

Self-directed learning in the Gross Anatomy medical curriculum

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SUMMARY

The Medical School of the University of Castilla-La Mancha (UCLM) in Albacete is the most recent School of Medicine approved in Spain. The Institution was launched in the academic year 1998-99 with the specific aim of implementing educational innovations in the medical curriculum. The ultimate goal is to provide future doctors with the competences and skills for medical practice among the people of the region of Castilla-La Mancha, and Spanish society in general, by providing the means for easy integration into the job market of our society. The medical curriculum at UCLM, as in any other medical school in the country, is six years long and is divided into a basic sciences part (first to third years) and clinical sciences part (fourth to sixth years). The teaching method of the UCLM Medical School departs from most Medical Schools in Spain by incorporating the most recent educational trends and technological advances, lead and directed by a Medical Education Unit. The UCLM Medical School organizes its medical curriculum according to two different, but not mutually exclusive, educational approaches:

1. self-directed learning, organized in modules of objectives (basic sciences), and
2. problem-based learning (PBL, for the clinical sciences).

The ultimate goal of the curriculum is an integration of basic and clinical disciplines, both

among courses in each year of the medical curriculum and among the different years of the degree at both the preclinical and clinical levels. Likewise, maximal interaction between Faculty and students is strongly encouraged, and indeed facilitated by restricting the number of new students per year to a maximum number of 80, divided into four groups of 20 students (basic sciences), and 6 students in the clinical sciences.

Gross Anatomy courses are given in the first and second years. During the first year, the locomotor system is presented as a 10-credit course (one credit equals 10 hours of teaching activity). During the second year, Anatomy and Embryology are integrated as a single course, along with Physiology and Histology, comprising 70 credits altogether. In both instances, the contents are organized into modules of objectives two to three weeks long. Each module is divided into five phases. **Phase 1** includes an introduction to the objectives and its resources (books, anatomical CD programs, and other educational material), in order to help the student to accomplish the objectives. **Phase 2** is a self-learning period, followed by **Phase 3**, in which the students expound on and discuss the contents related to the objectives. **Phase 4** is another period for self-learning and tutorials, while **Phase 5** is the evaluation of individual or several thematically related modules.

In Gross Anatomy, practical courses are interwoven in the modules in phases 2 and 4. In addition, this past year we have introduced 4 lectures per year in which the students attend to

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more general and clinical aspects of several modules of objectives. It is important to point out that in addition to the regular practical hours and learning periods, students carry out two gross anatomical dissections per year with the help of handouts and other reference material, after which they present a written report that is a percentage of the final score. Throughout the program, both the autonomy and interests of the students are emphasized. Here, preliminary theoretical and practical results will be discussed.

Key words: Medical Education – Gross Anatomy – Integrated Medical Curriculum – Modules of objectives – Gross Anatomy Laboratory

INTRODUCTION

General principles of learning at the School of Medicine of the University of Castilla-La Mancha

The University of Castilla-La Mancha (UCLM) decided in 1996 to request permission to the Council of Rectors, to start a new School of Medicine that would offer the society of the region of Castilla-La Mancha the possibility of completing all the courses for a medical degree in one of the capitals of the region. Permission was granted and the courses proposed in the medical curriculum were approved and officially published in July 1998. The UCLM had a commission composed of three Professors of Medicine, who counseled the Rector of UCLM as regards implementing new standards in medical education, because the institution started from scratch.

The specific objective at the UCLM School of Medicine is to develop a teaching method based on recent educational innovations (Alfonso-Roca and Fonseca, 2001) to prepare medical professionals who will be, on one hand, fully integrated at the technical proficiency level in an up-to-date medical context and, on the other, at the specific social environment level. This approach in innovative educational methods in a medical curriculum aims to be a step forward from the usual approach offered by most Medical Schools in Spain. The UCLM model replaces the traditional medical educational system based on lectures of individual disciplines, and favors an integrated learning model based on the establishment of professional competences as the main goal of the medical curriculum (García-Barbero et al., 1995). Although this educational method is currently used in more than 120 Medical Schools around the world, this methodology has not been widely implemented in Europe (Alfonso-Roca and Fonseca, 2001).

This educational approach emphasizes active participation by students in order to develop

motivation, autonomy and self-interest in the learning process. This multidisciplinary approach, practice-oriented, aims at integrating the biological, clinical and psychosocial sciences. Students are responsible for their own learning process, thus avoiding a passive attitude to the lectures.

The practical approach of both basic and clinical subjects is especially relevant. For instance, beginning in the second medical year, students attend Family Medicine courses in community health centers as part of their medical formation, along with other basic sciences courses. In this way they can acquire early experience of the social aspects of their future medical practice.

The ultimate goal of this system is therefore the promotion of: (1) independent learning, (2) communication and cooperation among students, and (3) integration of the basic and clinical sciences in a decision-making approach.

Thus, the foundations of the medical curriculum at the UCLM Medical School is based on three main conceptual pillars:

1. integration of disciplines
2. self-learning methodology based on modules of objectives
3. problem-based learning (PBL) method, mainly (but not exclusively) for application in clinical courses.

The staff at the UCLM Medical School are strongly encouraged to maintain a close follow-up of the progress of a small group of students (6-8 students), adopting a tutorial role in relation to the students' learning process, at all times encouraging self-learning rather than lecturing the contents of their respective disciplines.

The Medical curriculum at the UCLM Medical School is six years long. The number of students is limited to 80 per year, divided into groups of 20 each for basic courses, and 6 for the clinical ones. Owing to the inevitable fact that a certain number of students fail to pass all courses, the number of students is always increased.

In order to achieve this goal, the medical curriculum at UCLM attempts to foster the active participation of students in every possible aspect by introducing "Modules of objectives". A module is a group of educational objectives: that is, the knowledge, skills and attitude that each student must learn for a given topic in each discipline in order to achieve the professional competences for an adjusted professional practice within our specific social and cultural context. A set of objectives is usually related to a specific part of the program of each course, adapted to the particular calendar each year, and not surpassing the norm for teaching periods in the Spanish University system. Each objective corresponds to a set of contents: that is, the most spe-

cific items of evaluative knowledge that, together, lie at the core of professional competences. Each course has a designed set of modules of objectives, based on the total credit load of each course and according to the Spanish directives, that is elaborated by the member of staff responsible for the course. The number of weeks devoted to each module varies between two or three weeks, depending on the number and intrinsic difficulties of the contents in each module.

Each module lasts for two-three weeks and consists of five distinct phases.

1. **Phase 1** involves a careful reading of the objectives, in which the students are tutored in understanding the terms and concepts pertaining to the actual objectives of the module. The participation of the students by posing questions, phrasing them clearly (under the supervision and guidance of Faculty members) is strongly emphasized with a view to fastening more focused and efficient planning of individual work.
2. **Phase 2** is devoted to the students' individual work to achieve the objectives, with the help of complementary activities, mainly in the laboratory.
3. **Phase 3** is the period in which the students, individually or in small groups, present and peer-discuss the main content related to each objective. The students' presentations are supervised by Faculty members at all times, and participation and active discussion is strongly encouraged.
4. **Phase 4** is a self-learning period in which students have the opportunity to request individual tutorials to clarify their doubts. Students can request as many tutorials and complementary activities as they consider necessary.
5. **Phase 5** consists of the evaluation of a single or a group of thematically related modules. Such evaluations may include different courses simultaneously, instead of individual courses (Alfonso-Roca and Fonseca, 2001).

Here we report our initial experience obtained for the first and second courses during the 2000/2001 academic year. We also present the theoretical and practical results obtained in Human Anatomy and Embryology.

HUMAN ANATOMY AND EMBRYOLOGY AT THE UCLM

Traditionally, Human Anatomy and Embryology has been taught based on lectures and laboratories. Since we are now firmly entrenched in the information era, with the constant development of new computer resources, a renovation

of the students' approaches and of the methodology of teaching seem necessary. This represents an enormous challenge to medical educators and Faculty members alike, particularly in the field of the Human Anatomy and Embryology, where imaging (X-ray, magnetic resonance imaging, computerized tomography, etc.) has become an important part of the learning materials, at the same time offering the opportunity to understand the clinical meaning of the descriptive parts of the courses. On the other hand, the huge explosion of molecular and cellular biology in modern medicine has led to a decrease in the time allocated to Human Anatomy and Embryology (Yates, 1999; Paalman, 2000). Therefore, we need to increase time efficiency in the process of learning Human Anatomy and Embryology by focusing on aspects of Clinical Anatomy.

Human Anatomy and Embryology are integrated both horizontally (within other courses in the first and second years of the medical degree) and vertically with other disciplines such as Radiology, Surgery, etc. During the first year, "Topographical Anatomy", which comprises the Locomotor Apparatus, is a 10-credit course. It is imparted along 11 modules of objectives (Table 1). Topographical Anatomy starts with an introductory module of general principles and nomenclature. The course is then organized into four main sections or units:

1. Trunk and neck (standing system of the trunk and head, comprising two modules).
2. Lower limbs (general posture and locomotion, expanding to three modules).
3. Upper limbs (motor systems of grasping, extended to three modules).
4. Head (skull and facial and masticatory systems, lasting two modules).

The topographical, functional (principles of Biomechanics), surface, and sectional aspects of Anatomy are considered together with clinical examples. Dissection courses play an important role (see below).

General Human Embryology is integrated in 5 modules with General Histology and Structure and Function of the Cell. These modules include objectives that range from gametogenesis to the fourth week of embryonic development.

Special Human Embryology (Organography), however, is included in the second year in a course entitled: "Development, morphology, structure and function of the body systems in health". In this broad course (70 credits), the objectives of Human Embryology, Anatomy, Histology and Physiology are integrated, considering specific systems as units (i.e. the digestive system comprising development, Gross Anatomy including topographical, sectional, radiologic and clinical aspects, microscopic structure and

functional aspects all run together at the same period of time), although each discipline teaches its own contents (Table 2). Students must learn the development and the organization of body systems integrating anatomical, histological and physiological contents. The organization of this extensive course is as follows:

1. The central nervous system, which comprises the first four modules of objectives.
2. The endocrine system, comprising one module.
3. The blood, which also comprises one module.
4. The circulatory system, including the heart and vessels, and comprising one module

each: two modules total.

5. The respiratory system, which also includes the nose and larynx, and comprises one module.
6. The digestive system, including the mouth with the salivary glands, tongue and pharynx, and comprising one module.
7. The excretory system, which also includes the pelvic floor and comprises one module.
8. The reproductive system, which comprises one module.

In both courses of Gross Anatomy and Embryology, each module comprises a varying number of objectives. The actual number of objecti-

Table 1.- Table of contents of the first year curriculum at the UCLM Medical School. The distribution and contents of the Anatomy are specified.

TABLE OF CONTENTS	MODULE 0	MODULE 1	MODULE 2	MODULE 3	MODULE 4	MODULE 5	E V A L U A T I O N	MODULE 6	MODULE 7	MODULE 8	MODULE 9	MODULE 10	E V A L U A T I O N	MOD 11	MOD 12	MOD 13		
Biochemistry		1	2	3	4	5		6	7	8	9	10						
Biochemistry	Introduction and general concepts	Trunk and neck I	Trunk and neck II	Lower limb: I	Lower limb: II	Lower limb: III		Upper limb: I	Upperr limb: II	Upper limb: III	Head: I Skull	Head: II Neuromuscular systems						
Strcture and Function				1	2	3		4	5	6	7	8				9	10	11
Physical Bases		1	2	3	4	5												
Embryology											1	2				3	4	5
Informaticis & Documentation		1	2	3	4	5		6										
History		1	2	3	4	5		6										
Management											1	2				3	4	5
Epidemiology									1	2	3	4				5		

Table 2.- Table of contents of the second year curriculum at the UCLM Medical School.

MODULE 1	MODULE 2	MODULE 3	MODULE 4	E V A L U A T I O N	MODULE 5	MODULE 6	MODULE 7	MODULE 8	E V A L U A T I O N	MODULE 9	MODULE 10	MODULE 11	E V A L U A T I O N	MODULE 12	MODULE 13	
NERVOUS SYSTEM					ENDOCRINE SYSTEM AND METABOLISM	BLOOD AND IMMUNE SYSTEM	CARDIOVASCULAR SYSTEM			RESPIRATORY SISTEM	DIGESTIVE APPARATUS EXCRETORY AND REPRODUCTIVE SYSTEMS					
Development and general organization	Perception, sensitive and sensorial systems	Action systems neuromuscular and motor	Anatomic nervous system, emotion, memory, associative cortical functions, cerebral rhythms, regulation of cerebral activity		Endocrine System and metabolism	Blood and immune system	Heart	Blood vessels and hemodynamic		Respiratory system	Digestive apparatus	Excretory and reproductive systems				
					Primary Attention										Primary Attention Practices	
					1	1									Molecular Genetics	
										Molecular Genetics					4	5
										1	2	3			Health Legislation	
										Health Legislation					4	5
										1	2	3				

ves depends on the number and intrinsic difficulties of the anatomical structures in each module. In order to achieve the objectives in a module, the students must work on the contents of each objective (i.e. assuming that the identification of the vessels responsible for arterial and venous irrigation of the heart were an objective, the contents for that objective would be the origin, course and branches of the coronary arteries and veins). The objectives include flexible theoretical, clinical and functional aspects of each structure or system to be studied. The objectives and contents of each module, as well as the corresponding text resources, complementary bibliography and anatomical computer programs and anatomical web pages, are made available to the students through an intranet web-page.

As stated previously, each module is made up of five phases. For instance, in Human Anatomy and Embryology **Phase 1** takes 2-3 hours per group and week (about 20 students per group) to read and discuss the terms of the objectives. During this phase, the biological and medical meaning of the objectives are clarified by Faculty members, who illustrate the structures involved and state the resources for each objective. Most of the difficulties relate to anatomical nomenclature and mental imagery in three dimensional representations of anatomical structures. During **Phase 2** students work with the recommended bibliography either individually or in groups. Moreover, they also receive Laboratory courses at the Gross Anatomy laboratory, which is divided into “dry” and “wet” areas. In the “dry” area, students can examine individual bones, skeletons, plastic

models of anatomical structures, sectional anatomy models, and X-rays (plain X-rays, special radiological studies, CT scans and MRI scans) of different parts and organs. The “wet” area (there are two of them) is where students examine the prosections related to the module’s contents and each module is prepared by Faculty members. Participation in the dissection room during this phase is encouraged and students may spend as many hours as they consider necessary whenever the Gross Anatomy laboratory is available. **Phase 3** usually requires 3-4 hours, in which the students, after synthesizing the contents of the different objectives, make a peer-assessed oral presentation to their fellows based on overhead transparencies or computer (Power Point presentations or anatomical computer programs), either individually or in groups of up to three students. Instructors orient the discussion, asking questions or solving the problems proposed by the group when considered necessary. The main problem stems from the extent of the contents of many objectives; hence the need to focus on the main issues for critical analyses and applications of theoretical knowledge. Particular anatomical details are extended and further discussed with students out of the classroom, and also in **Phase 4**. This includes another round at the prosections and anatomical models in the Gross Anatomy laboratory, where the students can fix the concepts and, in particular, the spatial relationships of the different anatomical structures. This methodology is intended to prepare students to become used to independent inquiry. **Phase 5** is where a global eva-

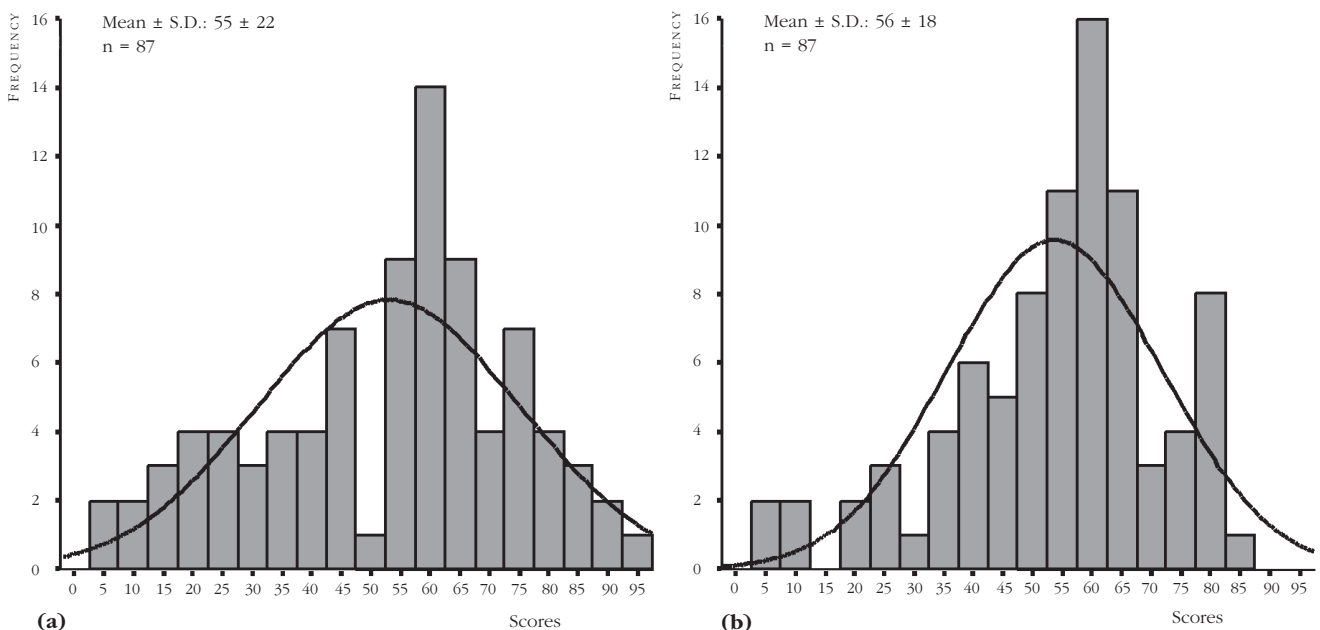


Fig. 1.- Histogram of the scores obtained by students in the first course. **(a)** Topographical Anatomy results. **(b)** Global evaluation of the first course (integrated).

luation is performed at the end of each module. Other assessments are made after each three or four modules, usually of related body systems, and finally, a general evaluation is scheduled for the end of the academic year.

The evaluation pertaining Human Anatomy and Embryology comprises a theoretical and a practical part. The first consist of varying number of multiple-choice questions, where the students must choose the correct answer from among five possible choices. The practical exam is based on the material available at the Gross Anatomy laboratory, and consists of a recognition test in which they must recognize a structure previously selected by Faculty members, and clearly marked on human bones, plastic models, images, prosections, etc., for which they have an allocated time of 30 seconds per structure. All this material has been offered to them previously during the laboratory periods (**Phases 2 and 4**).

The final score is the mean of the theoretical and practical examinations. The results are shown in figures 1 and 2 for the first and second courses, respectively. The frequency distribution of the scores followed an approximately Gaussian distribution for the results of Topographical Anatomy (Figure 1a) and overall score of all courses of the first medical year (Figure 1b). However, the second year shows that the students' scores have two groups of frequency distribution, with a peak score between 55 and 75, while a reduced group of students displayed a lower level of learning of the integrated discipline (Figure 2).

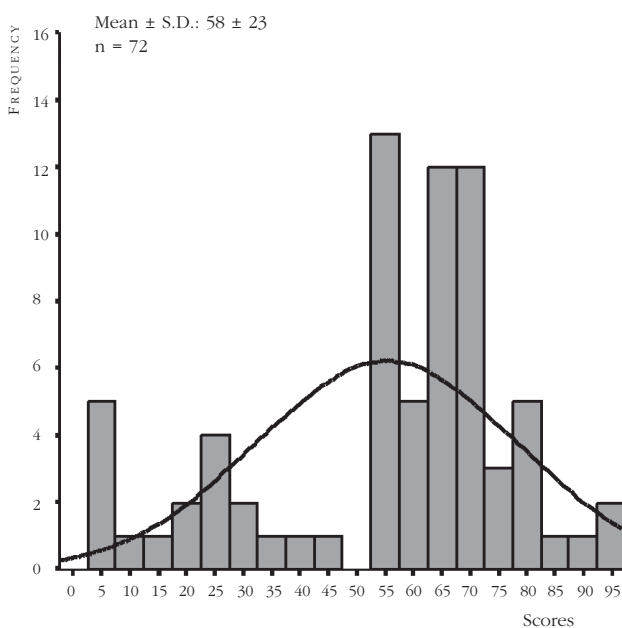


Fig. 2.- Histogram of the scores obtained by the students in the second course with respect to the integrated discipline (Development, morphology, structure and function of the healthy apparatus and corporal systems).

GROSS ANATOMY DISSECTIONS

There are many and often divergent opinions about the effective and efficient use of dissection and/or prosections in human cadavers as a part of Gross Anatomy courses (Dinsmore et al., 1999; Jones, 1997; Utting and Willan, 1995). In general, it is broadly accepted that even with the increasing availability of computer programs and simulators of human body dissection, there is no substitute for dissection (Ashraf-Aziz et al., 2002), especially as regards understanding the three-dimensional approach to the structures of the human body (Sandy and Marks, 2000). We believe that Gross Anatomy dissection offers a unique opportunity for students to come into direct contact with a human body; at the same time they have the best workbench on which "theory" can be tested to understand and learn Gross Anatomy.

As stated above, the Human Anatomy and Embryology section at the UCLM Medical School organizes courses so that students use either cadavers or anatomical models during regular practical anatomical sessions (see above **Phases 2 and 4**). Every two weeks, prosections in human cadavers are prepared by Faculty members to demonstrate anatomical features related to the next module.

In addition, the students are required to perform two Gross Anatomy dissections of a given anatomical region per year after they have learned the theoretical concepts of the region to be dissected. Groups of three students perform a Gross Anatomical dissection with only the help of some general introductory information about Gross Anatomy dissection procedures, a summarized handout, reference atlases, and the necessary dissection material. Students must dissect a number of structures previously determined by Faculty members for each dissection. The students fill in a form with a list of the structures to be dissected, as well as with the specific problems and difficulties that may arise along the dissection. They have a maximum of four hours to dissect such structures. Finally, a Faculty member supervises and evaluates, at the Gross Anatomy laboratory, the degree of accomplishment (number of correctly dissected structures) as well as other features of the dissection such as cleanness, integrity of the anatomical structures, etc., and at the same time clarifies any doubts or concepts. Students are required to take photographic evidence of their dissections and to present a written report.

Students also receive a questionnaire at the end of their experience in Gross Anatomy dissections. We ask their opinions about the usefulness and efficacy of Gross Anatomy dissections performed on human cadavers by the students. A large majority of students seem to believe that personal dissection is very helpful and that it is

a really efficient and effective way for understanding and learning Gross Anatomy. In general, they express more interest in more extensive active dissection or a personal dissection experience instead of group dissections because this increases their understanding of the material learned during the modules.

Assessment of the value of self-directed learning in Gross Anatomy at the UCLM School of Medicine is reviewed elsewhere (Arroyo-Jiménez et al., 2004).

CONCLUSION

Gross Anatomy is one of the fundamental topics in building a medical curriculum. In the teaching program in Gross Anatomy, we face the well-known handicap that at a time when students have to master a large body of anatomical information, their awareness of its application in clinical medicine is very small. On the other hand, when they are ready to use the anatomical knowledge they have gained, a substantial part of this material has been forgotten. Nevertheless, it is clear that anatomical knowledge and the application of anatomical principles in the understanding of clinical medicine are important. To date, after only a few years of experience with the methodology we use, both Faculty members and students are very satisfied with self-directed learning, at least according to an opinion poll. Notwithstanding, there is still a long way to go, and the methodology must be adapted to achieve a true vertical integration between Human Anatomy and Embryology and clinical courses, especially those with a strong surgical component.

The current Spanish educational system is mainly based on disciplines, is seldom coordinated, and is most often taught through lectures to large groups of students. When students enter our novel system, they are usually surprised and feel challenged by our encouragement of active participation and the integration of different subjects. This generates problems of adaptation, especially in the beginning of the first year of the degree. Once they have become familiarized with the system, most of them appreciate the benefits of active self-directed learning and feel an increasing motivation to learn. Moreover, this model allows students to fulfill their own medical curriculum. Additional benefits of the method are the honing of students' communication skills, the need and effort involved in conceptual organization for peer-teaching, and the importance of group effort. Group work also serves to provide an additional means of study as well as to for preparing students for future medical prac-

tice. Faculty members working with students must cope with additional demands to provide quality cooperative teaching. Unfortunately, success in passing exams remains the major driving force for institutions and students alike, instead of actual learning. The use of a global evaluation system for all the courses in one year, instead of individual course evaluations is one of the principal obstacles. However, this system promotes integration of the different courses in the basic and clinical sciences.

After the pertinent adjustments, it is anticipated that this model will be applied up to the academic year 2003/2004, when the first students complete their medical studies after having fully covered all the premedical and medical years. After they have completed all the courses, they will have to take the Spanish national examination that allows them to begin their medical specialty training. We might then be in a better position to perceive and to assess—in educational terms—sound strategies that we can implement in Human Anatomy and Embryology teaching, integrated with other basic and clinical sciences.

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