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Survey on Virtual Microscopy versus Light Microscopy in Histological Education among Students in Medicine and Dental Medicine

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Virtual microscopy (VM) involves digitally photographing tissue sections on microscope slides and provides a physically distant opportunity for histology education. This method was particularly important during the Covid-19 pandemic. The aim of the present study was to verify the students' opinion on this innovative method and its implementation in histological education. 152 UK and 50 Bulgarian students at Medical University of Plovdiv participated. We performed a survey using Google Forms test among the students. The students think that virtual microscopy will increase the understanding of the microscopic structures but cannot replace the conventional light microscopy and teacher guidance. 147 of them prefer studying histological sections via both methods. Virtual microscopy represents a modern tool with increased quality and utility in microscopy education. However, the role of the teacher and the light microscopy are also very significant and using both methods will provide the most beneficial training in histology.

Key words: histology, light microscopy, medical education, virtual microscopy

Introduction

Medical histology has been a basic science course in the medical school curriculum worldwide [3]. A sound knowledge of microscopic anatomy and histology is of fundamental importance in medical training and education. Since the middle of the 19th century, light microscopes and histological specimens have been used. In Heidelberg, in 1846, Jacob Henle became the first anatomist (and pathologist) to introduce a microscopy course where every student worked at an individual microscope. At the beginning of the 20th century, projectors were introduced to the market with the aid of which the microscopic specimens could be projected onto a screen. This method has been used for a long time [13]. During the late 20th century electron photomicrographs

were introduced. Such methods depend on the availability of suitable classroom space (microscopy lab) with rigid opening hours and a teacher [14]. Since the beginning of the 21st century there has been a huge technological development allowing histological specimens to be scanned. Afterwards these images are compressed and stored on the Web or disks. The Covid-19 pandemic led to the cancelation of face-to-face teaching [5]. The academics sought to create an environment that balanced student independence with teacher guidance. Research has shown that an active learning approach to histology teaching that incorporates Virtual microscopy leads to a beneficial outcome on student success [4, 12, 15]. Virtual microscopy is an emerging technology which provides a physically distant opportunity for histology and histopathology education. It involves digitally photographing tissue sections on microscope slides using one or more microscope objectives at one or more focal planes. Furthermore, Virtual microscopy software reproduces a high-quality image with meticulous clarity and added features that allow students and teachers to highlight, annotate, and zoom. Using computer software these images can be viewed on a monitor. Magnification and focus can be adjusted by clicking the mouse button [10].

In the Department of Anatomy, Histology and Embryology of Medical University-Plovdiv students in Medicine and Dental medicine study Cytology, General histology and Embryology and Organ Histology using conventional light microscopy plus a histological database of digital microscopic slides on CDs and USB flashes and stored in SharePoint (Microsoft). Our team participates with specialists from Romania, Spain, and Poland in an international Erasmus project which aims to scan microscopic slides using Leica Aperio AT2 scanner and upload them in a shared virtual platform to upgrade our existing slides collection.

Aim

Based on the long experience of our department with the use of a histological database of digital microscopic slides, the aim of the present study was to verify the opinion of the Medical University-Plovdiv students on this innovative method – virtual microscopy and their attitude to its implementation in anatomical and histological education, especially if distant learning is required.

Subjects and Methods

152 UK students at Medical University of Plovdiv participated (61 males and 91 females). 122 of them were students in medicine and 30 were in dental medicine, 127 of them were in first year and 25 were in second year. 50 Bulgarian students also took part in the survey (26 males and 24 females), 41 of them were students in medicine, 9 in dental medicine, 25 of them were first year and 25- second year.

We performed a survey via Google Forms test which included 10 yes-and-no questions as well as multiple choice questions on the students' opinion based on media and internet.

Our histological database contains slide collection images taken on Leica microscope model DM3000LED equipped with a digital camera model Leica FLEXACAM C3. The used microscopic magnifications are x100 and x400. The average size of the image files is 1.2 MB, and the type of the image is JPEG.

Results

Statement 1. Virtual microscopy will increase students' level of understanding for the microscopic structures.

Ninety four (68.8%) of the UK students think that Virtual microscopy will increase their level of understanding of the microscopic structures, 9 (5.9%) of them disagree with that and 49 (32.2%) are not sure about the statement. At the same time 22 (44%) of the Bulgarian students agree with the statement, 13 (26%) do not and 15 (30%) are not sure (**Fig. 1**).

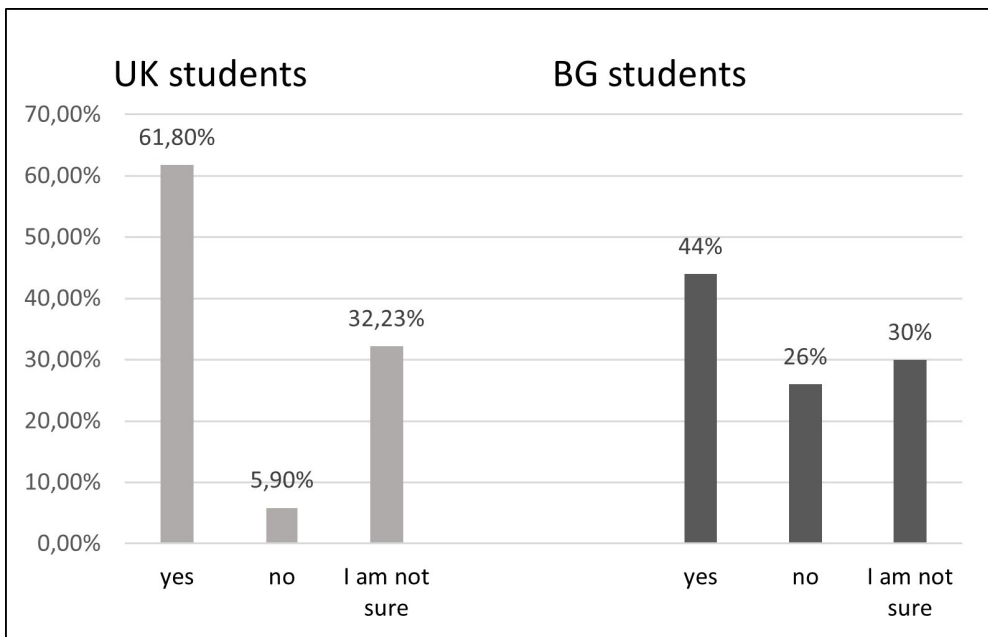


Fig. 1. Do you think that VM will increase your level of understanding the microscopic structures?

Statement 2. Limitations for using Virtual microscopy.

When asked what limitations they think Virtual microscopy might have 9 (5.9%) of the UK students answer hardware limitations, 15 (9.9%) say software limitations, 22 (14.5%) state internet connection, 41 (27%) give lack of experience as an answer and most of them - 65 (42.8%) think that all these reasons will limit them. 2 (4%) of the BG students answer hardware limitations, 3 (6%) say software limitations, 3 (6%) state internet connection, 20 (40%) give lack of experience as an answer and again most of them – 22 (44%) think that all these reasons will limit the usage of VM (**Fig. 2**).

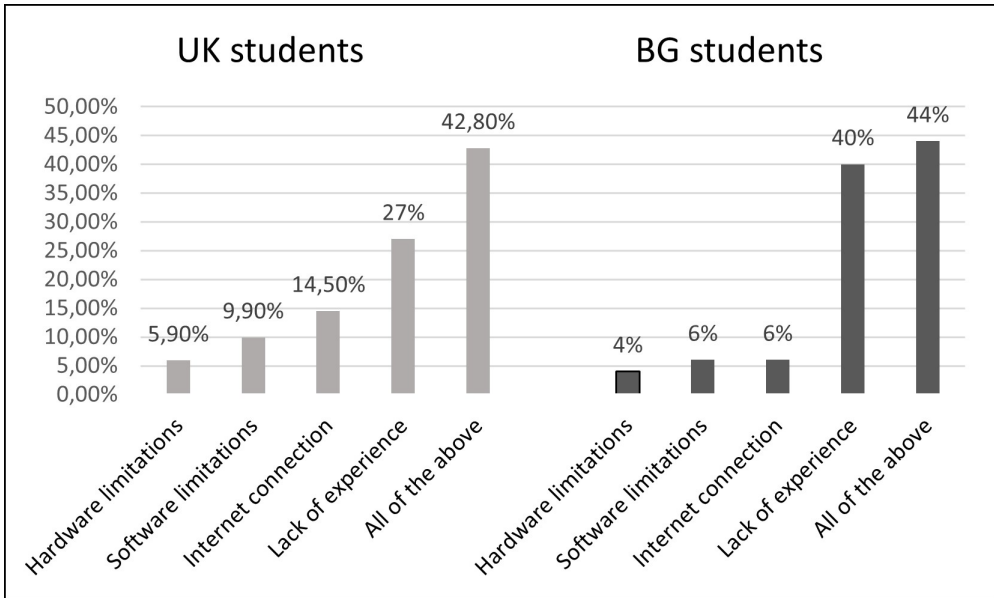


Fig. 2. What limitations do you think VM might have?

Statement 3. Virtual microscopy can replace the teacher’s role.

Thirty one (20.4%) of the UK students agree with the statement that Virtual microscopy can replace the teacher in studying microscopic structures, 23 (15.1%) are not sure, but most of them – 98 (64.5%) disagree with the statement. At the same time 4 (8%) of the BG students agree, 3 (6%) are not sure and again most of them – 43 (86%) disagree (**Fig. 3**).

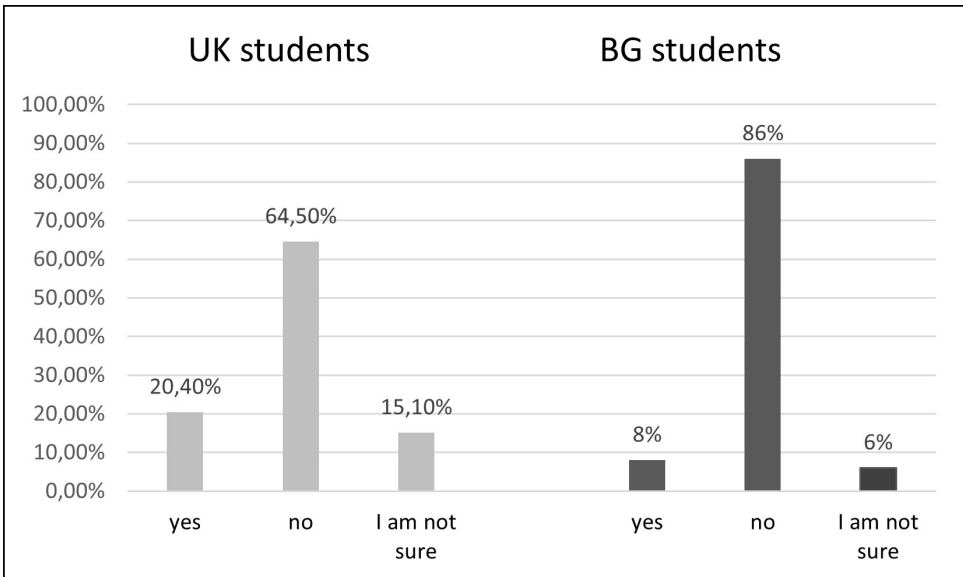


Fig. 3. Do you think that VM can replace the teacher in studying microscopic structures?

Statement 4. Virtual microscopy will make studying easier.

Ninety five (62.5%) of the UK students think that Virtual microscopy will make their studying easier, 8 (5.3%) do not share this opinion and 49 (32.2%) are not sure. 25 (50%) of the BG students also agree with the statement, 13 (26%) disagree and 12 (24%) are not sure (Fig. 4).

Statement 5. Which method do students prefer?

When asked which method they prefer to study microscopic structures, 21 (13.8%) of the UK students answer conventional microscopy, 19 (12.5%) say virtual microscopy, but most of them - 122 (80.3%) state they prefer combined method. 14 (28%) of the BG students say they prefer conventional microscopy, only one answers virtual microscopy and again most of them - 35 (70%) respond they prefer combined method (Fig. 5).

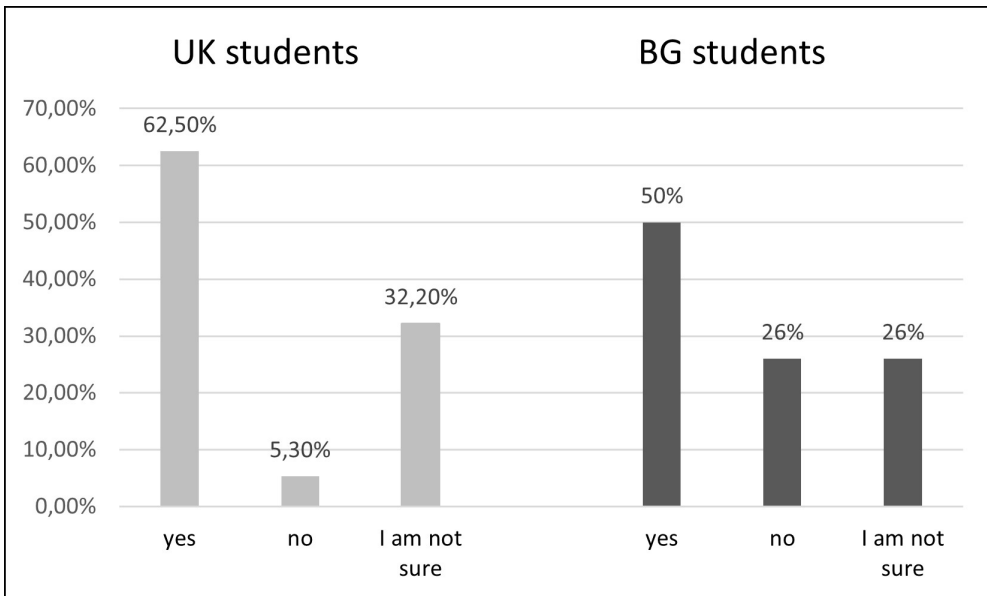


Fig. 4. Do you think that VM will make your studying easier?

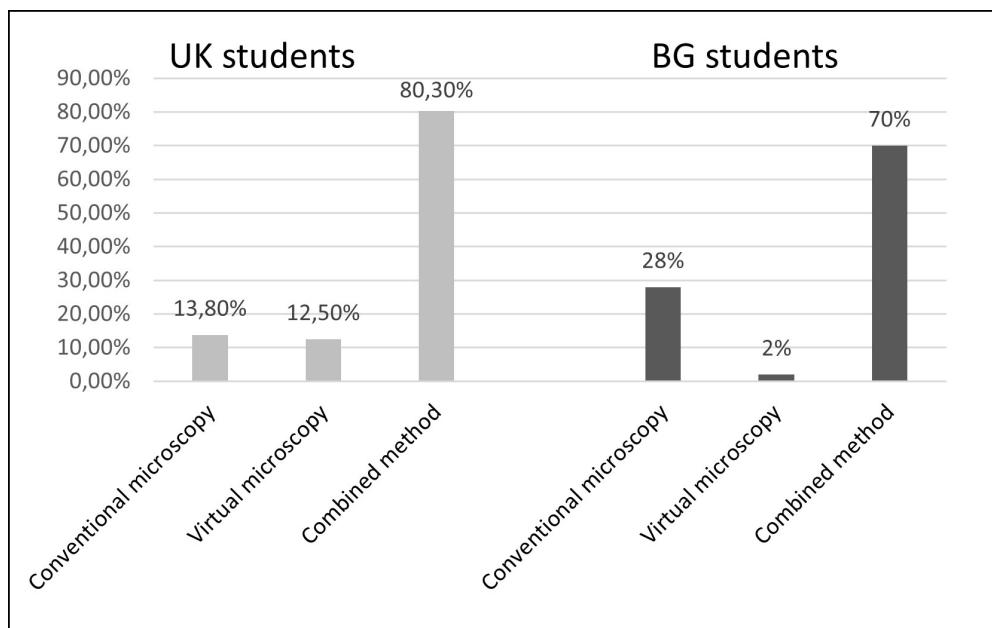


Fig. 5. You prefer studying microscopic structures by:

Discussion

The course in “Cytology, Histology and Embryology” in medical studies in the 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 aim of the histology course in medical studies in the Department of Anatomy, Histology and Embryology is to give students knowledge of the normal microscopic structure of the human eukaryotic cells, tissues, and organs. Thus, they can apply this knowledge in the distinction of histopathology structures. This is of main 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 histology and histopathology studies in Medical University - Plovdiv 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 allowing 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.

This course is considered highly challenging by the students, so histology academics committed to improve student learning by incorporating Virtual microscopy in teaching especially with the rapid acceleration in the use of computers and the Web [5]. Universities such as the University of Copenhagen [16], the University of South Carolina School of Medicine [5], the University of Iowa [8], the University of Los Angeles, CA [16] have been using virtual slides and microscopes since year 2000. According to surveys among the students at these universities they prefer the accessibility and efficiency of the Virtual Microscope Laboratory versus the regular microscope laboratory. Regular microscope laboratories were opened during the day, while Virtual Microscope Laboratory could be used without limitations. This was very useful for the students especially before practical examinations. In addition, students rated the quality of images and navigation of the virtual microscope equal to or better than a real microscope. Virtual slides are always in focus with ideal condenser and light adjustment, thus decreasing the student time and some of the frustration in operating a real microscope [9, 2, 11]. All students have identical slides. This reduces student complaints that the slides in their individual collection were not as good as those of a fellow student. Furthermore, Virtual Microscopy incorporated in a virtual platform on the Web allows sharing information between different universities which is not possible with glass slide collection.

As in other universities Covid-19 pandemic led to cancelation of face-to-face teaching for a few months. This has provoked our team at the Department of Anatomy, Histology and Embryology in Medical University- Plovdiv to create an environment that combines student independence with teacher guidance. In this relation, we decided to validate our students' opinion upon Virtual Microscopy and its implementation in histology teaching. 68.8 % of the UK students and 44 % of the Bulgarian ones state that Virtual Microscopy will increase their level of understanding the microscopic structures while 32.2 % of the UK students and 30 % of the Bulgarian ones are not sure. 62.5 % of the UK students and 50 % believe that Virtual Microscopy will make their studying in histology easier by reducing the time and accessing the specimens wherever and whenever they choose. Over two thirds of the students that participated in a similar survey at the University of South Carolina also found using virtual slides easier than light microscope and glass slides. They agreed that using this method saved them time [3].

However, we believe that student-teacher communication is of great importance for the most beneficial outcome from learning histology. This totally corresponds to our students' opinion. When asked if they think that Virtual Microscopy can replace the role of the teacher 64.5 % of the UK students and 86 % of the Bulgarian ones disagree with the statement. Anatomical and histological sciences should not be delivered predominantly online, particularly programs that are designed to equip students with practical skills in medical laboratories. This opinion refers to other universities also [6, 15, 1]. In our university, most anatomical and histological work is performed using a microscope, which is a vital skill for medical students, therefore development of skills face to face in the laboratory is the golden standard for teaching. The situation is the same in University of South Australia [4] and other universities [7]. This is in total agreement with our students' opinion. 80.3 % of the UK students and 70 % of the Bulgarian ones state that they prefer studying the microscopic structures using combined method, both conventional and virtual microscopy.

Conclusion

The results of the current survey revealed that the medical students in our university prefer studying the microscopic structures using combined methods, both conventional and virtual microscopy. According to our students' opinion Virtual microscopy represents a modern tool that will increase their level of understanding of the microscopic structures. However, for our students the role of the teacher and the light microscopy are also very significant and using both methods will provide the most beneficial training in histology.

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