

This is an Open Access document downloaded from ORCA, Cardiff University's institutional repository: <https://orca.cardiff.ac.uk/id/eprint/100675/>

This is the author's version of a work that was submitted to / accepted for publication.

Citation for final published version:

Moxham, Bernard John, Emmanouil-Nikoloussi, Elpida, Brenner, Erich, Plaisant, Odile, Brichova, Hana, Kucera, Tomas, Pais, Diogo, Stabile, Isobel, Borg, Jordy, Scholz, Michael, Paulsen, Friedrich, Bueno-Lopez, Jose Luis, Arraez Aybar, Luis Alfonso, De Caro, Raffaele, Arsic, Stojanka, Lignier, Baptiste and Chirculescu, Andy 2017. The attitude of medical students in Europe toward the clinical importance of histology. *Clinical Anatomy* 30 (5) , pp. 635-643. 10.1002/ca.22889

Publishers page: <http://dx.doi.org/10.1002/ca.22889>

Please note:

Changes made as a result of publishing processes such as copy-editing, formatting and page numbers may not be reflected in this version. For the definitive version of this publication, please refer to the published source. You are advised to consult the publisher's version if you wish to cite this paper.

This version is being made available in accordance with publisher policies. See <http://orca.cf.ac.uk/policies.html> for usage policies. Copyright and moral rights for publications made available in ORCA are retained by the copyright holders.



ORIGINAL COMMUNICATION

The Attitudes of Medical Students in Europe Toward the Clinical Importance of Histology

BERNARD JOHN MOXHAM,^{1*} ELPIDA EMMANOUIL-NIKOLOUSI,² ERICH BRENNER,³ ODILE PLAISANT,⁴ HANA BRICHOVA,⁵ TOMAS KUCERA,⁵ DIOGO PAIS,⁶ ISOBEL STABILE,⁷ JORDY BORG,⁷ MICHAEL SCHOLZ,⁸ FRIEDRICH PAULSEN,⁸ JOSÉ LUIS BUENO-LÓPEZ,⁹ LUIS ALFONSO ARRAEZ AYBAR,¹⁰ RAFFAELE DE CARO,¹¹ STOJANKA ARSIC,¹² BAPTISTE LIGNIER,¹³ AND ANDY CHIRCULESCU¹⁴

¹Cardiff School of Biosciences, Cardiff University, Cardiff, Wales CF10 3AX, United Kingdom

²Laboratory of Histology-Embryology and Anthropology, Faculty of Medicine, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece

³Division of Clinical and Functional Anatomy, Department of Anatomy, Histology and Embryology, Medical University of Innsbruck, Innsbruck 6020, Austria

⁴University of Paris Descartes, Sorbonne Paris Cité, URDIA, Paris, EA 4465, France

⁵Institute of Histology and Embryology, Charles University Prague, First Faculty of Medicine, 128 01 Prague 2, Czech Republic

⁶NOVA Medical School | Faculty of Medical Sciences, NOVA University of Lisbon, Lisboa, 1169-056, Portugal

⁷Department of Anatomy, University of Malta, Tal Qroqq, Msida, Malta

⁸Department of Anatomy II, Friedrich Alexander University Erlangen-Nürnberg, Erlangen 91054, Germany

⁹Department of Neurosciences, School of Medicine and Nursing, The University of the Basque Country (UPV/EHU), Leioa 48940, Spain

¹⁰Department of Human Anatomy and Embryology, Faculty of Medicine, Complutense University, Ciudad Universitaria, Madrid 28040, Spain

¹¹Department of Neurosciences, Institute of Human Anatomy, Padova 35121, Italy

¹²Department of Anatomy, Faculty of Medicine, University of Niš, Niš 18000, Serbia

¹³Laboratoire de Psychopathologie et Psychologie Médicale (LPPM-EA 4452), Université Bourgogne-Franche Comté, Dijon 21000, France

¹⁴Department of Morphological Sciences, Division of Anatomy, Faculty of Medicine, C. Davila University, Bucharest, Romania

Many studies have been undertaken to assess the attitudes of medical students to the clinical importance of gross anatomy. However, much less is known about their attitudes toward the clinical importance of histology. Using Thurstone and Chave methods to assess attitudes, over 2,000 early stage medical students across Europe provided responses to a survey that tested the hypothesis that the students have a high regard for histology's clinical relevance. Regardless of the university and country surveyed, and of the teaching methods employed for histology, our findings were not consistent with our hypotheses, students providing a more moderate assessment of histology's importance compared to gross anatomy but more positive than their attitudes toward embryology. Histology should play a significant role in medical education in terms of appreciating not just normal structure and function but also pathology. We conclude that teachers of histology should pay special attention to informing newly-recruited medical students of the significant role played by histology

*Correspondence to: B. J. Moxham, Cardiff School of Biosciences, Cardiff University, Museum Avenue, Cardiff CF10 3AX, United Kingdom. E-mail: moxham@cardiff.ac.uk

Received 19 April 2017; Accepted 20 April 2017

Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22889

in attaining clinical competence and in underpinning their status as being learned members of a healthcare profession. This work was conducted under the auspices of the Trans-European Pedagogic Research Group (TEPARG). Clin. Anat. 00:000–000, 2017. © 2017 Wiley Periodicals, Inc.

Key words: anatomy; student attitudes; histology; medical students; microscopical anatomy

INTRODUCTION

The clinical importance of gross anatomy in the medical curriculum has been extensively reported (e.g., Monkhouse, 1992; Prince et al., 2003, 2005; Older, 2004; Hinduja et al., 2005; Pryde and Black, 2005; Waterston and Stewart, 2005; Patel and Moxham, 2006; Moxham and Plaisant, 2007; Korf et al., 2008; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). Indeed, both professional anatomists and medical students (at various stages of their course) in different parts of Europe possess very positive attitudes toward the clinical relevance of gross anatomy (Patel and Moxham, 2006; Moxham and Moxham, 2007; Moxham and Plaisant, 2007; Korf et al., 2008; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). To date, however, we know much less about the perceived importance of microscopic anatomy in the medical curriculum.

Institutional and national reviews of the medical curriculum have led to significant decreases in the time allotted to the biomedical sciences and particularly for some anatomical sciences. However, Drake et al. (2002, 2009, 2014) have reported that the number of hours devoted to histology in US medical schools has not changed significantly from 2002 to 2014. They found that in 2014 the average histology course lasted 72 hr (range 4–142 hr) compared with 79 hr (range 20–160 hr) in 2002. However, in terms of teaching methodologies, significant changes have also been reported and there are marked differences in the

organization of academic departments teaching microscopic anatomy. Indeed, the anatomical sciences are divided in some medical schools into separate departments of gross anatomy, histology, and embryology, with each department providing separate courses to the students. Elsewhere, the anatomical sciences are integrated and/or integrated with the rest of the medical curriculum such that histology courses are not “stand alone.” Drake et al. (2002, 2009, 2014) have highlighted the changes in the teaching of histology in US medical schools. They reported that, by 2014, on average a school delivered 31 hr of histology lectures (range 0–97 hr) and 33 hr of histology practicals (range 0–69 hr). This compares with 51–60 hr of practicals in 2002 (range 0–100 hr), representing >50% of the total course hours. It is thus noteworthy that some courses give neither lectures nor practicals. Furthermore, only 36% of courses were stand-alone, 52% existed in an integrated curriculum, and 12% in a mixed curriculum. The greatest change seen relates to the use of microscopes. In 2014, 82% of courses relied upon extensive use of virtual microscopy and this compares with 71% in 2009 and only 14% in 2002.

As a contribution to the debate on the importance of the anatomical sciences in medicine, in this article, we report on an assessment of the attitudes of medical students toward the clinical relevance of histology since, to understand best how to deal with the teaching of microscopic anatomy, it is necessary to evaluate the attitudes of students, academics, and clinicians (perhaps even Deans and medical educationalists). This is

TABLE 1. Summary Statistics of the Attitudes of Medical Students Toward the Clinical Relevance of Histology at the Universities Surveyed (Alphabetical Order)

Country	<i>n</i>	Attitude scale (range)	Attitude scale (mode)	Embryology
Austria (Innsbruck)	187	2–9	4	2–10 (4 mode)
Czech Republic (Prague)	253	1–9	3	1–9 (4 mode)
France (Paris, Sorbonne)	265	2–8	4	
Germany (Erlangen)	165	2–9	4.5	NK
Greece (Thessaloniki)	151	2–10	4.5	2–9 (5.5 mode)
Italy (Padova)	119	2–11	4	NK
Malta	185	2–10	2 & 8 bimodal	1–9 (6 mode)
Portugal (Lisbon)	109	2–8	3 & 6 bimodal	1–8 (5 mode)
Romania (year 1) (Bucharest)	109	2–8	3.5	Combined 2–8 (5 mode)
Romania (year 2) (Bucharest)	92	2–10	3.5	
Serbia (Nis)	183	2–9	2 & 4 bimodel	NK
Spain (Madrid, Leioa)	172	2–9	4	NK
U.K. (Cardiff)	156	2–9	5	2–9 (modes 3.5/6)
Total	2146			

	tick box
Although Histology is interesting, the subject needs selective understanding in the clinic	
Histological terminology develops the vocabulary of Medicine	
Histology is a useful tool for satisfactory medical practice	
Histology is a "necessary evil" in Medicine	
Histology is of some use in the clinic, but its importance may be exaggerated	
Histology is only of benefit in certain medical specialities	
Histology is so old-fashioned that it has no importance in contemporary Medicine	
Histology is time wasted in the medical curriculum	
Histology needs to modernise if it is going to be really useful in Medicine	
Every doctor must have a good knowledge of Histology	
If alternative and Eastern Medicine can do without Histology, so can Western Medicine	
It is impossible to conceive of good medical training without a major Histology component	
It is not possible to make a reasonable medical diagnosis without Histology	
Medicine could not exist without Histology	
Most medical conditions do not require a great knowledge of Histology	
Of all the basic sciences, Histology is the most clinically relevant	
Only a limited histological knowledge is required for satisfactory medical practice	
Rather than learn Histology, medical students should concentrate on clinical sciences	
The principles of Medicine are not founded on histological knowledge	
Without a knowledge of Histology, the doctor is of limited effectiveness	

Fig. 1. The Thurstone and Chave attitude questionnaire used in the survey.

an initial stage for such investigations where we record the attitudes of medical students in their early years of training in a variety of universities across Europe using Thurstone and Chave attitude analyses similar to those previously employed to assess the attitudes to gross anatomy and some other biomedical disciplines (Patel and Moxham, 2006; Moxham and Plaisant, 2007; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014; Moxham et al., 2016). Our initial hypothesis was that

medical students, at the early stages in their training, well appreciate the clinical importance of histology.

METHODS

Research was undertaken under the auspices of the Trans-European Pedagogic Research Group (TEPARG).

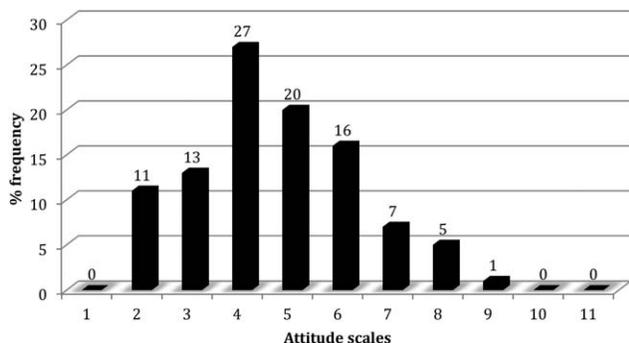


Fig. 2. Histogram showing the results obtained from the students at Innsbruck (Austria) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

Medical students who were at early stages in their education at the Medical University of Innsbruck (Austria), Charles University Prague (Czech Republic), Université Paris Descartes, Sorbonne Paris Cité (France), the Friedrich Alexander University of Erlangen-Nürnberg (Germany), the Aristotelian University of Thessaloniki (Greece), the University of Padova (Italy), the University of Malta, the NOVA University of Lisbon (Portugal), C. Davila University Bucharest (Romania), the University of Niš (Serbia), Complutense University, Ciudad Universitaria at Madrid and the University of the Basque Country (Spain), and Cardiff University (U.K.) took part in the survey. In total, 2,146 students responded and Table 1 records the numbers of respondents at each participating university. It was deemed useful, for the purposes of comparison, to have a variety of universities that adopt different approaches to the teaching of histology (see Discussion).

Ethical approval for the study was obtained from the ethics committee at the Cardiff School of Biosciences, Cardiff University to ensure that the surveys were conducted anonymously, that the data remained strictly

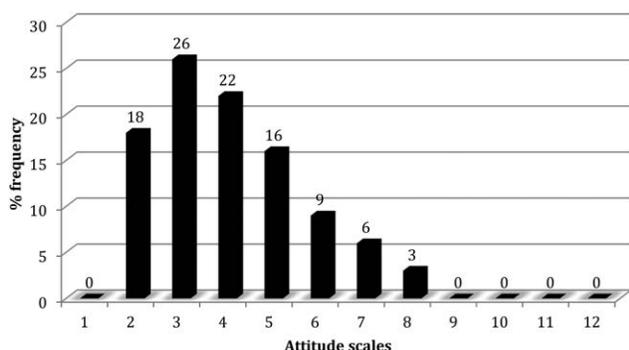


Fig. 3. Histogram showing the results obtained from the students at Prague (Czech Republic) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

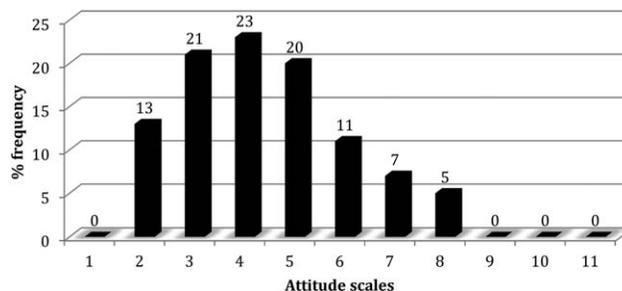


Fig. 4. Histogram showing the results obtained from the students at Paris, Sorbonne (France) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

confidential, that no vulnerable groups were included, and that participation in the survey was voluntary.

The questionnaire provided to the medical students was brief, essentially comprising a Thurstone and Chave attitude protocol (Fig. 1) whose phraseology was similar to that used previously to assess the attitudes toward gross anatomy and embryology (e.g., Moxham and Plaisant, 2007). In conformity with the principles devised by Thurstone and Chave (1951), 20 statements concerning the clinical relevance of histology were devised for the analyses that cover the range from very pro-sentiments to very anti-sentiments (and with a series of more neutral statements). These statements were randomly arranged in the questionnaire and required the participating student to only tick those statements with which she/he was in full agreement. Prior to conducting the investigation a group of 50 "judges" were asked to score each statement on a scale of 1 to 11, where 1 represents a very pro-sentiment and 11 a very anti-sentiment (with the complete range of scores in between to represent the various shades of opinion). The median scores of the "judges" provided a numerical value for each of the statements in the questionnaire that could subsequently enable quantitative data to be obtained for each student and each cohort of students.

F1

T1

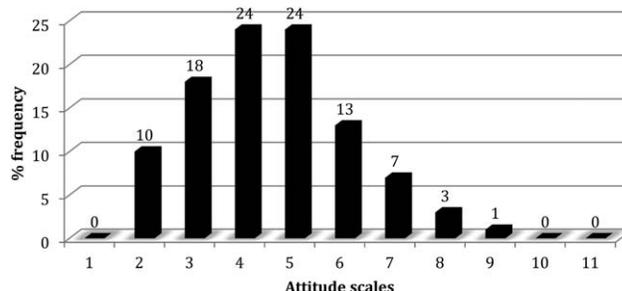


Fig. 5. Histogram showing the results obtained from the students at Erlangen (Germany) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

AQ1

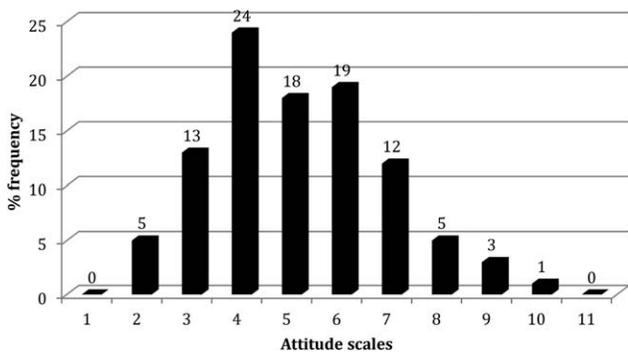


Fig. 6. Histogram showing the results obtained from the students at Thessaloniki (Greece) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

To analyze the data statistically, Microsoft Excel was employed for creating graphs and conducting simple calculations. MINITAB, SPSS, and SAS were used to test for normality of datasets and to run statistical tests, including ANOVA and *t* tests. To make comparisons between each country's data, following ANOVA, a Tukey test was employed for *post-hoc* analysis.

RESULTS

F2-F14 Figures 2–14 display histograms that record the students' attitudes toward histology according to Thurstone and Chave (1951) scale of 1 (extremely positive attitude) to 11 (extremely negative attitude). The ranges and mode scores for each university/country are shown in Table 2.

T2

Statistical analyses show that data from Greece, France, Austria, Portugal, Romania, Germany, Spain, Italy, and Serbia are alike whereas variance analyses ($F=9.05$; $P=0.00$), and the Tukey test, indicate that there are significant differences for the data from the UK, Czech Republic, and Malta ($P < 0.03$).

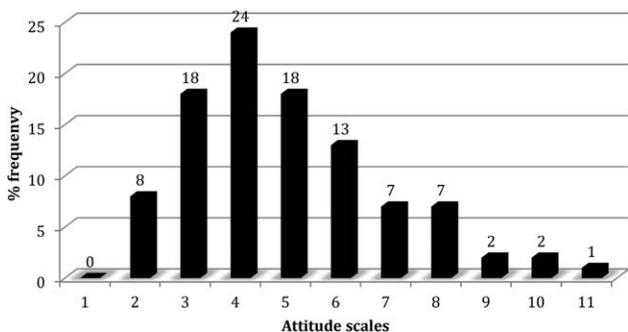


Fig. 7. Histogram showing the results obtained from the students at Padova (Italy) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

Attitudes of Medical Students Toward Histology

5

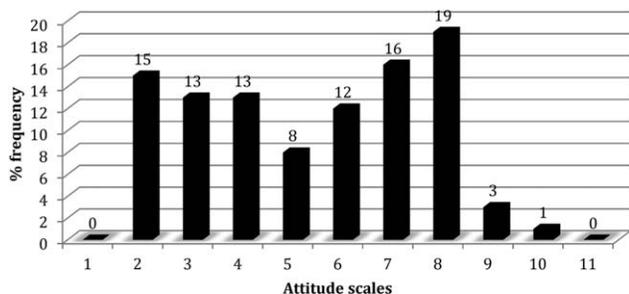


Fig. 8. Histogram showing the results obtained from the students at Malta where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

DISCUSSION

The findings overall are not consistent with our initial hypothesis that medical students at the early stages in their training appreciate well the clinical importance of histology. Although most data remain on the positive side for the attitude scale employed (i.e., central tendencies for the data ranging from 2 to 8), the students show more scepticism about histology's relevance than seen for the attitudes toward the importance of gross anatomy using the same Thurstone and Chave (1951) methodologies (Patel and Moxham, 2006; Moxham and Moxham, 2007; Moxham and Plaisant, 2007; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). However, the data is more positive than those previously reported for the clinical relevance of embryology in the European medical curriculum (Moxham et al., 2016). Indeed, a highly significant statistical difference was found between the data for histology and embryology ($P = 0.00$). Figure 15 provides a comparison graphically between data for histology, embryology, and gross anatomy, where the mode for gross anatomy is 3 on the attitude scale compared with a mode of 5 for embryology and 4 for histology. It can thus be concluded that, while there is no need to "propagandise" the importance of gross anatomy to newly recruited

F15

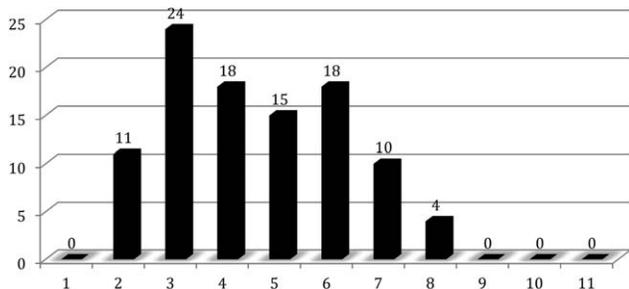


Fig. 9. Histogram showing the results obtained from the students at Lisbon (Portugal) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

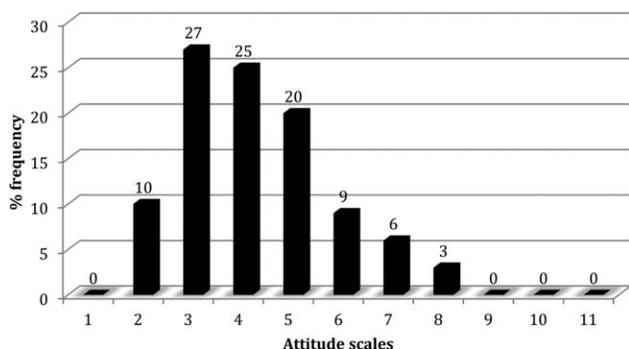


Fig. 10. Histogram showing the results obtained from the students at Bucharest Year 1 (Romania) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

medical students who are well aware of the importance of the discipline to their clinical training, there certainly is a need to instruct and inform the students about the importance of studying histology. To histologists, the relevance of the discipline to such clinical areas as pathology is obvious but it is clearly not so obvious to the students.

Indeed, many of the students had yet to undertake or complete their histology courses and so students' attitudes toward histology were not always influenced by the teaching of histology at the medical school itself, but by their pre-university education, mainly in biology classes. We assume that, although there is some histology taught, at least to some extent, in secondary school, histology, unlike gross anatomy, is not anchored in the general population's mind as crucial for medical education.

With the exception of the universities at Cardiff, Prague, and Malta, a consistent pattern was seen across the other European medical schools surveyed. This was surprising given the great variation in the courses and methods of examination employed at the various medical schools surveyed. Table 2 shows that the number of hours devoted to the teaching of histology ranged from 40 hr to 180 hr. Furthermore, while

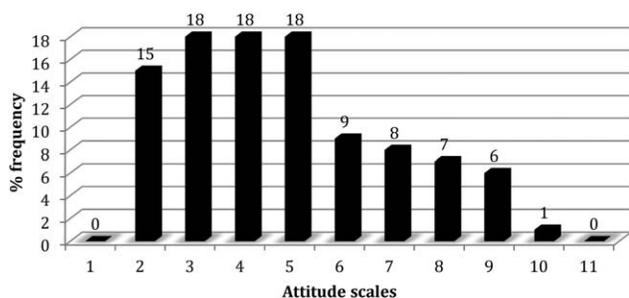


Fig. 11. Histogram showing the results obtained from the students at Bucharest Year 2 (Romania) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

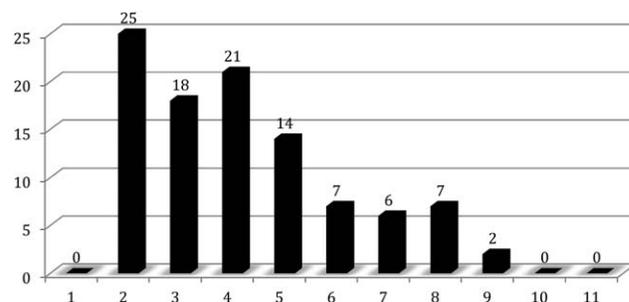


Fig. 12. Histogram showing the results obtained from the students at Nis (Serbia) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

some of the schools had histologists incorporated within a unified department of anatomical sciences, many had separate departments devoted to histology (or histology and cell biology and/or embryology) and separate from departments of gross anatomy. Five medical schools had independent histology course whereas the remaining eight schools had integrative courses (either just with anatomy or with the whole medical course). Most of the courses occupied timetable slots in Year 1 of the medical curriculum but several extended across into Year 2 or even Year 3. Four schools effectively had no clinically qualified teachers while the others had variable numbers of clinical teachers. It can also be seen that there is variability in the use of clinical cases within the histology courses but nearly all the courses relied upon the continuing use of microscopes and not virtual microscopy. Great variation was also discerned for examinations, ranging from oral examinations, to essay writing, to evaluation of clinical cases, to practical tests, to MEQ tests. Compared with the histology courses for medical schools in the USA (see Drake et al., 2002, 2009, 2014), where the average histology course lasts 72 hr (range 4–142 hr), where most courses are integrative, and where 82% of courses rely on virtual microscopy (see also Cotter, 2001; Blake et al., 2003; Bloodgood and Ogilvie, 2006), many histology courses in Europe remain "stand alone," with more hours of tuition and little use as yet of virtual microscopy.

Thus, in view of the consistency of attitude found in this survey, we can suggest that the slightly less positive attitudes toward histology compared with gross anatomy relate not to teaching methods but to the difficulties faced in persuading students of the discipline's relevance because of the attitudes they bring with them from their pre-medical school experiences or assumptions. Overall, we can conclude that teachers of histology must be aware that their students do not naturally see the clinical relevance of the subject and consequently its importance must be stated explicitly at the start of their course and must be often reinforced. We would therefore recommend that histological topics should be reintroduced at various stages of medical education. In addition, ways must be found to improve the general population's perception of histology's

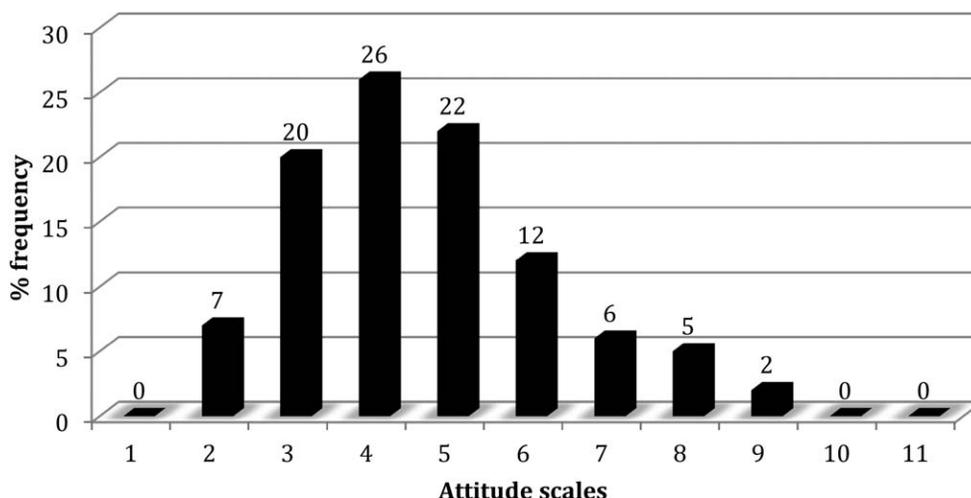


Fig. 13. Histogram showing the results obtained from the students at Madrid and Leioa (Spain) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

relevance and, difficult and time-consuming as it might be, should encourage the teaching of some histology in secondary schools.

The question should here be addressed as to why the results for Cardiff, Malta, and Prague differed from the other schools surveyed. Without further objective investigation, the definitive answers will not be presently known but we can offer some pointers now. For Cardiff, the poor attitudes might be related to the lack of a defined histology course and the low number of hours given over to the subject (note that the 40 hr figure given in Table 2 overestimates time dedicated to histology since topics often just feature as part of pathophysiology presentations or merely as an adjunct to other material in the integrative course). It might also be suggested that the low numbers of dedicated histologists and participating clinicians has a contribution. However, the explanation probably lies in the way histology is examined at Cardiff, since teachers are all too familiar with the way students learn strategically for examinations. It was discovered that histology at

Cardiff is assessed in Year 1 by means of single best answer questions and, at the summative papers at the end of the year, out of 240 questions, there are 12 histology-based items. Thus, histology comprises just 5% of the total material examined and, given that there is no requirement to pass these questions, it could be argued that there is little incentive for the students to study the subject in depth. For Malta, also providing a very negative attitude toward histology's relevance, other than the same limited number of teaching hours and examination questions devoted to the subject, there is little else to offer in terms of explanation. Nor at this stage, can an explanation be found for the very positive attitudes expressed by the students at Prague, although it is clear that the course is fulsome and well structured with dedicated teachers. Indeed, in addition to lectures, material is available electronically on the web and the lecturers are available for consultations.

In view of our findings, a few general comments can be made that are pertinent to understanding how students' attitudes might be improved. First, we would argue that there is a need to ensure that the teachers of histology are clinically qualified, persons with whom the students can empathise and who can clearly point out medical evidence by giving appropriate clinical examples. Second, sufficient time should be found in the medical curriculum to ensure that histology is correctly positioned in the curriculum since students are quick to spot whether organizational and logical issues impinge upon the importance given by a course director to different disciplines and topics. Furthermore, if histological topics are too dispersed in an integrative course then the students might again lose sight of the discipline's importance and get little feel for the "wholeness" of the subject. Third, gross anatomy, embryology, and histology in the past were often taught together and integrated. The "divorce" between these anatomical sciences has had several impacts. Most importantly, clinical scenarios for both gross anatomy and histology are more powerful when they are constructed together.

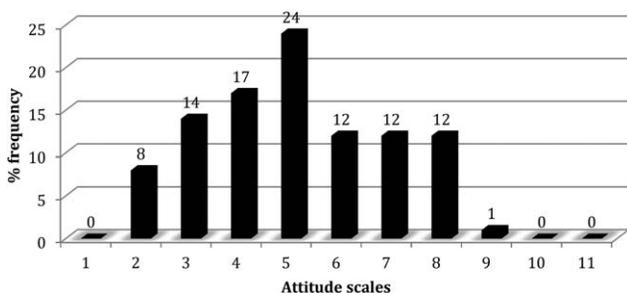


Fig. 14. Histogram showing the results obtained from the students at Cardiff (UK) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

TABLE 2. Summary of the Main Features of the Histology Courses/Tuition in the Universities Surveyed (Alphabetical Order)

Country	Integrative or stand alone	Total hours	Practicals, Yes/No	Microscopes and/or virtual microscopy	Year of study	Clinical teachers—% or number	Clinical cases
Austria (Innsbruck)	Integrative Stand alone	89	Yes	Microscopes	1 and 2	None	No
Czech Republic (Prague)	Integrative Stand alone	130	Yes	Mainly microscopes	1	ratio MD:PhD 8:2	Included for each lecture
France (Paris, Sorbonne)	Integrative with embryology (Yr 1), with systems (Yr 2, 3)	60.5	Yes	Virtual microscopy	1, 2 and 3	With pathologist	No
Germany (Erlangen)	Integrative Stand alone	150	Yes	Mainly Microscopes	1	None	No
Greece (Thessaloniki)	Integrative Stand alone	150	Yes	Microscopes	2	All MD	No
Italy (Padova)	Integrative with gross anatomy	30	Yes	Microscopes	2	ratio MD:PhD 5:3	Yes
Malta	Integrative	50	Yes	Microscopes	1 and 2	All MD	Few
Portugal (Lisbon)	Integrative Stand alone	57	Yes	Microscopes	1	1 in 12 is an MD	No
Romania (Bucharest)	Integrative Stand alone	70	Yes	NK	2	50%	NK
Serbia (Nis)	Integrative with embryology and pathology	180	Yes	Both	1	None	Yes
Spain (Madrid, UCM)	Stand alone	138	Yes	Microscopes	1 and 2	25% are MD, PhD	Yes
Spain (Leioa)	Stand alone	126	Yes	Both	2	Most teachers are MD, PhD	Yes
U.K. (Cardiff)	Integrative	40	Yes	Both	1 and 2	1 pathologist	Yes

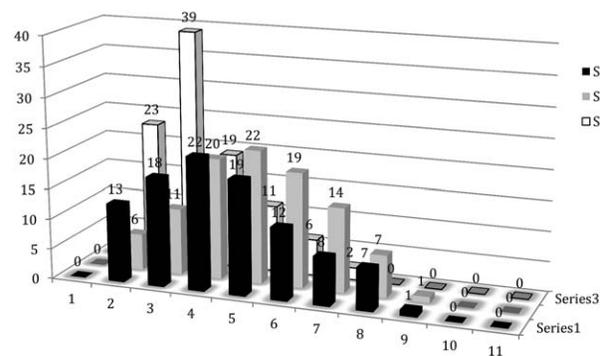


Fig. 15. Histograms comparing data relating to medical students' attitudes to clinical relevance of the anatomical sciences: Series 1 = Histology (Mode 4); Series 2 = Embryology (Mode 5); Series 3 = Gross Anatomy (Mode 3).

Fourth, histologists should agitate for the development of a core syllabus for the discipline that is internationally based. This is currently being organized by the International Federation of Associations of Anatomists (IFAA). Finally, in order to plead for the necessity of the survival of histology, directors of medical education frequently want to see, not only the clinical relevance of disciplines and topics, but also the research relevance. Accordingly, it could be significant that, not following the ethos within a university of taking students to the frontiers of knowledge, can lead to a poorer appreciation of the importance of histology in medical education.

REFERENCES

Blake CA, LaVoie HA, Millette CF. 2003. Teaching medical histology at the University of South Carolina School of Medicine: Transition to virtual slides and virtual microscopes. *Anat Rec Part B: New Anat* 275:196–206.

Bloodgood RA, Ogilvie RW. 2006. Trends in histology laboratory teaching in United States medical schools. *Anat Rec Part B: New Anat* 289:169–175.

Cotter JR. 2001. *Anat. Record (New Anat)* Laboratory instruction in histology at the University of Buffalo: Recent replacement of microscope exercises with computer applications. *Anat Rec Part B: New Anat* 265:212–221.

Drake RL, Lowrie DJ, Prewitt CM. 2002. Survey of gross anatomy, microscopic anatomy, neuroscience, and embryology courses in medical school curricula in the United States. *Anat Rec* 269: 118–122.

Drake RL, McBride JM, Lachman N, Pawlina W. 2009. Medical education in the anatomical sciences: The winds of change continue to blow. *Anat Sci Edu* 2:253–259.

Drake RL, McBride JM, Pawlina W. 2014. An update on the status of anatomical sciences education in United States medical schools. *Anat Sci Edu* 7:321–325.

Hinduja K, Samuel R, Mitchell S. 2005. Problem-based learning: Is anatomy a casualty? *Surgeon* 3:84–87.

Kerby J, Shukur ZN, Shalhoub J. 2011. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. *Clin Anat* 24:489–497.

Korf HW, Wicht H, Snipes RL, Timmermans JP, Paulsen F, Rune G, Baumgart-Vogt E. 2008. The dissection course—Necessary and indispensable for teaching anatomy to medical students. *Ann Anat* 190:16–22.

- Monkhouse WS. 1992. Anatomy and the medical school curriculum. *Lancet* 340:834–835.
- Moxham BJ, Moxham SA. 2007. The relationships between attitudes, course aims and teaching methods for the teaching of gross anatomy in the medical curriculum. *Eur J Anat* 11(Suppl 1):19–30
- Moxham BJ, Plaisant O. 2007. Perception of medical students towards the clinical relevance of anatomy. *Clin Anat* 20:560–564.
- Moxham BJ, Emmanouil-Nikoloussi E, Standley H, Brenner E, Plaisant O, Brichova H, Pais D, Stabile I, Borg J, Chirculescu A. 2016. The attitudes of medical students in Europe toward the clinical importance of embryology. *Clin Anat* 29:144–150.
- Older J. 2004. Anatomy: A must for teaching the next generation. *Surg J R Coll Surg E* 2:79–90.
- Olowo-Ofayoku A, Moxham BJ. 2014. Comparisons between the attitudes of medical and dental students toward the clinical importance of gross anatomy and physiology. *Clin Anat* 27:976–987.
- Patel KM, Moxham BJ. 2006. Attitudes of professional anatomists to curricular change. *Clin Anat* 19:132–141.
- Prince K, van Mameren H, Hylkema N, Drukker J, Scherpbier A, van der Vleuten C. 2003. Does problem based learning lead to deficiencies in basic science knowledge? An empirical case on anatomy. *Med Educ* 35:15–21.
- Prince K, Scherpbier A, Van Mameren H, Drukker J, van der Vleuten C. 2005. Do students have sufficient knowledge of clinical anatomy? *Med Educ* 39:326–332.
- Pryde FR, Black SM. 2005. Anatomy in Scotland: 20 years of change. *Scott Med J* 50:96–98.
- Thurstone LL, Chave EJ. 1951. *The Measurement of Attitude; A Psychophysical Method and Some Experiments With a Scale for Measuring Attitude Toward the Church*. Chicago, IL: University of Chicago Press.
- Waterson SW, Stewart IJ. 2005. Survey of clinician's attitudes to the anatomical teaching and knowledge of medical students. *Clin Anat* 18:380–384.

WILEY
Author Proof

AQ1: Please check whether the short title is OK as set.

AQ2: Please provide department/division name for affiliation 2.

AQ3: Kindly note that the author name in the reference citation is spelt as "Waterston and Stewart, 2005," whereas in the list it is given as "Waterson and Stewart, 2005". Please correct wherever applicable.

AQ4: Please confirm that given names (red) and surnames/family names (green) have been identified correctly.

WILEY
Author Proof