

2023



Virtual Microscopy Histology and Histopathology

MAPPING RESEARCH

IN ROMANIA

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

ERASMUS+ PROJECT, REF.NO. 2022-1-RO01-KA220-HED-000089017

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Phase 1 - Literature research

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

Histology and histopathology are studied in all Medical Universities in Romania, as parts of larger Departments comprising fundamental studies. The curricula of medical universities register some variations, as part of the university's autonomy principle. All universities have adapted lecture halls, equipped with whiteboard, computer and video-projector and seminar rooms, equipped with whiteboard, microscopes for individual study and microscopes linked to a video-projector used for practical demonstrations, while few of them have initiated the use of virtual slides in education. Teaching staff in both Histology and histopathology, may be histopathologists (in training/ specialists/ consultants).

Although there are few differences in curricula and in numbers, according to the size and date of university opening, there are many similitudes in the organization type between medical universities in Romania.

As an example, the Discipline of Histology of "Grigore T. Popa" University of Medicine and Pharmacy, part of the Department of Morphofunctional Sciences teaches the subject "Histology" for second-year students of Medicine, Romanian, English and French programs (1 year - 28 courses/ 2 hours and 28 practical works/ 2 hours), for first-year students of Dental Medicine, Romanian, English and French programs (2 semesters - 19 courses/ 2 hours and 19 practical works/ 2 hours), for first-year Nursing students (1 semester - 7 courses/ 2 hours and 10 practical work/ 2 hours) and the Discipline of Morphopathology, part of the same Department teaches the subject "Morphopathology" for third-year students of Medicine (1 year - 22 courses/ 2 hours and 16 practical works/ 2 hours), for second-year students of Dental Medicine (1 semester - 10 courses/ 2 hours and 14 practical works/ 2 hours), and for second-year Nursing students (1 semester - 14 courses/ 2 hours and 14 practical works/ 2 hours), while both Disciplines (Histology and Morphopathology) are teaching the first to fifth-year Pathology in training residency program postgraduate students, comprising modules of education, according training curricula. The Department of Histology of "Grigore T. Popa" University of Medicine and Pharmacy teaches over 1,000 students for two semesters of the second year (Medicine), for first-year students of Dental Medicine, in Romanian, English and French programs, over 550 students for the first year (Dental Medicine and Nursing), over 60 students for the third year (Medicine), and over 45 first to fifth-year Pathology in training junior doctors. Moreover, the teaching staff of the discipline of Histology of "Grigore T. Popa" University of Medicine and Pharmacy has implemented four optional courses (two for Medicine Faculty: "Neurosciences" for third-year Medicine Faculty students and "Integrative Medicine" for second-year





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Medicine Faculty students and two for Dental Medicine Faculty: “Applied histology in dental practice – from molecular to clinic” for first-year Dental Medicine students and “Histological techniques in oral pathology – from practice to research” for first-year Dental Medicine students, English program.

The annual teaching load in Histology Department of University of Medicine and Pharmacy of Iasi is approximately 2,300 teaching hours, for which 14 academic teachers are employed. The Department of Histology has 6 classrooms for simultaneous study for 96 students, 1 laboratory for learning of histological techniques and 1 laboratory for immunohistochemical techniques. Most teaching staff of Histology Discipline of “Grigore T. Popa” University of Medicine and Pharmacy have experience in teaching histology and histopathology in Romanian, English and/or French and have been part of previous European projects of the Discipline and of the University. The teaching team of the Department of Histology has been part of a national collaborative group which translated the internationally acknowledged textbook of histology "Histology. A Text and Atlas with correlated Cell and Molecular Biology", eighth edition, by Wojciech Pawlina, 2019, Wolters Kluwer Health Publishing House.

The concept of computer-assisted instruction was firstly implemented in University of Medicine Iasi since 1997, through the development of two pioneering digital instruments, namely the Histology Album and the Oral Histology Album, built for learning microscopy and available, at that time, as Internet resources. The application of this particular e-learning method was imposed by the importance of well-defined visual images in acquiring basic histologic principles. Thus, the use of modern technology involving multimedia tools represented a valuable application of a new trend in the educational process, based on the theoretical principles of computer vision. The digital microscopic images of these collections are correlated to teaching and research activities. The use of these two collections of digital images ensures the facilitation of the stages of collective viewing and interpretation of visual information, refining the process of analysis and knowledge consolidation. The Histology Album provides teaching support for the systemic histology concepts, being organized in distinct sections for the immune, endocrine, digestive, respiratory, renal and genital systems, whereas The Oral Histology Album focuses on aiding the learning of dental histology notions, from tooth development to characterization of mature enamel, dentin, pulp, superficial and deep periodontium, and associated structures in oral cavity.

The Specific Competences Acquired in Histology & Histopathology are classified into:

- a) Professional Competences (knowledge and skills):
 - Theoretical characterization and microscopic identification of organism fundamental tissues.
 - Theoretical characterization and microscopic identification of specific structures for organism systems.
 - Ability to establish organ diagnosis, by application of microscopic criteria of diagnosis.



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- Knowledge of basic pathology.
 - Knowledge of the main mechanisms of diseases.
 - Abilities to understand a pathology report
- b) Transversal Competences in Histology & Histopathology (roles, personal and professional development):
- Ability of normal microscopy data usage for oral and systemic pathology benchmarks understanding.
 - Imagination development, by the exercise of organism tridimensional structural information translation in microscopic two-dimensional image.
 - Knowledge of morphological methods (cytological and histopathological diagnosis on smears and biopsies) used in clinical diagnosis and patient therapy.
 - Knowledge of gross pathology and histopathology in various pathological conditions.
 - Basic understanding of the laboratory data and of the relationship between laboratory and morphological changes in disease status.
 - Correlation of basic science knowledge to clinical medicine.

Objectives of the Discipline of Histology & Histopathology (related to the acquired competences) are classified into:

a) General Objectives:

- Students' instruction regarding tissue and systemic structure of the human organism in correlation with functionality, by (i) theoretical concepts covering the fundamental characterization of the main tissues and systems; (ii) practical activity related the microscopic elements identification and the formulation of the organ diagnosis.
- Acquisition of knowledge of morphological and clinical characteristics of a broad spectrum of lesions
- Understanding of the main mechanisms of disease
- Establishment of clinic-pathological correlations in various pathological processes
- Learning the diagnostic methods and their specific indications for various injuries.

b) Specific Objectives:

- Knowledge of organism fundamental tissues components, in optical microscopy, electron microscopy, along with molecular level, and of structural-functional correlations.
- Knowledge of the structure of components which form organism systems, in optical microscopy, electron microscopy, along with molecular level, and of structural-functional correlations.
- Microscopic identification of specialized cellular types.
- Tissues microscopic identification.





- Organs microscopic identification, by applying diagnostic algorithms which include successive steps of structural components recognition.
- Accumulation of a background knowledge essential for the understanding of the systemic pathogenic mechanisms.
- Learning the morphology and clinical characteristics of a broad spectrum of disease entities.
- Understanding the pathophysiology of diseases.
- Interpretation of laboratory data and correlation with clinic-pathological data.

2. Use of Virtual Microscopes on Medical Universities in Romania

While the importance of Histology and Histopathology in medical studies results from the necessity of microscopy studies for the understanding of the disease diagnosis and management, as a base for clinical studies, the implementation of Virtual Microscopy in Histology and Histopathology teaching represents a good alternative if distancing is required and an attractive method for students to improve their microscopy skills.

There are 11 Medicine Universities in Romania. According to our research, the use of Virtual Microscopy is just starting to be implemented in Medical Universities in Romania. Based on available information, the potential use of VM in these universities has been registered into a chart.

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

University	Additional information	Self-developed / external service
"Vasile Goldis", Arad	https://somapp.ucdmc.ucdavis.edu/slides/ *donation form UC Davis School of Medicine USA (access to 1500 digital slides of various animals & humans)	External service
Transilvania, Brasov	NO	
"Carol Davila", Bucharest	https://www.histology.ro/Histology/Info.html *collection of static histological images (not virtual) and links to external free educational sites http://www.e pathology.ro/ *collection of static pathological images (not virtual) and links to external free educational sites http://morfopat.medicalstudent.ro/ *virtual histopathology atlas – not functional at the moment	Self developed
"Iuliu Hatieganu", Cluj-Napoca	NO	





"Ovidius", Constanta	NO	
Craiova	http://86.122.148.72/DSServer/Login.aspx *histology virtual atlas – log in credentials needed https://www.umfcv.ro/ro/educatie/facultati/medicina/program-de-studiu-medicina/morfopatologie/medicina-atlas-de-morfopatologie-disciplina-morfopatologie * collection of static pathological images (not virtual)	Self developed
"Grigore T. Popa", Iași	NO	
Oradea	NO	
"Lucian Blaga", Sibiu	NO	
Târgu Mureș	NO	
"Victor Babeș", Timișoara	https://www.3dhitech.com/research/software/eschool/ *log in credentials needed	External service

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

Few universities from Romania (especially *technical* ones) have a well-developed infrastructure able to sustain a fully online teaching and assessment.

Medical universities have an extremely low developed e-Learning and online assessment facilities.

- Literature research, in the field of Medicine and Health Sciences, in the following database: EMBASE, EBSCO, NATURE, OVID, OXFORD JOURNALS, ProQuest, ScienceDirect, Scopus, SpringerLink, Wiley Online Library, ResearchGate, Reaxys, PubMed, Clarivate, Google Academic, using the following **keywords**: virtual microscopy, digital slides, e-Learning, e-Assessment, medicine, histology, pathology, revealed:
 - 0 metaanalyses
 - 0 reviews
 - **only 4 original articles – published in 2020:**
- Focus on the implementation of Digital and Virtual Technology in Medical Education, mainly in Histology and Histopathology departments.
- University of Medicine and Pharmacy "Victor Babeș" Timișoara: VM platform E-School teaching module (Case Center) – **1500 scanned slides** – open access – not accessible at the present moment
<https://www.3dhitech.com/research/software/eschool/>) and E-School Exam Module





ARTICLE 1

R. M. Coșniță, A. Maria Cimpean and M. Raica, "Online versus On-site e-Assessment in Medical Education: are we ready for the change?" 2020 International Symposium on Electronics and Telecommunications (ISETC), Timisoara, Romania, 2020, pp. 1-4, doi: 10.1109/ISETC50328.2020.9301150.

General information:

- Publication name: 2020 International Symposium on Electronics and Telecommunications (ISETC)
- DOI or bibliographic reference: 10.1109/ISETC50328.2020.9301150
- Year of publication: 2020
- Country: Romania
- Type of institution University of Medicine and Pharmacy "Victor Babeș" Timișoara (public)
- Subject and degree: comparison of two E-assessment platforms (E-School Exam Module versus FlexiQuiz) and evaluation of the impact of online versus on-site examination by analyzing students' outcomes
- VM platform:
 - E-School teaching module (Case Center) – 1500 scanned slides – open access – not accessible at the present moment
<https://www.3dhitech.com/research/software/eschool/>
 - FlexiQuiz – online subscription. platform for hosting exams. URL or website address of VM platform – unknown. Not posted on the university's website

Educational intervention:

- Number of students participating: two groups (group 1 – 480 students, group 2 – 527 students)
- Gender distribution of the students – not available
- Grouping of students (balanced groups of students registered in second year medical school)
- Type of images WSI
- Tissues studied through VM: histology slides
- Variables to be measured:
 - performance categories (established by marks/grades at the final exam)
 - onsite versus online evaluation of outcomes for the practical exam / theoretical exam
 - time of the examination (60 sec/ question onsite versus 120 sec/question online)

According to www.researchgate.net: Number of Citations 0; Reads 96





ARTICLE 2

A. M. Cimpean, R. Minodoru Coșniță and M. Raica, "To "paint" with Human Tissues and Modern Technology: This is Art in Histology Gamification," 2020 International Symposium on Electronics and Telecommunications (ISETC), Timisoara, Romania, 2020, pp. 1-4, doi: 10.1109/ISETC50328.2020.9301122.

General information:

- Publication name: 2020 International Symposium on Electronics and Telecommunications (ISETC)
- DOI or bibliographic reference: 10.1109/ISETC50328.2020.9301122
- Year of publication: 2020
- Country ROMANIA
- Type of institution University of Medicine and Pharmacy "Victor Babeș" Timișoara (public)
- Subject and degree: gamification in histology– as an alternative learning method for developing students' practical skills
- VM platform:
 - E-School teaching module (Case Center) – 1500 scanned slides – open access – not accessible at the present moment
<https://www.3dhitech.com/research/software/eschool/>
 - Facebook page created for hosting the event
- URL or website address of VM platform – unknown. Not posted on the university's website

Educational intervention:

- Number of students participating: 181 students.
- Gender distribution of the students not available
- Grouping of students – none - project addressed to all second-year medical students
- Type of images WSI, Fixed magnification images
- Tissues studied through VM: histology slides
- Variables to be measured:
 - Testing student creativity using technology
 - Communication between students and teachers

According to www.researchgate.net: Number of Citations 0; Reads 57





ARTICLE 3

R. M. Coșniță, A. M. Cimpean, R. Maerz and M. Raica, "Opening the Door through the E-Learning and EAssessment for Preclinical Medical Education in Romania: Academic, Social and Psychological Impact," 2020 International Conference on e-Health and Bioengineering (EHB), Iasi, Romania, 2020, pp. 1-5, doi: 10.1109/EHB50910.2020.9280225.

General information:

- Publication The 8th IEEE International Conference on E-Health and Bioengineering - EHB 2020
- DOI or bibliographic reference: 10.1109/EHB50910.2020.9280225.
- Year of publication: 2020.
- Country: Romania.
- Type of institution University of Medicine and Pharmacy "Victor Babeș" Timișoara (public)
- Subject and degree: evaluation of the e-Learning and e-Assessment impact on students' skills and performance and on teachers and tutors work
- VM platform E-School teaching module (Case Center) – 1500 scanned slides – open access – not accessible at the present moment <https://www.3dhitech.com/research/software/eschool/>) and E-School Exam Module
- URL or website address of VM platform – unknown. Not posted on the university's website

Educational intervention:

- Number of students participating: project addressed to all second-year medical students (number not specified)
- Gender distribution of the students – not available
- Grouping of students – not available
- Type of images: WSI, Fixed magnification images
- Tissues studied through VM: histology slides.
- Variables to be measured
 - Students' compliance to the e-Learning method assessed by their performances
 - percent of graduation from practical labs compared with theoretical one
 - teachers' perception on the new system
 - time of examination
 - Social and economic impact of e-Learning and e- Assessment

According to www.researchgate.net: Number of Citations 0; Reads 33





ARTICLE 4

Cosnita RM, Cimpean AM, Raica M. E-learning and e-assessment: two big challenges of medical education management in Romania. International innovative business. 2020;12(1):61-71. doi:10.32015/JIBM/2020-12-1-8

General information:

- Publication name International innovative business
- DOI or bibliographic reference 10.32015/JIBM/2020-12-1-8
- Year of publication 2020
- Country: Slovenia
- Type of institution University of Medicine and Pharmacy "Victor Babeş" Timișoara (public)
- Subject and degree: evaluation of the e-Learning and e-Assessment impact on students' skills and performance and on teachers and tutors work
- VM platform E-School teaching module (Case Center) – 1500 scanned slides – open acces – not accessible at the present moment (<https://www.3dhitech.com/research/software/eschool/>) and E-School Exam Module
- URL or website address of VM platform – unknown. Not posted on the university's website

Educational intervention:

- Number of students participating about 1500 students
- Gender distribution of the students - not available
- Grouping of students 3 sets (3 consecutive generations of students – during 2018 – 2020 reaching up to 500 students/year), each set sub-grouped into 3 categories based on the language of teaching (Romanian, English and French)
- Type of images WSI
- Tissues studied through VM histology slides.
- Variables to be measured:
 - Acceptance /not acceptance of the system
 - Appreciation of system facilities
 - The need to introduce additional facilities to the existing ones
 - Student-teacher interaction
 - Online accessibility of the e-learning system
 - Examination in digital system - transparency
 - Time allotted for examination
 - Applying the use of the system to other disciplines in the university

According to www.researchgate.net: Number of Citations 4 (self-citations); Reads – not available.





Phase 2 - Interview questionnaires on virtual microscopy potential

1. Methodology of the interview questionnaires applied in Romania

Ten experts participated in the questionnaire, three professors, two associate professors, two lecturers, and three assistant professors. Eight of them have PhD and two of them are PhD students. Seven of them are Histopathology Consultants, while three of them are Specialists in Histopathology. They all teach histology and/or histopathology in the Department of Morphofunctional Sciences I, of “Grigore T. Popa” University of Medicine and Pharmacy Iasi, Romania.

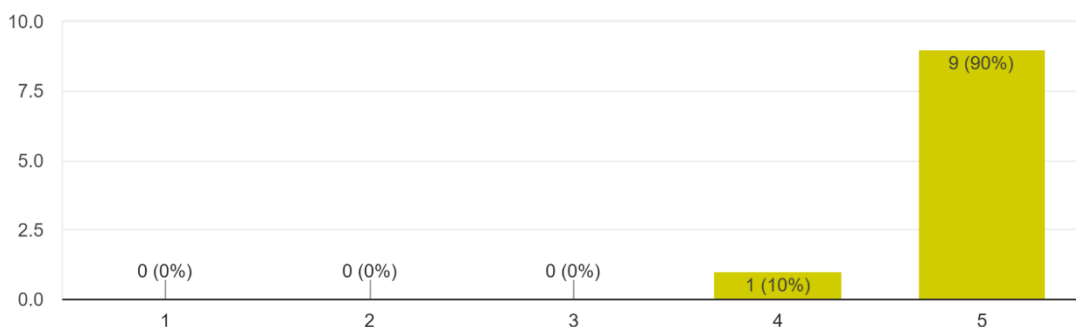
The survey was conducted via Google Forms test which included 10 questions evaluating on a scale 1 to 5, yes and no questions, as well as open questions, regarding a wide range of issues and opinions.

2. Analysis of the applied interview questionnaire in Romania

Q1. 90 % of the respondents answered that they are completely familiar with VM technology and VM based teaching, while 10% are partially familiar with VM.

1. I am familiar with VM technology and VM based teaching.

10 responses



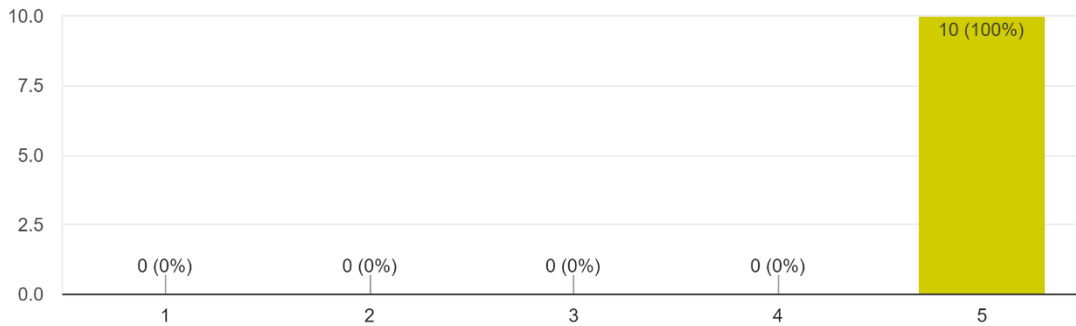
Q2. 100% of the respondents answered that they would be fully interested in accessing a free VM library to improve their knowledge of histology or histopathology.





2. I would be interested in accessing a free VM library to improve my knowledge of histology or histopathology.

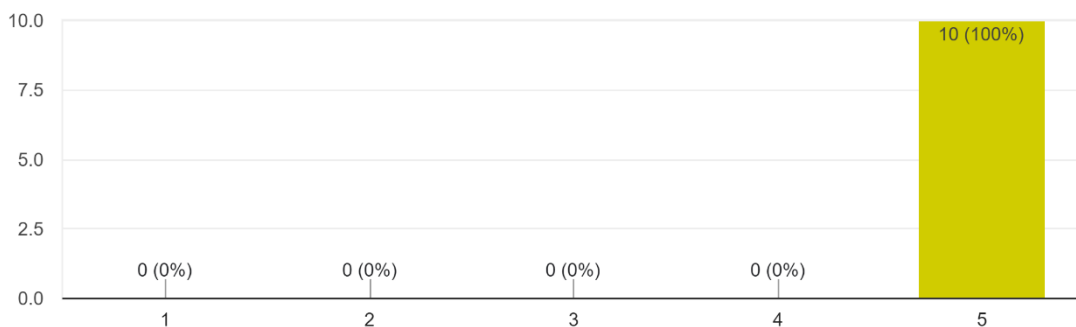
10 responses



Q3. 100% of the respondents answered that VM will surely increase their/student's understanding of the histological sections.

3. VM will increase my/the student's understanding of the histological sections.

10 responses



Q4. 70% of the respondents answered that VM may surely strengthen the teacher-student relationship, while 30% answered that VM will relatively strengthen the teacher-student relationship.



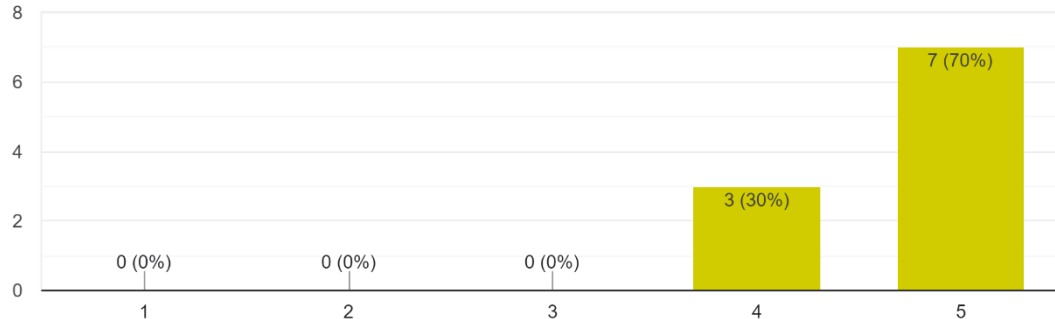


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4. VM may strengthen the teacher-student relationship.

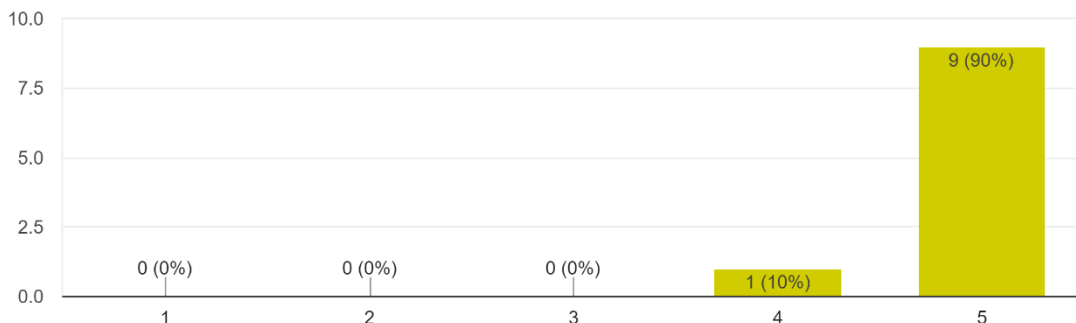
10 responses



Q5. 90% of the respondents answered that it would be very helpful for students to introduce a VM tutorial on using the digital slide platform in the introductory lecture on histology, while 10% answered that it would be helpful.

5. It would be helpful for students to introduce a VM tutorial on using the digital slide platform in the introductory lecture on histology.

10 responses



Q6. 80% of the respondents answered that it would be very useful to introduce the Multiple Choice Questions MCQs/ quiz section regarding virtual slide understanding for self-testing the student's level in histology & histopathology, while 20% answered that it would be useful.



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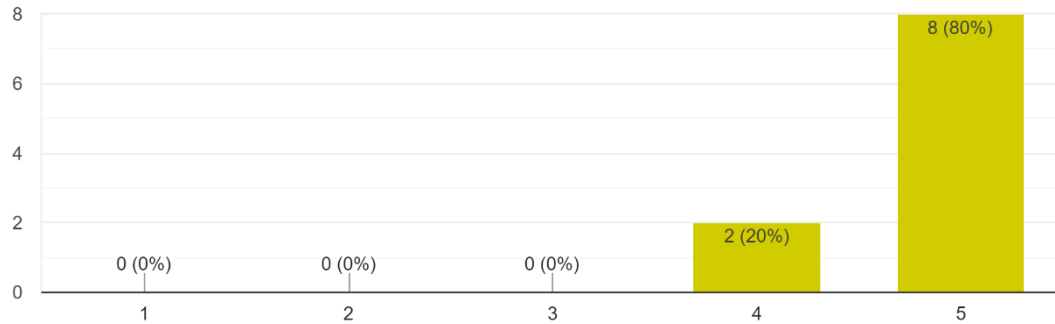


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6. It would be useful to introduce the Multiple Choice Questions MCQ / quiz section regarding virtual slide understanding for self-testing the student's level in histology & histopathology.

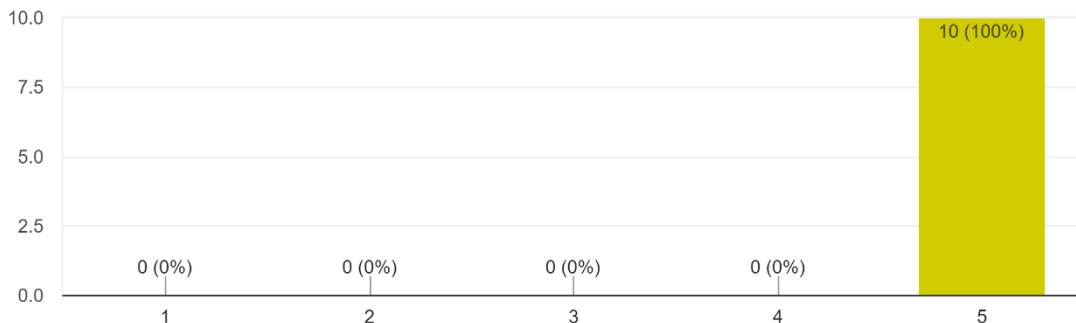
10 responses



Q7. 100% of the respondents answered that they would like to contribute with their collection of slides to a VM library of histology, cytology and histopathology.

7. I would like to contribute with my collection of slides to a VM library of histology, cytology and histopathology.

10 responses



Q8. 80% of the respondents answered that a VM system, accessible outside a limited institutional frame, can be prone to electronic fraud and IT hacking, while 10% answered that it is possible, while 10% consider this event as less possible.



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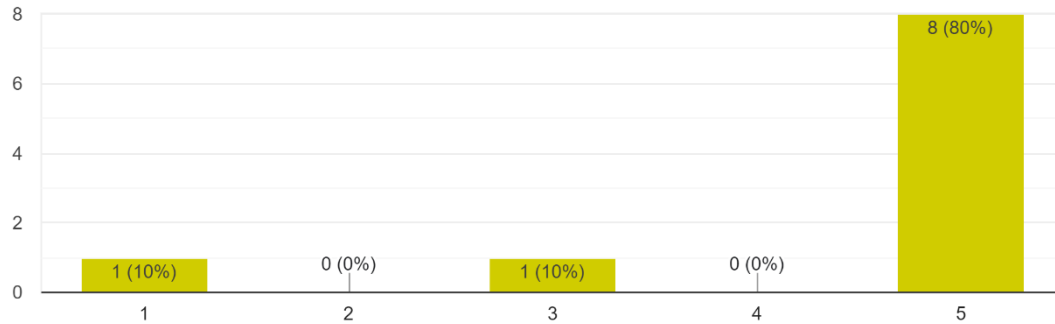


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8. A VM system, accessible outside a limited institutional frame, can be prone to electronic fraud and IT hacking.

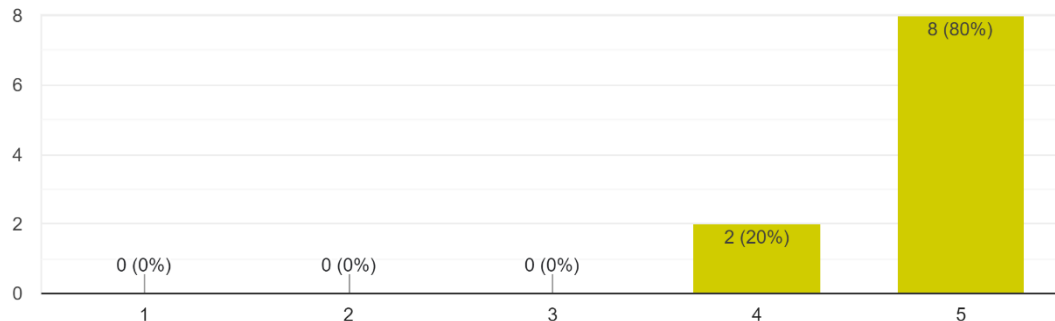
10 responses



Q9. 80% of the respondents answered that virtual microscopy will significantly reduce the time for studying the histological sections, while 20% consider that VM will partially reduce the studying time.

9. Virtual microscopy will reduce the time for studying the histological sections.

10 responses



Q10. 50% of the respondents answered that they prefer a “whenever and wherever” method of education, while 30% partially prefer it, and 20% have a weak preference of this method.



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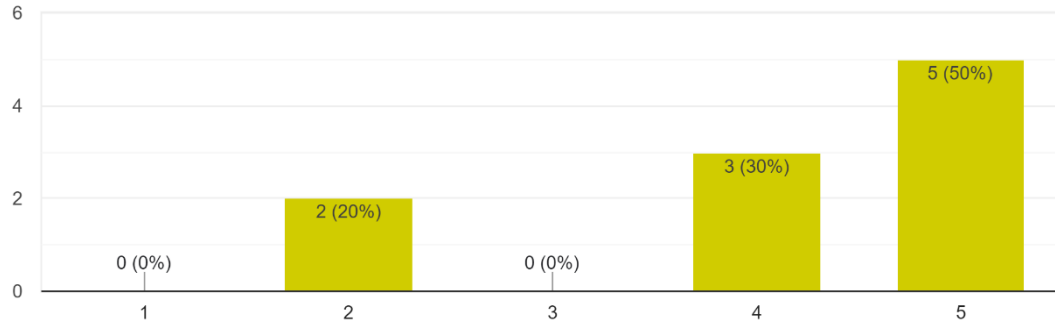


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10. I prefer a “whenever and wherever” method of education

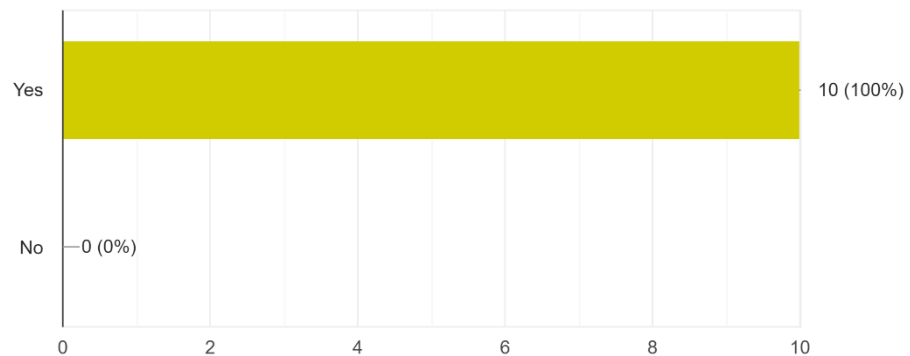
10 responses



Q11. 100% of the respondents answered that they use a slide collection for histology/ histopathology (in classes, in the office or at home).

11. Do you use a slide collection for histology / histopathology (in classes, in the office or at home)?

10 responses



Q12. 90% of the respondents answered that, if available, they would apply both VM and LM in their teaching, while 20% would apply just VM. The justifications of the answers were:

- classical slides also test your ability to work with the microscope, and VM can be an easy method to test your knowledge after working with classical slides
- VM may complete the traditional microscopy education. However, in medical profession, the knowledge regarding the use of a microscope should be achieved during the basic training.
- I think that students must also have direct experience with microscopic slides



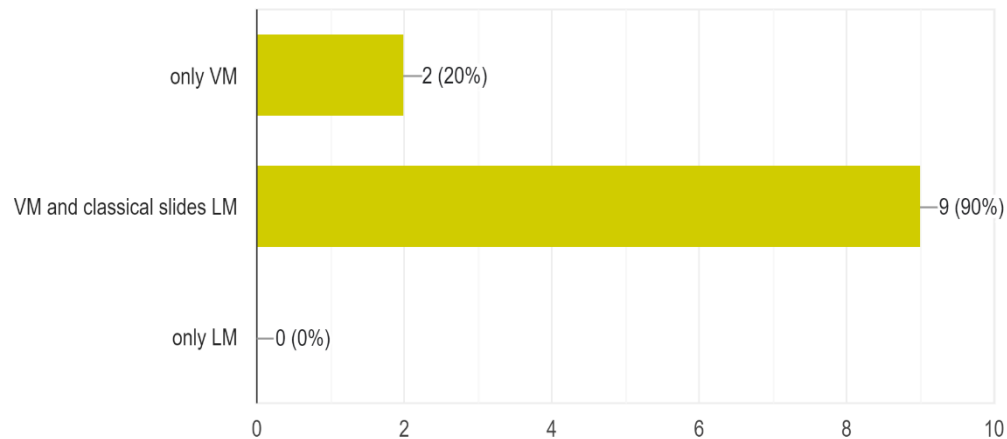
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12. If available, which of the three methods would you apply to your teaching? (VM= Virtual Microscopy LM= Light microscopy)

10 responses



Q13. The respondents answered that, in their opinion, the advantages of virtual microscopy over conventional microscopy are the following:

- 1. easy access; 2. intuitive interaction; 3. easier measurements on the slides; 4. easier orientation on the slides (if the software allows it)
- Virtual microscopy has the main advantage that it facilitates education and training at distance, so it may be used whenever physical distancing is required or wherever remote education and/or diagnosis / consultation may be necessary. Additionally, virtual microscopy exploits the current trend of digitalization, makes microscopy education more interesting for the students, provides the use of different available tools (annotation and measurement), allows self-assessment, and may strengthen the relationship between teacher and student.
- The Virtual Microscope allows users to examine and explore cells and microscopic features of tissue, helping them to develop classification and identification skills without the need for high-cost microscopes and thin section preparation facilities.
- Individual study or in small groups and an individual flexibility of the study program.
- accessibility, speed, ease of learning
- favors individual remote learning
- I think it would improve the quality of teaching
- We are in an age of information technology, to which the younger generation is very open. VM can stimulate students' interest in microscopy as a digitally based learning method. VM facilitates access to a large amount of information.
- VM allows a wider accessibility, a more detailed evaluation of the slide/case and the easy creation of a database for didactic and scientific purposes.





- high-quality images, easy navigation of slides, free access of the slides at any time, improves diagnosis ability

Q14. The respondents answered that the hardware and software limitations that a teacher can have are the following:

- VM for a teacher can be limited by their personal knowledge and experience regarding computer software use, but also depends on limitations of personal/institutional device (should have a minimum hardware requirement - minimum amount of RAM, of storage capacity, CPU capacity); also limitations can result from unstable/limited internet connection and vulnerability of the system to a potential cybernetic attack.
- The limitations for a teacher are related to the internet access and signal quality, the personal and/or institutional central processing unit and memory storage space, considering the large volume of digital slides and associated software, resulting in long lag time in whole slides opening, pan and/or zooming.
- Good microscopes slides and thin section preparation of sides.
- Hardware and software limitations are related to the processor memory of the computer that extend the teaching time and influence the teaching quality.
- Teachers do not have hardware and software limitation
- incompatible pc
- Lack of new generation devices
- Hardware limitations: RAM memory, storage capacity, connectivity issues. Software limitations: software compatibility between different available devices.
- Lack of software and hardware necessary for the teaching activity, like Office Professional, a good photo software, flat screen monitor, USB ports, good quality printer, etc

Q15. The respondents answered that the hardware and software limitations that a student can have, are the following:

- VM for a student can be limited by their personal knowledge and experience regarding computer software use (even though the majority have fundamental computer operating skills), but also depends on limitations of personal devices outside the institutional network (should have a minimum hardware requirement - minimum amount of RAM, of storage capacity, CPU capacity); also limitations can result from unstable/limited internet connection and vulnerability of the system to a potential cybernetic attack.
- The limitations for a student are related to the functionality of the account for the digital library, the internet access and signal quality, the central processing unit and memory storage space of different devices used.
- challenge students' knowledge in the testing section to see what the student learned.
- Hardware and software limitations are related to the Internet connection in some locations or hours.
- In general, students do not have hardware and software limitations
- incompatible pc





VM3.0 - Digital transformation of Histology and Histopathology by Virtual Microscopy (VM) for an innovative medical school curriculum

2022-1-RO01-KA220-HED-000089017

- Lack of new generation devices, accessible from home
- Hardware limitations: RAM memory, storage capacity, connectivity issues. Software limitations: unstable Internet connection due to the personal network provider, restricted access outside University network, security protocols.
- Lack of a smartphone and accessibility to the existing infrastructure in the discipline.
- internet connection, screen resolution, use of outdated browsers

Q16. The respondents answered that, in their opinion, the limitations of applying VM in the curricula of a histology and histopathology teaching program are the following:

- limitations of applying VM in the curricula could be determined by the different national or institutional curricula, and also by the general traditional approach of the teachers in the educational process
- The concrete limitation of applying VM in the curricula of histology and histopathology teaching are related to existent national and institutional curricula which has been established by traditional use of physical slides. Nonetheless, a minority of didactical staff may be partially biased considering that application of digital microscopy may diminish the quality of medical education, but this opinion may be overcome by the understanding of the advantages of VM application in modern era.
- good slides, university platforms, educational resources
- The inertia of our education system to changes.
- In my opinion, there are no real limitations for the introduction of virtual study into the school curriculum.
- lack of didactic slides for all tissues and systems
- Lack of new generation devices
- There are no limitations.
- Lack of funds for the acquisition of the infrastructure necessary for the implementation of the VM.
- national curriculum differences between universities, international curriculum differences between countries.



Co-funded by
the European Union

"The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the National Agency and Commission cannot be held responsible for any use which may be made of the information contained therein".