2023

Virtual Microscopy
Histology and Histopathology

MAPPING RESEARCH

IN BULGARIA

ON SETTING UP THE EU CURRICULA ON HISTOLOGY AND HISTOPATHOLOGY FOR THE VIRTUAL MICROSCOPY DIGITAL TRANSFORMATION

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DIGITAL TRANSFORMATION OF HISTOLOGY AND HISTOPATHOLOGY BY VIRTUAL MICROSCOPY (VM) FOR AN INNOVATIVE MEDICAL SCHOOL CURRICULUM

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Phase 1 - Literature research

1. A brief introduction on the histology and histopathology studies in Medical Universities in Bulgaria

The histology and histopathology studies in Medical Universities in Bulgaria are conducted in microscopic rooms equipped with conventional microscopes for each student in the presence of an assistant professor. Some of the microscopic rooms are equipped with a microscopic system connected to the teacher's screen, which allows control of the observing slides. A teacher's screen is connected to a TV monitor and a white board is available for discussions and to focus on certain histological and histopathological structures. Students are provided with two handbooks – in Cytology and General Histology, and another in Organ Histology. The handbooks are provided along with a USB flash which includes JPEG files of the microscopic slides with numbered different structures in order to support the understanding of the histological images by self-studying in whenever, wherever method.

The course in "Cytology, Histology and Embryology" in medical studies in Medical University of Plovdiv is a mandatory propaedeutic step in teaching the fundamental discipline Human Anatomy. Students acquire knowledge of the basic structural elements in the human body: cells, tissues. The material is studied in three sections. Cytology provides knowledge on the structure of the eukaryotic cells - cell membrane, cell organelles, inclusions, nucleus, cytophysiology. General Histology - provides knowledge on the main structural, ultrastructural, histochemical and functional characteristics of the tissues and their histogenesis. Embryology – provides knowledge on the human embryonal and fetal development (fertilization, early and late gastrulation), primitive organs, extra-embryonic layers, twins, anomalies in the human embryonal development). It is organized in the following manner:

1. 1st year Medicine – Cytology, General Histology and Embryology – 45 hours practical lessons and 30 hours lectures.

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2. 2nd year Medicine – Organ histology – 60 hours practical lessons and 30 hours lectures.
3. 1st year Dental Medicine – 1st semester - Cytology, General Histology and Embryology – 30 hours practical lessons and 30 hours lectures.
4. 1st year Dental Medicine – 2nd semester - Organ Histology – 45 hours practical lessons and 30 hours lectures.

The Medical University of Plovdiv, Bulgaria, ensures the education of large number of students of Bulgarian and foreign origin in the specialties, given above; the learning process is thus organized in parallel lectures and practical classes in two courses – Bulgarian and English course of education. The students` approximate distribution by year and language type of education is as follows:

1. 1st year Medicine students – 380 English education
2. 1st year Medicine students – 200 Bulgarian education
3. 2nd year Medicine students – 360 English education
4. 2nd year Medicine students – 200 Bulgarian education
5. 1st year Dental Medicine – 120 English education
6. 1st year Dental Medicine – 120 Bulgarian education

Total – 1380 students

During the pandemic period of COVID-19 and later because of the large number of students, the Medical University of Plovdiv, Bulgaria, provided the use of the online platform of Microsoft Office 365 - MS Teams for distant education, which is conducted with scheduled meetings, using PPT presentations by sharing the screen. Some practical classes in Histology are conducted in hybrid manner – one week cycle of online and in-person classes. The MS Teams platform enables the use of videos and JPEG files of microscopic slides to be shared and demonstrated to the students during the distant practical lessons.

The aim of the histology course in medical studies in the Department of Anatomy, Histology and Embryology is to prepare students with knowledge of the normal microscopic structure of the human eukaryotic cells, tissues and organs in order to apply this knowledge in the distinction of histopathology structures, which is of main

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importance later in the differential diagnosis of various non-tumor and tumor diseases. Considering the latter, the practical in-person classes aim to train students in using conventional light microscopes during their first two years of education, while the online usage of JPEG files of the microscopic slides in USB drive helps the students with detailed learning and knowledge validation of the histological structures of human tissues and organs. Similar training approach is used in the histopathology studies in medical universities in Bulgaria.

The Department incorporates 5 (five) microscopic and 5 (five) macroscopic (anthropological) laboratories, equipped for functional, diagnostic, anthropological and experimental work. All rooms are equipped with multimedia techniques for presentations. Microscopic rooms hold various microscopes to study histology. Each week histological slides and posters on current topics are put out for practical classes. Expert help and advice are always present to guide the students. The laboratory facilities include general equipment (laboratory scales, refrigerators, thermostats, cryostats, centrifuges, etc.) and specific equipment (anthropometric and somatotype research kit, 3D 3 laser scanner with facial analysis software, tissue culture camera, image analysis, microscopic visual display system etc.).

After completing the Cytology, Histology and Embryology course, students should have the following knowledge and practical skills:

- deep knowledge of the structure of the eukaryotic cells - cell membrane, structural, ultrastructural and chemical organization, cell contacts, specialization the cell surface - cilia, flagella, microvilli, transport of the substances through the cell membrane - endocytosis and exocytosis
- deep knowledge of the cell organelles and metabolic inclusions in the cell
- deep knowledge of the tissues - structural, ultrastructural and functional characteristics - epithelial tissue, connective tissue, blood tissue, muscle tissue, nervous tissue, reproductive tissue.
- deep knowledge on General Embryology – the embryonal development and the initial stages of the fetal period, formation and structure of placenta, twins, anomalies in the human embryonal development.

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Histopathology in medical studies in Medical University of Plovdiv is being studied during the 3rd year of medical education as follows:

1. 3rd year Medicine – 1st semester- General Histopathology– 30 hours practical lessons and 30 hours lectures.
2. 3rd year Medicine – 2nd semester/ 4th year Medicine - 1st semester- Clinical Histopathology– 30 hours practical lessons and 30 hours lectures.
3. 3rd year Dental Medicine – 1st semester - General Histopathology– 15 hours practical lessons and 15 hours lectures.
4. 3rd year Dental Medicine – 2nd semester - Clinical Histopathology– 30 hours practical lessons and 30 hours lectures.

Students receive knowledge in intracellular accumulation of lipids, proteins and pigments; adaptative processes accumulation of fibrinoid, hyaline, amyloid, calcium salts and sodium urate in the intercellular matrix, necrosis, disturbances in blood circulation, inflammation, immunity pathology, tumors. They study pathology of the cardiovascular system, respiratory pathology, pathology of the hematopoietic system, pathology of the digestive system. pathology of the urinary system, reproductive system pathology, endocrine pathology, pathology of the nervous system, musculoskeletal pathology, infectious diseases.

The purpose of course is to study the basic pathological processes and structural changes in each nosological units and acquisition of detailed morphological knowledge of all sections of the clinical pathology which allows construction of high medical knowledge.

The objectives of the course are:

- Acquisition of detailed morphological knowledge of the basic pathological processes in all sections of clinical pathology.
- Learning in detail the theoretical basis of emergence, growth and development of tumors.
- Use the terminology of precancerous, benign and malignant tumors.

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- Use the principles of making biopsy, completing forms and learn skills for objective correlation with the clinical findings.
- Development of high medical knowledge.

Teaching methods that are used are lectures, seminars, and practical lessons.

Technical tools and equipment for the purpose in teaching are microscopes, permanent microscopic slides, gross preparations, audiovisual equipment, handbooks.

At the end of the course, students receive:

1. Theoretical knowledge in:
   - general pathological processes: inflammation, degeneration, disturbances in blood circulation, adaptive processes.
   - tumor pathology - etiology, pathogenesis, classification of neoplastic diseases.
   - etiology, pathogenesis and morphological changes in individual nosological units of all organs and systems.
   - formulating and organizing the clinical and pathological - anatomical diagnosis
2. Ability to:
   - work with a light microscope.
   - correctly making materials for cytological examination and biopsy.
   - introduction to how to fix the materials according to the pathological processes and organ localization.
   - correctly and completely fill slips for cytological examination and biopsy.
   - acquiring knowledge of the organization, operation and capabilities of the pathology department.

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2. Use of Virtual Microscopes on Medical Universities in Bulgaria

Chart with the availability of VM systems in Histology and Histopathology studies in Public Universities in Bulgaria:

University	Additional information	Self -developed / external service
Plovdiv	USB flash on Handbook 1 - Cytology, Histology and Embryology and Handbook 2 – Organ histology	Self -developed
Sofia	NO	
Varna	Virtual resources	Self -developed
Pleven	NO	
Stara Zagora	NO	
Burgas	NO	

3. Publications and projects (at Bulgarian level) in the application of VM in histology and histopathology education

Virtual microscopy is not yet used in Bulgaria, no research on the theme and no publications and projects on the theme are available at country level. The present project is the first of its kind in Bulgaria and would contribute a lot to the implementation of this innovative method in histology and histopathology education.

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Phase 2 - Interview questionnaires on virtual microscopy potential

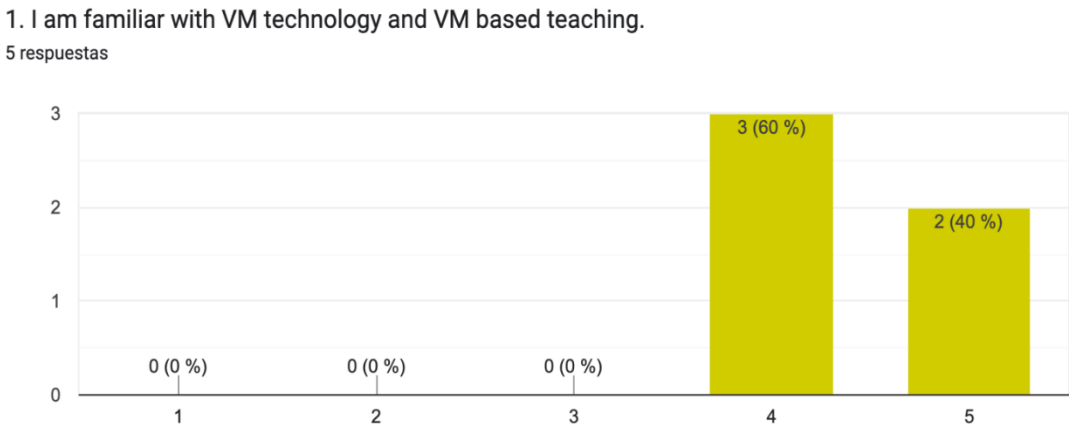
1. Methodology of the interview questionnaires applied in Bulgaria.

Five experts participated in the questionnaire. Three of them are associate professors, the other two are assistant professors. All of them have PhD. They all teach histology or histopathology in the Department of Human Anatomy, Histology and Embryology and the Department of General and Clinical Pathology in Medical University- Plovdiv.

The survey was conducted via Google Forms test which included 10 questions evaluating on a scale 1 to 5, yes and no questions, as well as open questions, regarding a wide range of issues and opinions.

2. Analysis of the applied interview questionnaire in Bulgaria.

Q1. 60 % of the respondents answered that they are familiar with VM technology and VM based teaching - level 4, while 40 % give level 5:



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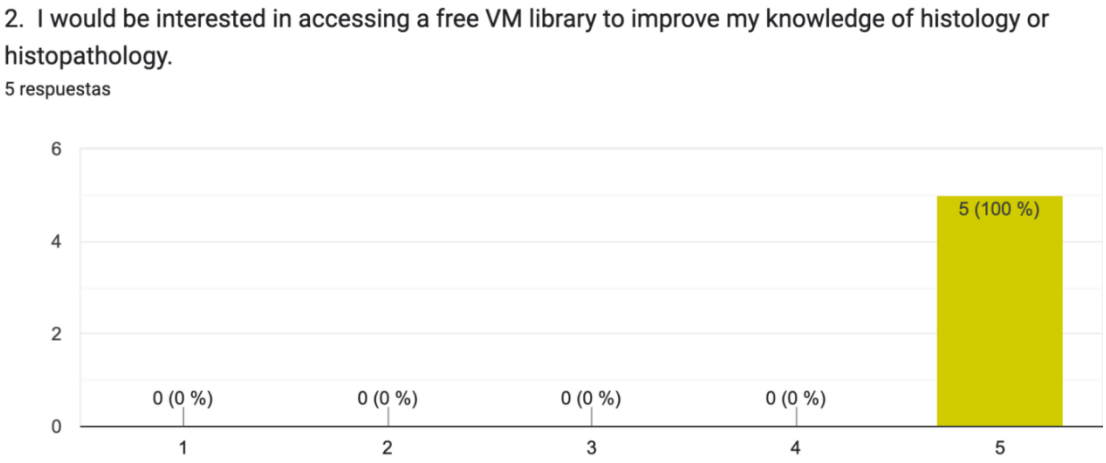
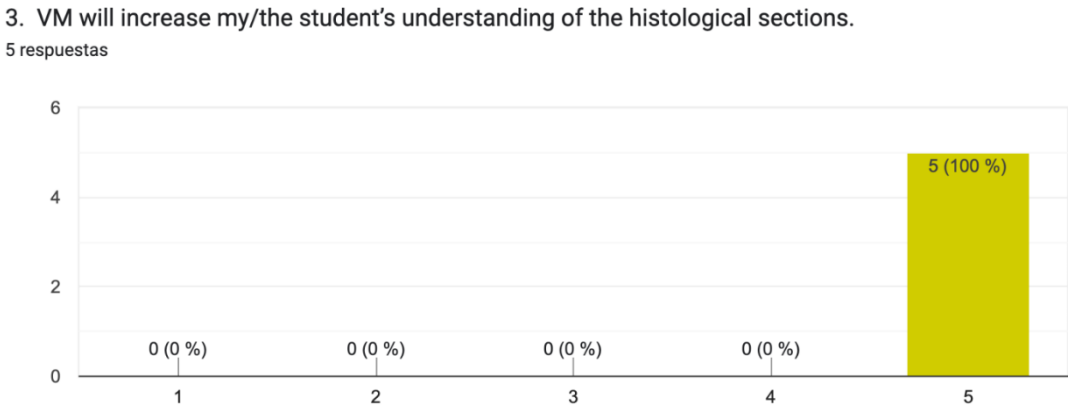
Q2. 100 % of the respondents answered that they would be interested in accessing a free VM library to improve their knowledge of histology and histopathology - level 5.



Q3. The third question concerned both teacher`s and student`s level of understanding of the histological slides in potential use of virtual microscopy. All our experts (100 %) think that VM will increase their/the students' understanding of the histological sections – level 5.



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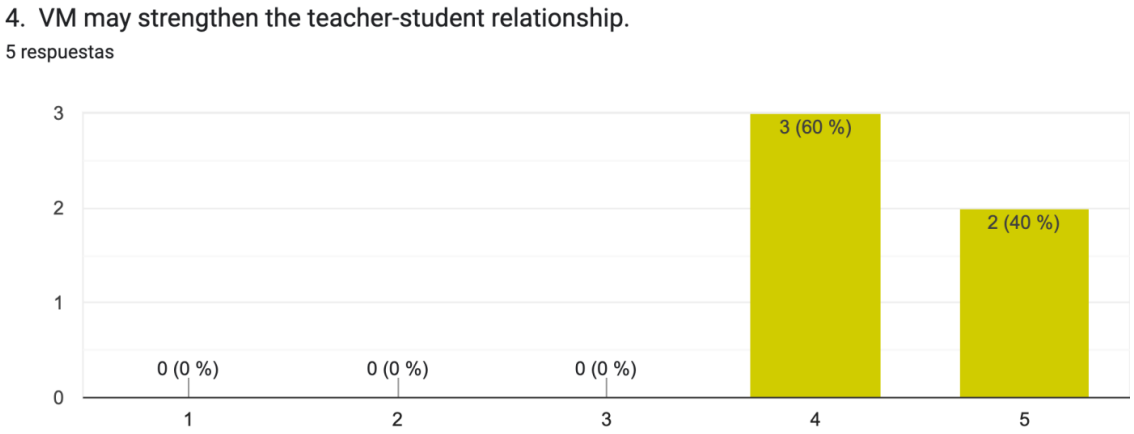
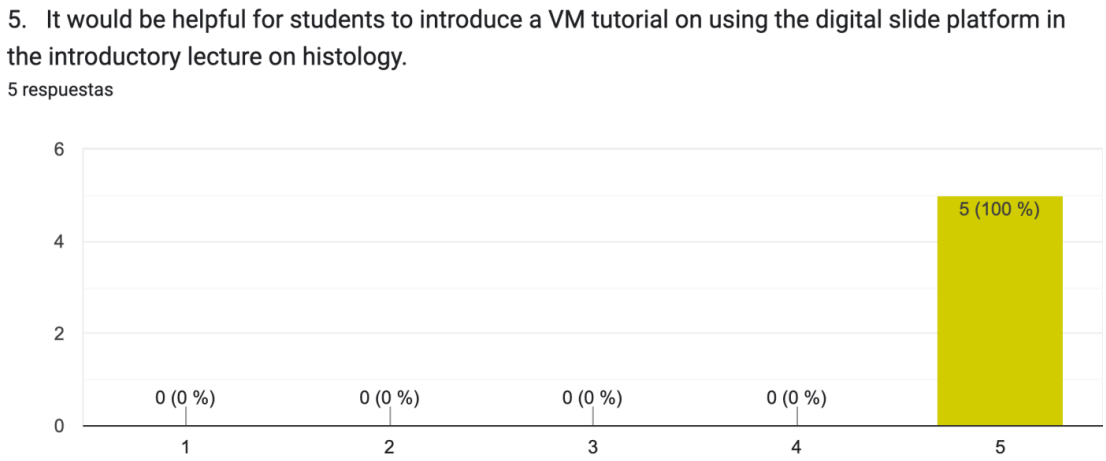
Q4. 60 % of the respondents think that VM may strengthen the teacher-student relationship - level 4, while the other 40 % give level 5:



Q5. 100 % of the experts think that introduction of VM tutorial on using the digital slide platform in histology lectures would be helpful for the students - level 5:



Q6. 100 % of the experts say that introduction of Multiple-Choice Questions MCQ / quiz section regarding virtual slide understanding for self-testing the students' level in histology and histopathology will be useful - level 5:

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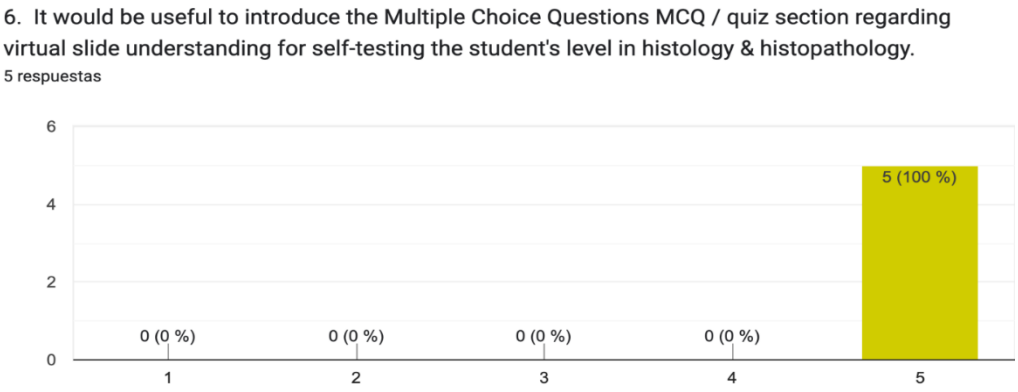
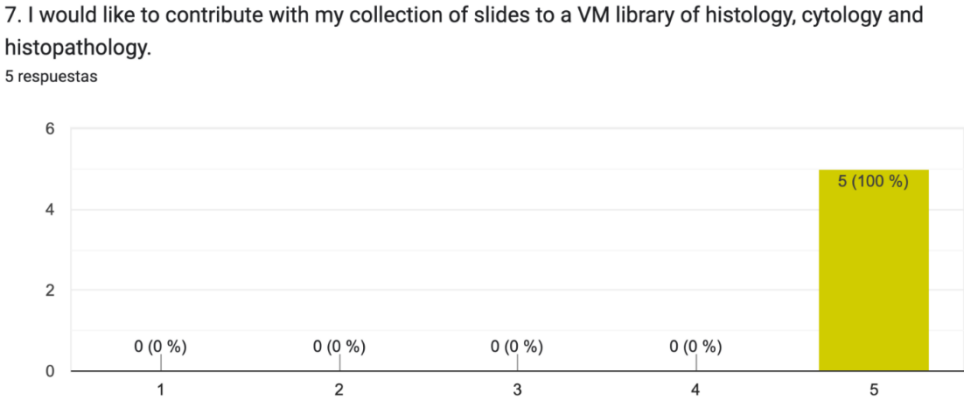


Q7. 100 % of the respondents would like to contribute to a VM library of histology, cytology and histopathology with their own collection - level 5:



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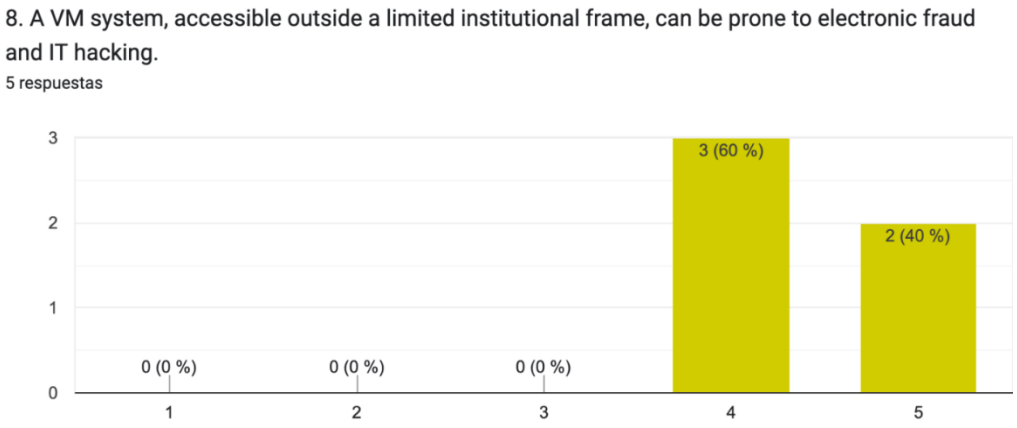
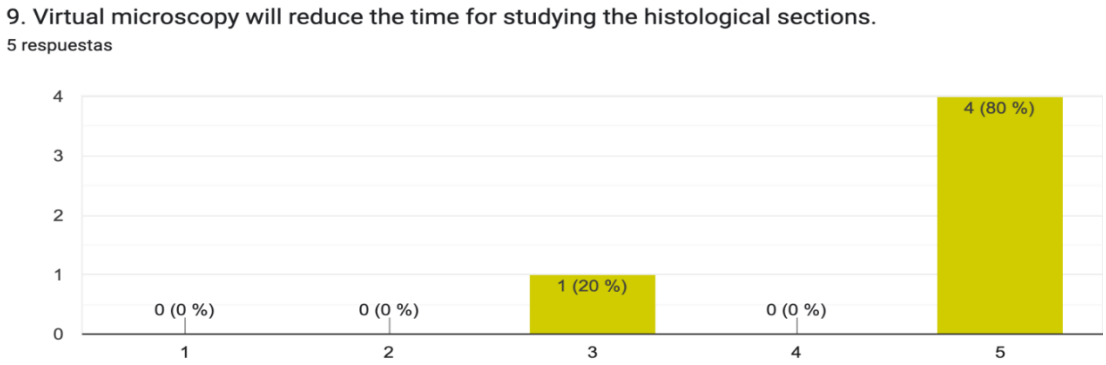
Q8. 60 % of the experts think that a VM system, accessible outside a limited institutional frame, can be prone to electronic fraud and IT hacking - level 4, while 40 % give level 5:



Q9. 80 % of the respondents say that VM will reduce the time for studying the histological sections - level 5, while 20 % give level 3:



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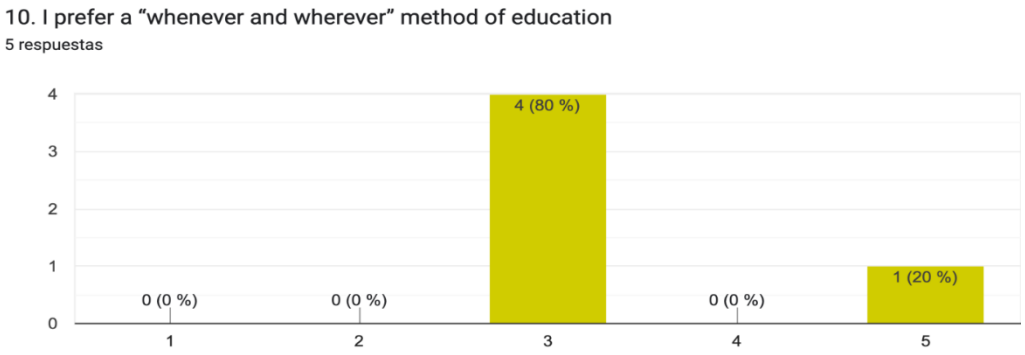
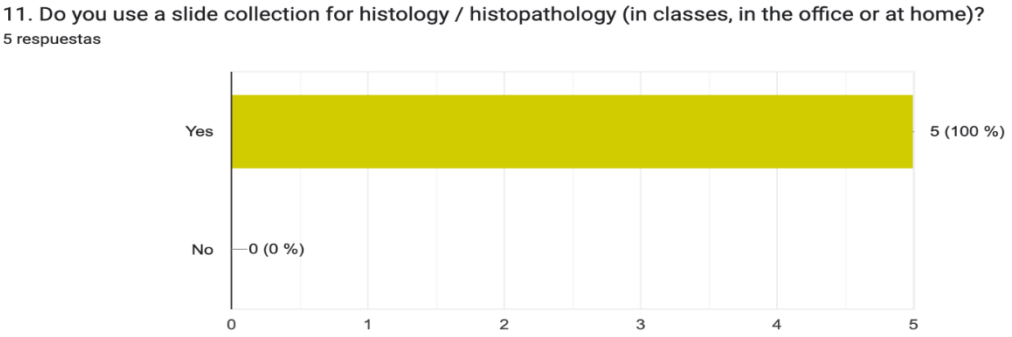
Q10. 80 % of the experts prefer “whenever and wherever” method of education - level 3, while 20 % give level 5:



Q11. 100 % of the experts say they use a slide collection for histology/ histopathology (in classes, in the office or at home) - level 5:



Q12. 100 % of the experts say that if available they would prefer a combination of the methods (VM and LM):

Justification of the answer:

The experts gave the following arguments for choosing both methods:

1. Both methods have advantages in teaching.
2. Both methods have advantages.

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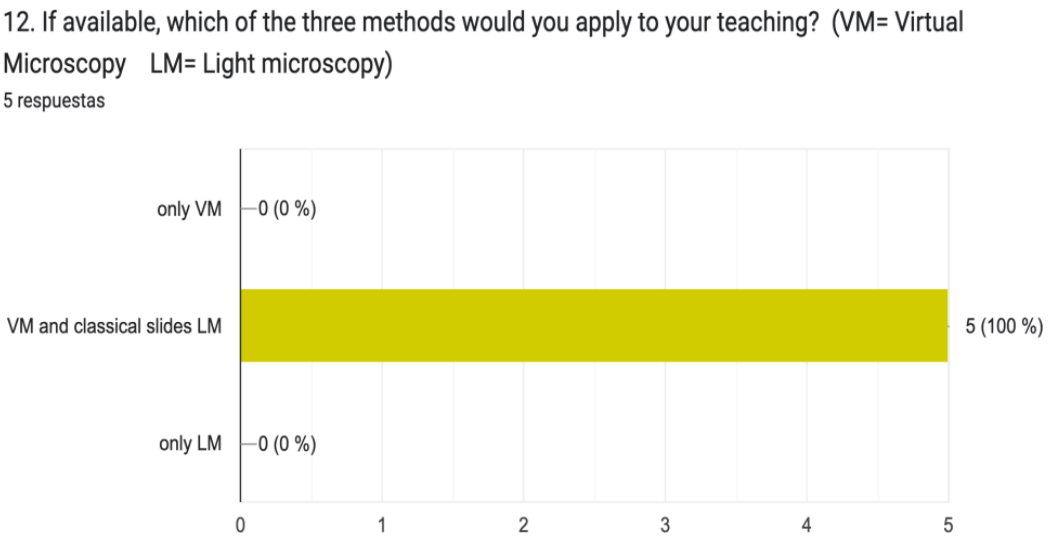
3. Working in class with your teacher could be very helpful as a discussion on the slides and the different topics.



Q13. In your opinion, what are the advantages of virtual microscopy over conventional microscopy?

Regarding the advantages of virtual microscopy over conventional microscopy, the experts gave the following opinions:

1. Virtual microscopy provides high-quality ready-made images.
2. Students can access the VM library when they have opportunity, for example when they are at home or away from the university.
3. Students can use VM library whenever and wherever they can.
4. Easier explanation and teaching
5. 1. Distance 2. Multiple participants on one slide simultaneously 3. More precise details discussion on specimens 4. Reduction of in-person classes and staff personnel

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According to the experts` opinion, the hardware and software limitations are similar for both teachers and students, which is presented in the answers of the next two questions (14 and 15):

Q14. What hardware and software limitations can a teacher have?

1. The teacher must work with an up-to-date software program. The level of hardware depends on the financial capabilities of the university where the teacher works.
2. Devices, technical problems, internet connection, lack of experience.
3. Devices, internet connection, experience
4. Technical limitations in classrooms
5. They are associated with the available hardware and software equipment.

Q15. What hardware and software limitations can a student have?

1. The student must have the skills to work with the presented hardware and software.
2. Devices, technical problems, internet connection, lack of experience.
3. Devices, internet connection, experience
4. None
5. Depending on the available device.

Q16. In your opinion, what would be the limitations of applying VM in the curricula of a histology and histopathology teaching program?

The disadvantages, given by the experts, include mainly technical and financial issues:

1. The limitations of implementing VM in the curricula of a histology and histopathology training program are determined by the technical competence of the teacher and the innovation that the university provides.
2. Extra time for learning how to use the VM library, technical issues, financial issues.

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3. Technical problems, additional courses for learning how to use VM library.
4. Technical limitations in classrooms
5. 1. Enough cloud space 2. Adequate internet speed 3. Available database of slides' images

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