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Educational strategies applied to the teaching of anatomy. The evolution of resources

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SUMMARY

In the present article, we review the technologies and strategies used in medical education, in particular in the field of anatomy, analysing the developmental changes that have occurred in the different resources employed in the teaching of anatomy. The analysis begins by taking into account what has been achieved at the University of Salamanca, similar to what has been done in other universities. We describe the development of anatomy books: from the oldest in which there was only text to be read, to more recent books containing illustrations and then to the current crop of books now supplemented with material on interactive CDs, students' work books, and e-books. Likewise, we describe the development of rooms for teaching anatomy, since the ancient "Anatomy Houses", amphitheatres, classrooms with blackboards, dissection theatres, classrooms with diverse technological advances, to the virtual classroom. We also address the issues of dissection and other complementary strategies used to gain a better understanding of the human body: prosections, anatomical models, computer-aided learning, and virtual models have all found a place in helping students to understand human structure. Finally, we summarise the development of the strategies aimed at involving students in the learning process, in individual or team work, together with different communication and information technologies, such as the development of the Visible Human Project, video streaming, and the Moodle platform. We conclude that the implementation of one strategy or another must necessarily depend on the university in question and that all the tools available should be used for anatomy education in order for them to be useful in the training of good medical professionals.

Key words: Anatomy – Teaching – Medical education – Evolution of resources

INTRODUCTION

Teaching strategies as applied to medicine, and in particular anatomy, are processes or sets of norms aimed at achieving optimum learning by students throughout their degree courses with a view to endowing them with the proper training and ensuring they achieve the learning outcomes set out for them by the course planning team. Since the thirteenth century, when the first universities —and those in which medicine (then called *Phisica*)

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was taught— were founded, the general teaching strategy consisted of teaching by means of lectures, whereby students had to listen to all the lectures as stipulated by the Rector.

From the sixteenth century, lectures remained a key part of any anatomy course, but practicals were also introduced; in the case of anatomy this was mainly in the form of cadaver dissection. The addition of practicals was the main strategy employed and has, with variations, survived to the present time. It is still considered by many to be the most effective form of anatomy education.

The teaching of anatomy consisted of explanations to the students in lectures (theoretical classes) and of study of the human body through dissection and osteology (practical classes). The students thus learned anatomy from these explanations and from diverse anatomy books, but were given little opportunity to participate (beyond engagement with practical sessions) and in general could be considered passive onlookers (Hubbard et al., 2005).

In the medical curriculum, anatomy formed part of the preclinical sciences and classically was kept quite separate from clinical activities. This strategy in medical education was initially implemented in the USA and Canada at the beginning of the twentieth century (Flexner, 1910). It is currently used worldwide and is still followed in most of our universities.

In the last quarter century, a broad range of new teaching resources for anatomy have emerged to complement theoretical and practical classes. Likewise, in an attempt to achieve an integral and sequential training of physicians, new strategies have arisen in recent years. Thus, mention should be made of horizontal (Lie, 1995) or vertical integration among the various preclinical and clinical components of medical courses (Lie, 1995; Marks and Cahill, 1988; Brynhildsen et al., 2002; Peck and Skandalakis, 2004), albeit with different variations and styles. One integrative approach of particular importance has been problem-based learning (PBL), in which an attempt is made to integrate the content of a medical course through solving of clinical problems (Ginzberg, 1993) and whose basic tenet is that students should learn on their own or in groups. Thus, one set of strategies could be characterised as encouraging students be participative in order that they are to attracted to medicine and become able to learn how to acquire knowledge while other strategies view instructors as being transmitters of knowledge, even though this involves their having to make continuous updates of their teaching methods, designing learning strategies, and guiding students through their learning of the materials. The final aim, however, is always the same: to offer students an integrated medical training and hence prepare better professionals.

Nevertheless, the implementation of these strategies, and the incorporation of new technologies in medical education, are certainly being carried out on an individual (almost ad hoc) basis and with poor spread of good practice between the various faculties and departments involved in anatomy. For example, in the United Kingdom, in an attempt to develop the process of education, changes were recommended by the General Medical Council who published in 1993 a document entitled "Tomorrow's Doctors". This offered suggestions for change in keeping with the new requirements of medical education and also addressed the teaching of Anatomy, although the suggestions were not prescriptive. According to Heylings (2002), in the United Kingdom and Ireland there remains considerable variety in the methods used to teach anatomy (i.e., the duration of medical studies and the strategies used) among the various medical schools.

In the present article, our aim is to explore the development of the teaching of medicine, and in particular that of anatomy, at the University of Salamanca tracing its history as a General Study, from its foundation nearly eight centuries ago (1218), when medicine was already taught, to the present time. In particular, we want to report the experience gained over the last 35 years by a group of professors at the Department of Human Anatomy and Histology of the School of Medicine of our university.

The influence of technology on the development of anatomy textbooks (Fig. 1)

Anatomy textbooks have undergone an important evolution over time. This has certainly been evident at the University of Salamanca, given its long history as a centre for medical teaching and similar developments can be seen in all universities worldwide.

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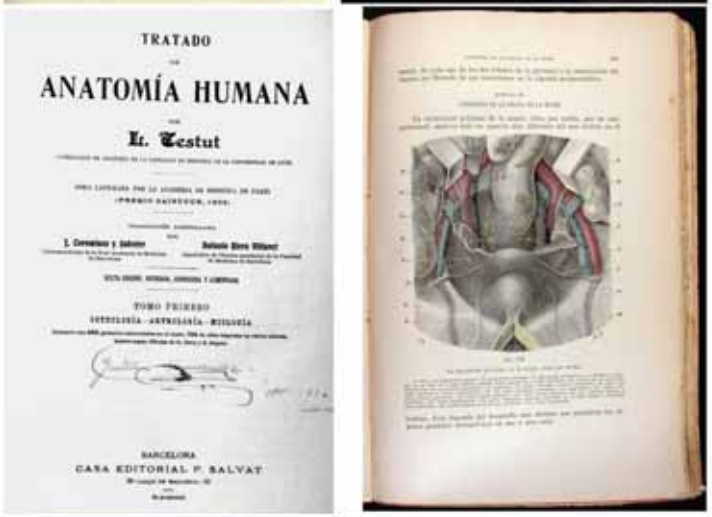

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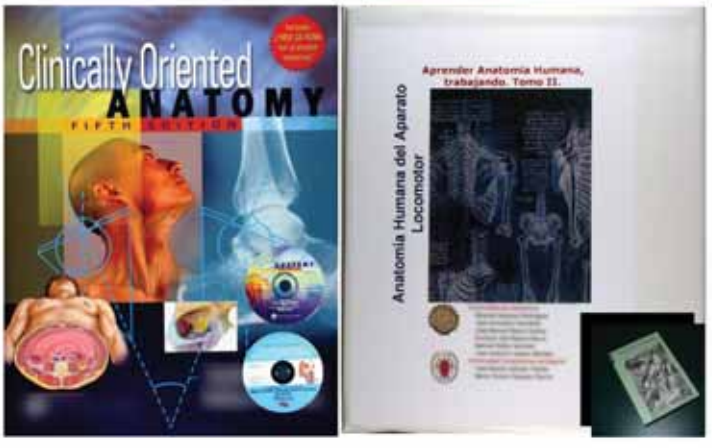

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Figure 1. *From the written book with only text to the e-book.*

a) Front cover of the book by Avicena, widely used at the University of Salamanca from early times. General Library of the University BGH 12237.
b) A representative page from the same book with text alone and no illustrations. General Library of the University BGH 12237.

c, d) Front cover of the book by Valverde de Amusco (c) and an illustrated page from the same book (d). General Library of the University BGH 35573.

e, f) Book by Testut on Human Anatomy, belonging to a student of medicine (e) and a page of the same with illustrations (f). Library of the Faculty of Medicine.

g) Current Anatomy book oriented to the clinical setting with an informatics support. Library of the Faculty of Medicine.
h) Volume II, dealing with the locomotor system, from the *Learning Anatomy through Work* project in collaboration with the Complutense University in Madrid. Library of the Department of Anatomy of the University of Salamanca.
i) Insert: e-book addressing the locomotor system compiled and used at the Faculty of Medicine of the University of Salamanca. Library of the Department of Anatomy of the University of Salamanca.

Since the first books used, e.g. those of Hippocrates, Avicena or Galenus (thirteenth century), which simply contained text that had to be "read, learned and inwardly digested" (Fig. 1 a, b), the first change that arose was the introduction of illustrations during sixteenth century (when the first illustrated books were printed and widely distributed). Of these, some of the most important that could be cited are: de Humanis Corpore Fabrica, by Vesalius (1543) and Historia de la composición del cuerpo humano by Valverde de Amusco (1556); the latter being one of many books now written in the vernacular. These books were widely used both in Salamanca and in other Spanish universities (Fig. 1 c, d).

From the sixteenth century onwards, illustrated books followed one another successively, using more realistic images that allowed the subject to be taught in increasing detail as well as serving to emphasise the importance of anatomy. Of these books, mention should be made of those of Graus, Gray, Laz and Wachsmuth, Paturet, Rouviere, Saphey, Testut, though many others could be listed (Fig. 1 e, f). The nineteenth century saw the publication of books with chromolithographic plates, cut and superimposed over one another. These attempted to give a planimetric view of the different anatomical structures. There were also many books describing the applications of anatomy, ranging from surgery, to the descriptions of different systems of the body, to drawing, and comparative anatomy. There was an explosion on the publication of such textbooks in comparison to previous times.

In the twentieth century, and specifically in Spanish universities (including Salamanca University), instructors continued to use new editions of some of the above-mentioned books. Additionally, for their students and lectures, the Spanish anatomical schools used the books edited by their Maestros, such as those of Orts and Escolar, which complemented descriptive anatomy with functional and applied anatomy. Similarly, the leading anatomists in other countries produced textbooks to satisfy the needs of their students. These treatises on anatomy, produced all over Europe and beyond, were accompanied by the publication of anatomical atlases, with excellent drawings and photographs (Netter, Prometheus, Rohen-Yokochi, Sobotta, Wolff-Heidegger) or atlases for planimetric reconstructions (Smith-Agreda).

Technical advances in physics have allowed important progress to be made in clinical diagnosis and have offered the opportunity to study living human bodies in section in unparalleled ways not previously thought possible. Anatomists have exploited such technologies to the full to allow them to view and describe anatomy in novel ways and this, in turn, has given rise, during last quarter of the last century, to books using these techniques as another way to emphasise the clinical applications of anatomical knowledge. Of particular relevance are the many books containing images obtained with radiography, ultrasound, CAT and MRI.

Books also began to appear with a new focus on anatomy. These were less descriptive than in the past, but were still underpinned by clinical bases. In so doing, they aimed to make anatomy more interesting and relevant to students, bringing them closer to the human body and providing information concerning the living being for the purpose of physical (surface anatomy) and applied explorations (e.g. by describing the anatomy of the body cavities; i.e., endoscopic and arthroscopic anatomy). There have also been books in which anatomy is studied by means of case reports in a further attempt to underline the anatomical bases of patient diagnosis.

Books published more recently tend to focus on clinical anatomy and nearly all of them are supported by complementary IT material, mainly in the form of CDs (Fig. 1g). This is an effective way of instructing and consulting students (of huge importance in this new methodology) and even for instructing and providing resources for instructors. The supplementary IT material contains images that can be accessed by students interactively and includes oriented case reports, quizzes with clinical applications, or MR images, for example. Our team at the University of Salamanca has attempted to fuse traditional anatomical knowledge with knowledge of clinical interest in an attempt to allow students to participate more in their own learning processes. To do so, currently we are developing a collection of books under the collective heading "Learning Anatomy through Work" (Vázquez et al., 2004a, 2006a, b). At the present time, books on embryology, visceral anatomy and the anatomy of the locomotor system are available. These books are neither anatomical treatises nor textbooks. Instead, they are books that demand individual work by students and offer a guide to working in practical classes.

Finally, another development in medical training has been the e-book with multimedia components, which attempt to motivate students in their teaching/learning process. Correct use of these resources should allow a participatory "dialogue" to be set up between the student and the interactive book. In Salamanca, we are now compiling e-books in interactive DVD format (Fig. 1i) These DVDs contain three main sections: a descriptive part in which, through a combination of audio and video oriented in Flash Macromedia format, the characteristics of the corresponding anatomical structures are explained; a second part, in which it is possible for students to navigate through the different images of the structures to be learned and where the students can learn the names and concepts for each part, and finally a third section, which involves a self-assessment system. In working through this part, students are given an opportunity to demonstrate to themselves that they are familiar with the anatomical details that a physician must know about a given body structure; typically, if the student cannot remember the relevant details then they can, by interacting with the program, be given further information (including a demonstration of the structure through by means of images). Currently, in the University of Salamanca, we are using one on osteology and the locomotor system, and another for neuroanatomy in sections.

Technology in the anatomy classroom (Fig. 2)

The classroom, as a place for instruction, has always been a core element in anatomy education. In our university, in the period from approximately 1550 to 1850, we have seen a gradual evolution from conventional classrooms where anatomy was read, towards anatomy houses and amphitheatres, where dissections were performed in parallel to the teaching, considering the cadaver as a true "book" in itself.

Across the western world, abuses committed in procuring cadavers led to tighter regulation of procedures with the consequence that dissections could

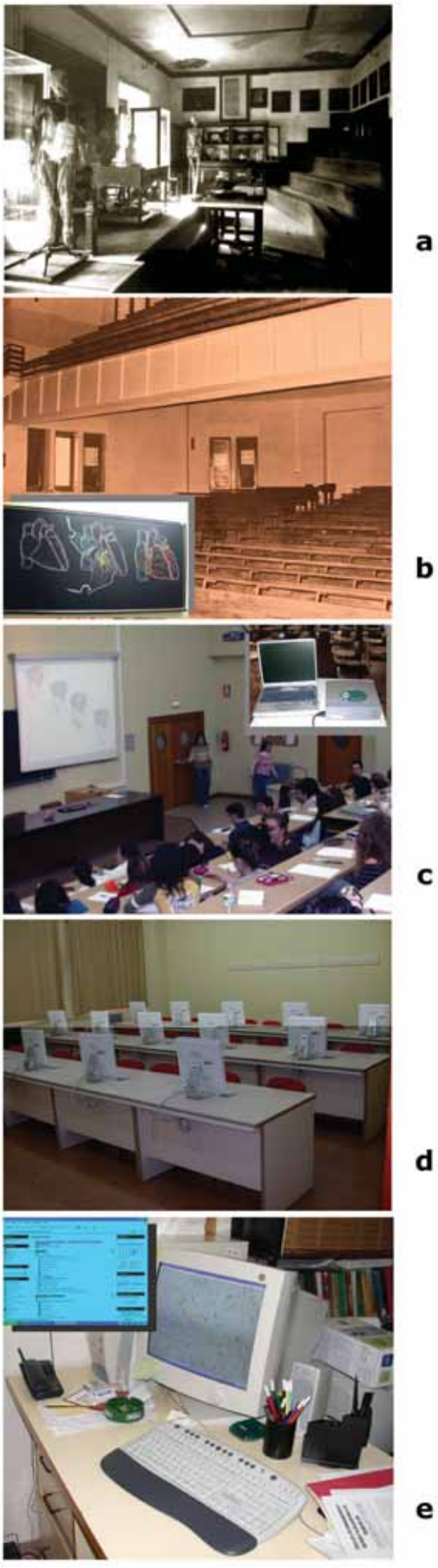

Figure 2. *From the traditional to the virtual classroom.*
a) Amphitheatre of the Faculty of Medicine of the University of Salamanca (mid-nineteenth century). Archivo Gombau. Ayuntamiento de Salamanca.
b) Traditional classroom, with blackboard (insert), of the Faculty of Medicine of the University of Salamanca (mid-twentieth century).
c) Modern classroom at the Faculty of Medicine of the University of Salamanca, endowed with teaching aids (insert: computer and video projector with access to the Internet).
d) Computer facilities at the Faculty of Medicine of the University of Salamanca.
e) Virtual classroom (at the home of a student) showing one of the programs designed by us (insert).

only be performed in schools of medicine. The second half of the nineteenth century saw the introduction of amphitheatres in schools, where dissections were undertaken and lectures were attended. Students would perform cadaver dissections in small groups, taking notes, and would contrast what they had observed in the cadavers and what they had heard in their lectures with the information in their anatomy books (Fig. 2a). Subsequently, theoretical classes were separated from dissection practicals, leading to the establishment of dissecting rooms and anatomy laboratories.

For many years, in classrooms the blackboard was (and indeed continues to be) the main bastion of anatomical teaching. Drawings were the only element used to help students understand what was being explained in the lectures (Fig. 2b and insert). Over time, these methods of illustrating theoretical classes have evolved substantially: aids to drawing emerged with the introduction of the first epidiascopes, which projected the illustrations from books directly onto a screen. These were superseded by slides, obtained from the same books as those used by the students. As time passed, these slides, with the corresponding improvements in photography and the projectors themselves, became an essential tool that for many people rendered the blackboard obsolete. Likewise, overhead projectors, which showed the requisite images and allowed these to be commented in class, were also important and had a further advantage of allowing the colouring of different planes.

The projection of films and videos provide anatomy with another very important medium for teaching. Such developments have continued and the advent of informatics has helped further to refine the projection of images. We now have PowerPoint presentations, which allow easy projection of images and the addition of text, animation, the projection of video-clips among other features. Naturally, such progress is ongoing and we now have the electronic screen, where it is possible to draw in colour, change images, capture them, print them and then use them to prepare student handouts. Together with the e-screen, there is also the PC tablet. Despite all these advances, however, the classic blackboard remains in our classrooms and is still widely used, remaining, for many anatomists, a fundamental tool.

Together with the traditional classroom, we are now using the virtual classroom, based on informatics applications, where students can tune into an impressive array of anatomical software. They may be located in the medical schools themselves as computer facilities (Fig. 2d) but are not confined to that location for they can be accessed in students' homes (Fig. 2e) or in any other place with remote access (WiFi). Many of these programs are interactive and students can take advantage of this as a way of self-learning (Stewart et al., 2007). The whole can be considered e-education, now playing a crucial role in the medical field.

Technologies used to bring students closer to the reality of anatomy (Fig. 3)

A full understanding of the reality of anatomy is gained through the acquisition of knowledge about the human body and its diversity. For most of the time that anatomy has been studied, such knowledge has mainly been gathered through cadaver dissection. Recently, although cadaver dissection has not been discarded as a source of information, there has been an increasing tendency to concentrate as much on the study of the live human body. Thus, students today spend time studying both cadavers and live human bodies.

From its earliest beginnings, although some dissections were carried out to gain insights about the human body, cadaveric dissections were not regularly performed because religious and legal authorities did not allow such investigations. Consequently, medical conclusions were largely based on findings obtained in primates and other animals (such as the pig). The foremost example of this would be the medical and anatomical studies of Galenus, which prevailed for fifteen centuries. During this period, sporadic studies of human cadavers were described, but such studies were never officially condoned.

From the time of Vesalius (sixteenth century) to the present day, cadaver dissection has been the most direct method used for study of the human body. In the time of Vesalius, cadaver preservation was still unknown and so dissection had to be carried out in the open air and quickly in order to avoid the problems of decomposition (hence the appearance of the houses of Anatomy and amphitheatres). For many years, cadaveric dissection formed the basis of both descriptive anatomy and medicine in general. Such investigations were frequently recorded in works of art of the period

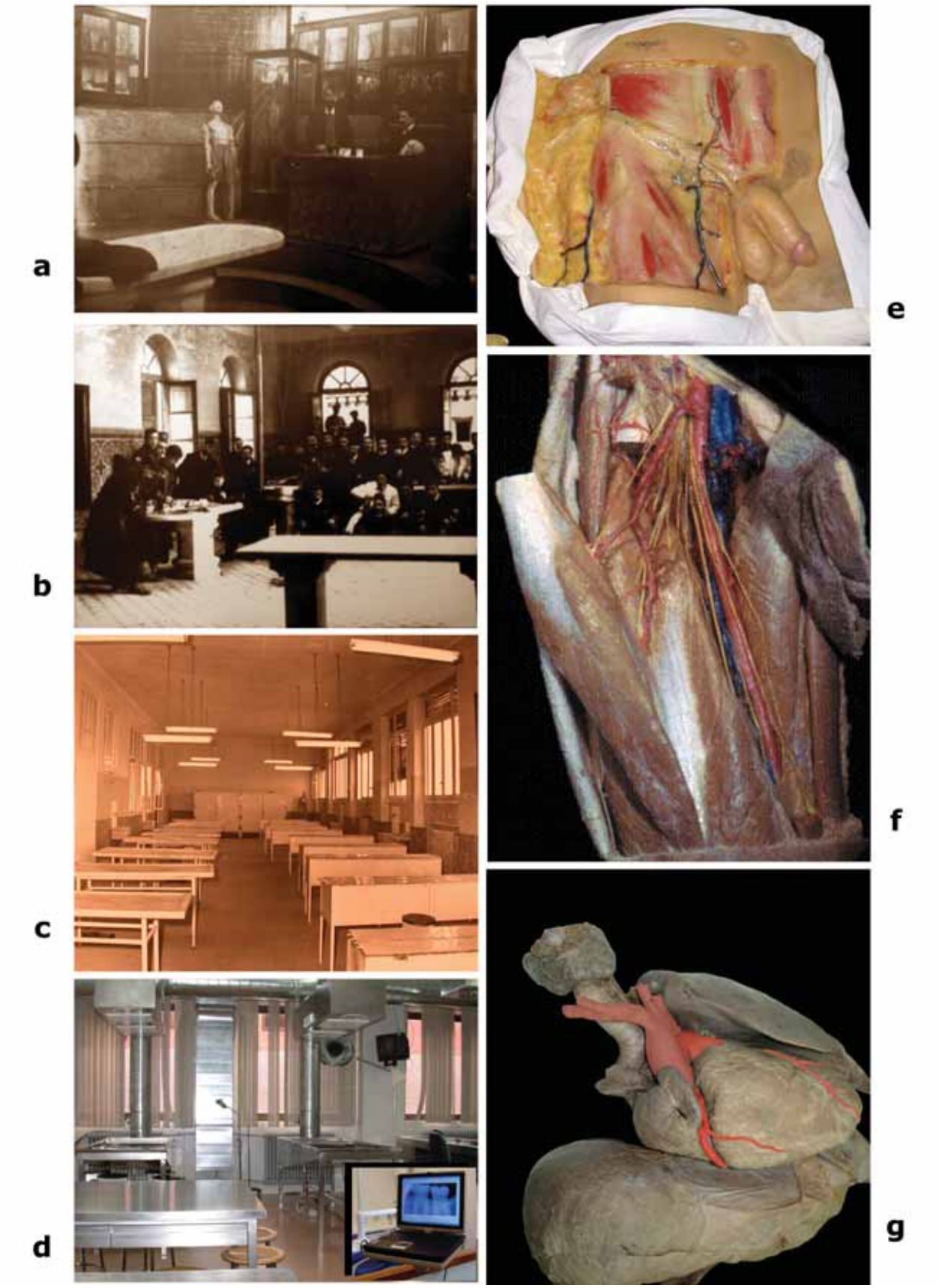

Figure 3. *From dissection of the human body to the study of the human body.*
a) Dissection table at School of Medicine of the University of Salamanca (second half of nineteenth century). Archivo Gombau. Ayuntamiento de Salamanca.
b) Dissection room: beginning of the twentieth century. Archivo Gombau. Ayuntamiento de Salamanca.
c) Dissection room: mid-twentieth century.
d) Today's dissection room, with suitable installations to prevent contamination due to formaldehyde and other toxic vapours, with a video projector and PC tablet (insert)
e, f, g) Wax model (e), prosection of Scarpa's triangle (f), and plastinated model of heart and diaphragm (g), kindly provided by the Department of Anatomy of the UNIBE, San José de Costa Rica.

of which Rembrandt's "The Anatomy Lesson of Dr. Nicolaes Tulp" (first half of seventeenth century) is one of the most well-known. The long history of cadaveric dissection highlights the importance of a procedure that has continued through to our own times (Gregory and Cole, 2002). Another important source of information about human anatomy has been the post-mortem examination where cadavers are used in teaching, although with greater emphasis on determining alterations consequent upon pathology and thus to aid in post mortem diagnosis and, to a certain extent, review what has been seen in the dissections of preserved cadavers. (Aziz et al., 2002).

The seventeenth and eighteenth centuries saw the introduction of wax models for teaching purposes and some authors have considered these as the forerunners of plastination and even of prosections (Fig. 3e). The use of anatomical models slowly became generalised; these were made of different materials (including wax) and represented different body parts or perhaps even the whole body. Later on, prosections (Fig 3f) were introduced; these could even feature the use of colour to illustrate the different structures. The plastination of viscera (Fig. 3g), and even of whole bodies, together with planimetric reconstructions of the body structures, also became available. The use of a variety of models in combination with actual dissection has proved of great use in demonstrating a wide variety of anatomical structures (Fasel, 1988; Garg et al., 1999; Smith-Ágreda, 2000; Moore and Mackenzie Brown, 2004).

The use of cadaver sections cut in the three main spatial planes has been of considerable help in understanding applied anatomy. Examination of these sections underpins the study of relationships in sectional anatomy and forms the basis of correlation for the study of sections obtained *in vivo* by imaging techniques.

Modern techniques have allowed the study of images collected at dissection with videos (Clemente et al., 1971; Galván et al., 1999), television (Reidenberg and Laitman, 2002) and PowerPoint presentations (Carmichael and Pawlina, 2000). Currently, a vast array of anatomical software is available and much of this is now also available to students forming, in many cases, the basis of what is termed computer-aided learning (CAL) (Nieder et al., 2000; Reidenberg and Laitman, 2002; Trelease, 2002; Inwood and Ahmad, 2005; Khalil et al., 2005). In certain cases, this has even been claimed to be of a quality sufficient to allow study of the human body without dissection (Schwartz, 1980; Walsh and Bohn, 1990; Van Sint Jan, 2003; McLachlan et al., 2004).

Living individuals have been used to perform surface studies with a view to carrying out artistic anatomy (and some artists also use a cadaver for the purpose). The study of the superficial anatomical landmarks of the human body and of anatomical imaging techniques - endoscopy, laparoscopy, MRI and CAT- has enlarged the discipline of living anatomy (McLachlan et al., 2004) and made it possible to employ the anatomical knowledge gained within the clinical skills laboratories (Evans and Watt, 2005).

Multimedia techniques applied to cadavers, on the one hand, and to living human beings, on the other, have allowed the study of the virtual body. In this case, the cadaver can be considered as a virtual structure leading to a multimedia three-dimensional anatomy or virtual anatomy. This is discussed more fully below (Spitzer and Scherzinger, 2006).

The new technologies and student participation in the teaching process (Fig. 4)

In traditional medical education, student participation in the teaching process was often very limited and the students were considered to be more or less passive participants in their own education. Nowadays, teachers are fully aware that this must change and that students must play a more active role in their own learning. This is a key feature of the drive for convergence in the European Higher Education Area (EHEA) and is one of the reasons why medical education has sought to change in recent years, seeking greater participation of, and interest from, the students. As expected, such changes have had considerable effects on how anatomy is taught.

Students become active learners when they participate directly in the instruction process and in their own learning. As active learners, they will feel more motivated if what they have to learn is relevant to their professional training. This holds both when they learn individually and when working in small groups.

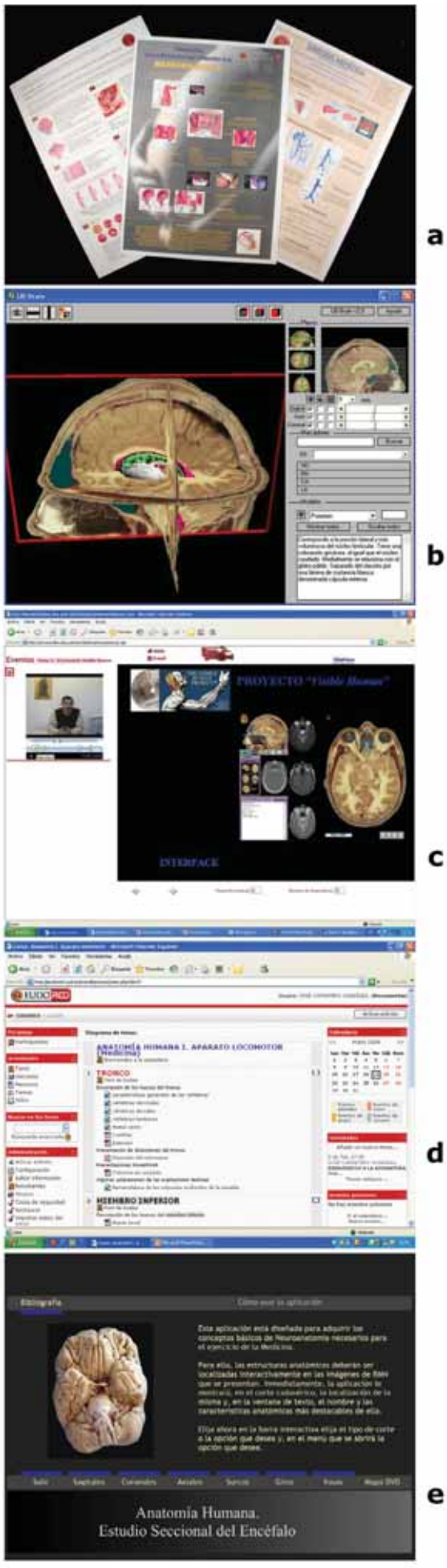

Figure 4. *Student participation in the teaching process.*
a) Collection of posters, and monographic project summaries carried out and presented by the students of the Faculty of Medicine of the University of Salamanca. Departmental Library.
b) Presentation of a UB-Brain project screen developed at the Universities of Salamanca and Barcelona.
c) Presentation of an interactive class by means of video-streaming technology. Developed by the Educational Services of the University of Salamanca and the Department of Anatomy of the same University.
d) One of the screens that appears on the Eudored educational platform (based on *Moodle*), corresponding to the material included within the subject *Anatomy of the Locomotor System* given at the Faculty of Medicine of the University of Salamanca.
e) Main menu of the DVD-supported e-book on Anatomy in Sections developed at the Department of Anatomy of the University of Salamanca.

At the University of Salamanca, our team often sets team work tasks (Fig. 4a) for the students. These groups allow students to work under more motivating conditions using their anatomical knowledge to solve clinical cases. They do the preparatory work relating to such cases themselves (although tutored) and then present their conclusions to the other students (either orally or in poster form). This is a good way to foster active participation, booster students' self-esteem and encourage rigorous self-assessment. In the same manner, the collection of books, prepared at Salamanca, entitled "Learning Anatomy through Work" allows both individual and collective work to be carried out, with similar objectives.

The use of communication and information technologies (CITs) means that, through their personal efforts, students will gradually acquire the expertise they need, among them, it is hoped, a deeper knowledge of anatomy.

The Visible Human Project (VHP), planned and implemented by the National Library of Medicine (NLM) in Bethesda (MD) USA (Spitzer et al., 1996), became available for use in anatomical applications through publication of the visible human dataset (Spitzer and Whitlock, 1998; Garg et al., 1999; Bajka et al., 2004). These models allow visualisation, manipulation and interaction with the images (Spitzer and Scherzinger, 2006). Other models have followed including: the Chinese Visible Human Project (Zhand et al., 2003), the Visible Korean Human (Park et al., 2005), as well as many applications based on images from the VHP (Jashtrow and Wollrath, 2002; Juanes et al., 2003; Robb and Hanson, 2006).

In parallel with these projects, we have, with our students, used the UB Brain Project, a joint project between the University of Salamanca and the University of Barcelona (Fig. 4b). This project, based on the processing of anatomical images of the brain obtained from frontal, axial and sagittal slices from the VHP, allows users to obtain 3D reconstructions of the human brain, either global or by planes, and

the localisation of brain structures or nuclei by means of processing and three-dimensional reconstruction. One of the advantages of the UB-Brain Project is its capacity to allow rotation in the three spatial planes, and the pinpointing of nerve structures from a glossary (Prats and Juanes, 2003). Another example of this approach is work in which we have participated involving the construction of a 3D model aimed at allowing students to learn about the optic tracts which has been correlated with serial MR sections on the three spatial planes (Prats and Juanes, 2006).

A further promising CIT technique used by us is the deployment of the virtual classroom through video-streaming techniques or audio/video transmission, either live or recorded, which is encoded and delivered through the internet or intranet as packets of information (Fig. 4c). Video-streaming is an efficient mode of transmission that can be accessed on-line by an unlimited number of users at any time and any place (flexi-time). Together with video, other elements can be presented (including pictures, text, charts and animations), all synchronised with the video in question. They can be adapted for PowerPoint presentations or portable network files such as HTLM, JPEG or GIF, and it is possible to add a course assessment questionnaire asking students about the course content or their degree of satisfaction with the materials provided (Apostolopoulos et al., 2002; Velasco et al., 2005).

Currently, institutions, universities and departments provide web sites to enable students to access information. Through these sites, and links they may also provide, it is possible to complement teaching activities, by offering additional information, providing facilities for discussion through e-mail and by providing access to virtual books and laboratories (Nieder and Nagy, 2002).

The possibility of students communicating with their instructors through the internet provides opportunities for a two-way exchange between students and lecturers. Thus, lecturers can resolve students' doubts, send out questionnaires, and convert their own computers into virtual classrooms (Fig. 4d). At the University of Salamanca, we have achieved excellent results with the use of the Moodle educational platform delivered through the internet. Students of human anatomy (in medicine) can use this platform to download information, communicate with one another and with their instructors, and to set up remote tutoring services.

Finally, e-books, mentioned above, are yet another application of the new technologies and of the direct participation of students in their own learning and training processes.

Discussion

Throughout the history of the development of medical education, different strategies have been used to deliver an education to medical students, depending on the state of knowledge at the time. For all of theses strategies, anatomy has, in one way or another, played a central role. Currently, for several reasons, it is clear that we need to change our manner of instruction in anatomy. Among the reasons for this are: the reductions made in the time made available for the study of the discipline; the growth in importance of some other subjects in the medical curriculum; the appearance of new, and valuable, technologies that can be employed in medical education (Vázquez et al., 2004b, 2005; Patel and Moxham, 2006).

Today, the difficulty lies in knowing which strategies to adopt and implement and the means that can be employed to do so. On the one hand, anatomists who defend traditional anatomical methodology can be reluctant to making changes to their teaching and continue to present their instruction through a lecture-based approach alongside cadaver dissection. These are considered to be traditional anatomists. On the other hand, there are those who wish to see radical changes made; these are considered to be the modernist anatomists, who are striving to use all the new techniques and resources available for teaching the subject (Elizondo Omaña et al., 2004; Patel and Moxham, 2006).

It would appear that the traditional approach to teaching anatomy still prevails in many places, although a clear trend can be identified in the direction of offering descriptive anatomy in parallel with clinical anatomy. This involves exploiting the advantages offered by new technologies, mainly computer-aided learning. Other important aspects are the anatomy of the living human body, surface anatomy, medical imaging. Some anatomists seem to have relegated cadaver dissection to the past, although it would appear that the general consensus is that a study of the cadav-

er remains essential for the best training of future physicians (Patel and Moxham, 2006)

It also seems germane to mention that both the traditional and modernist styles of instruction have already been compared in many publications, all authors concluding that the differences between one methodology and another are not significant and that students value cadaveric dissections or, when these are not possible, prosections, as a means of instruction although they also appear to appreciate the opportunities afforded by computer-aided teaching (for a review see Patel and Moxham, 2006).

At the University of Salamanca, we give our instruction mainly through a lecture-based approach, using, in each case, the techniques best-suited for delivery of our programmes and so we carry out cadaver dissections and, at the same time, use all the complementary media available. We believe that books on clinical anatomy, because both of their content and CDs and other supported supplementary materials, are also very important in that they offer a valuable complement to the student learning process since students become motivated, are able to broaden their sphere of knowledge and can interact with the material which they can access for themselves.

The books within the "Learning Anatomy through Work project" seem to be an important resource for students in helping them to advance in their studies in that they offer examples of clinical applications of anatomical knowledge that can be complemented with knowledge acquired from other resources and strategies. Either individually or in groups, the students explore a topic and write up their results. Thus, they see the importance of anatomy through the case reports they have examined and study living anatomy and images of sections of the human body. They are then assessed by the instructors. Furthermore, they must engage in deductive reasoning, seek information, and solve problems, reinforcing their acquisition of new knowledge. This type of instruction and learning, however, has the drawback that the students must devote more time to self-study in anatomy, possibly to the detriment of other subjects in the curriculum.

We have also used e-books. Once these have been explored under the supervision of an instructor, students can analyse them, use them for their own study purposes and in self-assessment, wherever and whenever they wish. Our experience in this field is limited but the impressions gained from the students seem to be favourable since e-books are yet another complement to their learning activities in which they can engage in interactive learning through audio and visual materials. Thus, the students have material available at all times to assist in answering questions and are provided with free access to images and explanations. Nevertheless, they must make an active decision to participate in this type of learning, because what they elect to do is not under the direct control of the lecturer.

We also believe in traditional lectures, but require the students to be present in small groups and to be well tutored as regards the discussion of contents. The classrooms where such lectures are delivered should be equipped with all the technologies necessary for students to complement their learning, including computers, hence fusing the traditional and virtual classrooms.

The most direct method for the study of the human body is cadaveric dissection. In Salamanca, we continue to teach what is considered to be "normal" body morphology, but also include certain variations to the norma and, on occasions, certain pathologies that students should remember as being of relevance. We are of the opinion that all students should have the chance to dissect certain regions of the body; other regions can be seen through peer-guided dissections or through prosections, models, planimetric reconstructions, plastinated pieces, and use of the vast array of software applications available. These latter resources have been acquired commercially or developed by us and among them are applications addressing the virtual and three-dimensional structures mentioned above.

In the process of educational convergence in the EHEA, apart from the students merely acquiring knowledge in the classroom, special emphasis is placed on students being able to acquire basic and clinical skills through their own work. Accordingly, dissection (together with the acquisition of anatomical knowledge) should also enable students to come into contact with death and should allow them to acquire the exploratory skills and motor dexterity that will serve as bases for the clinical skills they will presumably have to deploy later on in their professional lives as physicians

New teaching strategies require more active student participation. If students feel attracted to medicine and are motivated and

involved in the teaching/learning process, they should become good medical professionals, a goal sought since time immemorial. Modern strategies in medical education aim at involving students in learning and training. Student participation is crucial both for educational strategies employing horizontal and/or vertical integration and in strategies involving problem-solving.

The participation of students in group work, at least in our case, assessing clinical anatomy and its importance in the interpretation of certain pathologies, should allow them to learn and interpret images and gain a profound knowledge of the details that will facilitate the physical exploration of their future patients (working in reduced groups, the use of books in the "Learning Anatomy through Work" project).

The most modern techniques offer tools of considerable value for students to learn more about the human body. The Visible Human project offers an open door for students, via 3D representations, to analyse different structures of the human body. This is of great use, for example, in the field of neuroanatomy.

Video-streaming is a medium that can be used by students, but one that is most practical in the context of continued training since it can be used remotely, at any time the user wishes, with no time constraints.

Finally, at the University of Salamanca, taking advantage of the existence of the Eudored platform (based on *Moodle*), in a one-year experiment we learned that this is an extraordinarily efficient means of remaining in contact with our students. All of them have free access to the platform. In 2006 alone, there were 24,000 hits made by 400 students, indicating a mean of 60 hits per student per year. However, one drawback of this is that, although in many cases the students do participate, there remains a tendency towards over-reliance on their lecturers to solve the problems instead of resolving issues for themselves.

To conclude, we believe that today's strategies can be profitable and that all of them have their advantages and disadvantages. The point is to choose the most suitable one within each individual context and endow it with the new technologies available, although never overlooking the possibilities of cadaveric dissection. Whichever the strategy employed, it is crucial to work with small groups, motivate the students, and use their motivation as a catalyst in the learning and training process.

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