by the FDM printer compared to the SLA and the MJM printers. The correct choice of the technological parameters of the equipment is important for obtaining 3D printed cast patterns with high quality and minimum deformations.

4. Tihomir Vasilev, Tsanka Dikova, **Dzhendo Dzhendov**, Elisaveta Ivanova, Simulations of Cast and Selective Laser Melted Dental Bridges with Chewing Load, Scripta Scientifica Medicinae Dentalis, 2016 Dec 31;2(2):7-11.

The aim of the present paper is to evaluate and compare the strength properties and deformation characteristics of cast and Selective Laser Melted (SLM) Co-Cr dental alloys by using CAD/CAE software. The Solid Works Simulation software is used for simulation of chewing load of the virtual 3D model of a four-part dental bridge. Two Co-Cr dental alloys, cast and SLM were used in this study. During the simulation process by means of linear static analysis the displacements, strains, stresses, and reaction forces under the effect of the applied load were calculated. As a result, the equivalent von Mises stresses, Factor of Safety (FOS) and displacements were evaluated in this study. It was established that the highest values of the equivalent von Mises stresses of cast and SLM bridges are situated in the connectors between the teeth, i.e. the zones with the lowest areas of the cross sections. They are in the range 95-162 MPa, which is lower than the stress limits for the both materials. The minimum FOS of both materials is higher than 1. In the cast bridges it is 1.32-2.64 in the zones with the highest load, while in the SLM samples it is 2.61-5.68. As FOS shows the reserve strength of the material for the applied load, it is obvious that the SLM bridge possesses twice as high reserve strength. This allows optimization of the construction, economy of material and possibility for manufacturing of objects with porous structures.

5. Elisaveta Ivanova Tihomir Vasilev, Tsanka Dikova, **Dzhendo Dzhendov**, New methodology for measuring the fitting gap of fixed partial dentures using CAD softwere, Proceeding of 3-rd Int. Sci. Conference “Materials Science. Nonequilibrium Phase Transformations”, 11-14 Sept 2017, Varna, Bulgaria, STUME, 2017/9; 1(1):88-91; ISSN 2535-0218 (print), ISSN 2535-0226 (on-line);

The necessity of precise estimation of the gap between the crowns-retainers and abutments of dental bridges requires the development of new methods for their measurement. The introduction of rapid prototyping technologies, including 3D scanning and printing, enables trouble-free creation of virtual models of complex objects in terms of form. The determining of the gap between the bridges and abutment structures in CAD systems leads to difficulties mainly due to their complex shapes. The new methodology, based on engineering CAD software, was developed in this study, which overcome these difficulties. By applying the proposed approach for virtual adjusting between the dental constructions, it is possible to determine the gap between the bridge-retainers and the abutments in enclosed spaces, which are alternatively determined by indirect methods. The main advantages of the new methodology are: 1) complete tracking of the variation of the distance between the surfaces of the bridge-retainers and the abutments; 2) measurement of distances between the surfaces along the three axes and perpendicular; and 3) higher accuracy of the measurements.

6. Dikova T., **Dzhendov D**., Katreva I., Monov A., Dolgov N. *Surface Roughness of Dental Alloys Cast with 3D Printed Polymeric Patterns,* Proceedings of the III-rd Int. Sci. Conference – summer session "Industry 4.0", 18-21.06.2018, Varna, Bulgaria, STUME. 2018 June:62-66.

The present paper deals with investigation of surface roughness of Ni-Cr and Co-Cr dental alloys Wiron light and i-Alloy, cast with 3D printed patterns. The cast patterns were printed by stereolithographic printer Rapidshape D30 of polymer NextDent Cast with 35 μm and 50 μm layer thicknesses, inclined to the basis at 0o, 45o and 90o. It was found that besides the 3D print parameters of the cast patterns, the materials and technological regimes of the casting process also influence to the Ra values. The increased roughness of samples cast of an i-Alloy alloy with patterns, printed inclined (45° and 90°), in relation to those, whose patterns are made parallel to the substrate, is due to the layered morphology on their surface. The high roughness of the Wiron light alloy, cast with patterns printed parallel to the base, is the result of defects obtained during the casting process.

7. Diana Pavlova, Svetlana Angelova, Valintina Velikova, Iveta Katreva, **Dzhendo Dzhendov**, Maksim Simov, Metodi Abadzhiev, Tsvetan Tonchev, Tsanka Dikova, Investigation of the Dental Technicians' Readiness to Manufacture Dental Prostheses Using Digital Technologies, Scripta Scientifica Medicinae Dentalis, 2018/8; 4(1): 25-27; ISSN 2367-7236 (Print), ISSN 2367-7244 (Online)

INTRODUCTION: Modern digital technologies allow us to generate a virtual model of the patient and to design his/her smile. The future definitely belongs to the digital technologies because they offer a reliable, predictable and highly esthetic manner of treatment.
AIM: The aim of the present study is to investigate the dental technicians' readiness to manufacture dental prostheses using digital technologies.
MATERIALS AND METHODS: A total of 159 respondents - practicing dental technicians and students - were surveyed using an online survey. The survey was conducted via a social network platform. Results were processed with SPSS v. 20 using variational, comparative and correlation analyses.

RESULTS: Over 50% of the respondents have indicated that they use different types of digital technologies in their practice, the main reason being that the construction time is shortened and that the accuracy is improved (85.20%). There is a correlation between the length work experience and the use of new technologies ($p<0.05$), with younger specialists being the ones who primarily use modern technology. Young specialists are willing to invest in the purchase of modern equipment and to attend additional courses on working with it.
CONCLUSION: Despite the variety of methods for recreating the prosthetic field when manufacturing prosthetic constructions, a trend towards full digitalization of the process is observed. The results from the conducted analyses show that digitalization is being increasingly used by young specialists (CAD planning and software application – 78.40%), who prefer it because it increases accuracy and shortens production time (85.40%).

8. Radostina Vasileva, **Dzhendo Dzhendov**, Difficulties and opportunities for improving the training of left-handed dental medicine students at the at the faculty of dental medicine in Varna, Journal of the Union of Scientists - Varna. Medicine and Ecology Series. 2019/2;24:65-69

Introduction: Dental medicine requires mastering of not only theoretical knowledge, but also of highly developed manual skills, such as performing fine coordinated movements with the hands, fingers, body position.
Aim: The aim of the study is to determine how the lefthanded students studying dental medicine perceive their education, and to take the necessary steps to improve the training of left-handed students in the Faculty of Dental Medicine (FDM), Varna.
Materials and Methods: The opinion of English speaking students in their 6th year (1st and 2nd group) at FDM-Varna was examined. In the survey, students filled out a questionnaire.
Results: Among the 28 students who completed questionnaires, a total of 4 were left-handed students whose results were processed. Students find it difficult to practice prosthodontics, endodontics and periodontics. In their opinion, the opportunities for improving education are specialized equipment pursuant to their needs and personal training by left-handed assistant professor in dental medicine.
Conclusion: According to Henderson et al., the designed dental units are basically for right-handed individuals and create difficulties for left-handed students. The study found that left-handed students studying at FDM-Varna experience difficulties with the non-personalized dental unit design, and have a need for personal training. The results of this study support the changes that were made in the training environment in FDM-Varna, which improves and supports left- handed students education.

9. Milkov Mario, **Dzhendov Dzhendo**, 3D printing in the head area, International Bulletin of Otorhinolaryngology 2020/4

Digital technologies are evolving at a very high pace in science and technology. They are also increasing their influence in the fields of dental and general medicine. The processes are inevitable and irreversible. The advantage of these technologies is that they can create medical devices with a complex geometric shape, in a shorter time and with greater accuracy. The materials from which the sites are built go through constant development and improvement. In dental medicine, printing is expressed in the manufacture of prosthetic dental structures of removable and non-removable type, training models, production of artificial prostheses for the needs of oral and maxillofacial surgery. In the field of otorhinolaryngology, 3D printing is used for the production of

ectoprostheses in the removal of various inflammatory and tumor processes of the nose and ears, or as a result of occupational or traffic accidents. Printing also finds a place in ophthalmology for making eye prostheses. Regardless of the field of application, these technologies pose a challenge in their use in everyday clinical practice and are subject to constant monitoring by physicians and patients.

10. **Djendo Djendov**, Gergana Georgieva, Advantages and disadvantages of digital technologies in dental medicine education, Varna Medical Forum. 2021 Aug 20;10(2):258–61.

Digital technologies have begun their journey in dentistry in recent years. Thanks to this development, clinical practices and laboratory techniques are moving to digital processes. The merging of these digital puzzles into one whole is the logical continuum of this trend - the creation of a 3D virtual patient. In the context of medical education, the virtual patient is defined as an interactive computer simulation of a real-life clinical scenario for the purpose of teaching, learning and evaluation. This review is limited to one area of e-learning in dentistry. It is a fact that few studies have been published as to compare the effectiveness of new virtual and augmented reality systems in dental education. Advanced simulation technology shows the potential to improve training methods and quality. With the widespread adoption and integration of these technologies into the curriculum, students can achieve a higher level of competence before embarking on a clinical practice. Scientific researches will continue to offer a variety of technologies and effective treatments. To take full advantage of modern science, new knowledge and technology must be incorporated into the core of dental education. The aim of this study is to present the advantages and disadvantages of digital technologies and virtual simulators in dental education.

II. PUBLICATIONS DIFFERENT TO THESE, INCLUDED IN THE EVIDENCE FOR COVERING THE MINIMUM REQUIREMENTS FOR THE ACADEMIC POSITION "DOCENT"

B) FULL TEXT PUBLICATIONS IN BULGARIAN SCIENTIFIC JOURNALS

1. **Dzhendo Dzhendov,** Gergana Georgieva, Is it possible to use 5G in dental medicine education, International Interdisciplinary Virtual Meeting “Alumni Club and Friends” - March, 19-21, 2021

Information and communication technologies have reached their peak in recent years. With the development of virtual reality technologies, sensors and robotics, dental simulators provide better working conditions and facilitate the transition from the traditional simulation laboratory to the clinic. Innovations in digital technology, telemedicine, 5G technology and artificial intelligence (AI) create new opportunities for teaching dental students. Dentistry is a very precise specialty and the development of technology allows progress in the clinical training of dental students. The aim of the present study is to investigate the possibility of applying 5G technologies in the education of dental students. Using new technologies, dental simulators can now create an environment in which medical university students can practice clinical procedures such as prosthetic dentistry, endodontics, prosthetic dentistry, implantology and even extractions.

2. **Dzhendo Dzhendov**, Dental Simulators Used in Training of Students in Dental Medicine, Proceeding of national conference with international participation natural sciens, 30 th September – 2 nd October, 49, 2022 Shumen,

The development of technology has an impact on the education of dental students. Adequate response to curricula and teaching methods is a key factor in building capable and knowledgeable professionals. Phantom training in dentistry is a prerequisite for building professional and work habits related to subsequent clinical procedures. The selection of quality simulation systems is a key to modern learning. They should meet the needs of students gaining experience in all dental specialties.

3. **Dzhendo Dzhendov**, Gergana Georgieva, Students opinion survey on online dental education, Scripta Scientifica Medica, 2022;54, suppl.1:55-60, Medical University of Varna

The purpose of the present study is to examine the students' opinion regarding the conducted online education. Sociological methods: an anonymous Google forms survey was conducted including dental medicine students studying in the conditions of the COVID-19 pandemic, which led to the need to switch to an online form of education. It was conducted online on a voluntary basis in the month of March 2021. A total of 50 students from various years, studying Dental Medicine at the Medical University of Varna took part in the study. The provided survey consists of 20 questions. The majority of students categorically state that face-to-face study is preferable and that digital learning methods are motivating for them. Almost half of the students have a positive opinion regarding online lectures. Through them, they get more advice and guidance from the teachers and it is easier to participate in discussions. The participants in the survey shared that online training, as a result of the introduced anti-epidemic measures, was a good option for learning the theoretical study material.

4. **Dzhendo Dzhendov**, Gergana Georgieva, The application of simulators in dental medicine students training, Scripta Scientifica Medica, 2022;54, suppl.1:21-23, Medical University of Varna.

The simulation training of dental students has developed rapidly in recent years. The development of new technologies and virtual reality are an indispensable part of the education of dental students. The introduction of simulators in the education of dental students supports the harmonization and integration of knowledge from the pre-clinical and clinical education of the students. The opportunity to train on simulators in the field of dentistry helps future dentists to put their theoretical knowledge into practice and gain confidence to work with patients. Simulation operators are included in the students' pre-clinical exercises. In recent years, computer-based simulation and virtual reality-based simulation have become an indispensable part of the pre-clinical training of dental students. Nowadays, there is a wide range of dental simulator models with different features and functions. Some of them are: DentSim, Haptic Technology, Moog Simodont Dental Trainer, HapTEL, the Geneva System, Robotic Patients for Virtual Dental Patient Simulation, Virtual Reality Dental Training System, PerioSim, the VirDenT system, the Forsslund System, DSETM Expert Dental Simulation Units—KaVo Dental. In addition to student training,

these simulators can also be used to assess learner performance or quality control various teaching methods. The development of new technologies marks successes in the development and improvement of the simulators applied in the training of dental medicine students. The virtual patient application provides many opportunities to recreate clinical situations in virtual reality and will make learning even more rewarding and interesting for dental students.

24.11.2023 d-r Dzhendov

Varna