Povar M. A., Tkachuk S. S., Yasinska O. V. Cyclic visualization of the respiratory stages in teaching human physiology to english-speaking students. Journal of Education, Health and Sport. 2022;12(6):410-.417. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2022.12.06.041
https://apcz.umk.pl/JEHS/article/view/41110
https://zenodo.org/record/7385242

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 1, 2021. No. 32343. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).

Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 1 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe:Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

Received: 16.05.2022. Revised: 15.06.2022. Accepted: 30.06.2022.

CYCLIC VISUALIZATION OF THE RESPIRATORY STAGES IN TEACHING HUMAN PHYSIOLOGY TO ENGLISH-SPEAKING STUDENTS

M. A. Povar, S. S. Tkachuk, O. V. Yasinska

Bukovinian State Medical University, Chernivtsi

Abstract

In the course of Human Physiology, students of different specialties learn cyclic processes reflecting the work of the cardiovascular, respiratory, female reproductive systems and sleep as well. Visualization of the cyclic processes is essential for better understanding of the organization and functioning of these systems and finding pathological deviations with formation of defective cycles.

The objective of the work is to analyze the application of the visualization of the respiratory stages into the educational process. Dynamics of the physiological processes at various stages of respiration with the help of schematic visual figures allows effective formation of the students' systemic understanding of the respiratory system functions and its interrelations with the cardiovascular system. These enable to apply the acquired theoretical knowledge while solving clinical situational tasks and formation of professional competence.

Key words: cyclic visualization; respiration; respiratory cycle; Human Physiology.

Formation of the professional logics of a medical student does not depend on independent work on educational materials only, but it depends directly on the discussions together with a lecturer/teacher and highlighting the main important elements of a practical class subject. Reduction of study classroom hours and the time for communication with a teacher requires application of quick express-methods to assess students' knowledge objectively, for example, solving tests of situational tasks.

Introduction of a competence approach into the educational process increases the effect of classroom hour use promoting formation of both general and professional competence including the subjects of general biological area. During practical classes on Human Physiology, students develop their ability to analyze the state of normal functioning of the organs and systems, to choose information laboratory and instrumental methods of examination which findings will further be used for the purpose of both diagnostics and treatment.

Human Physiology as an educational subject is a standard constituent of the curriculum to train professionals in the field of Public Health. It is a basic subject for further learning clinical disciplines of both therapeutic and surgical branches. Learning Human Physiology forms an integral holistic view about interaction of the organs and systems of the body within the norm and in case of pathology, the mechanisms of adjustment to environmental changes.

Prevailing of digital technologies in modern world lead to the situation when the majority of students do not perceive the text work without visualization. Students experience certain difficulties in asking questions, explaining the mechanisms of realization of dynamic processes, and determining cause and effect relationships. In general, formation of complete and logic answers to questions on the subject becomes complicated. Therefore, structuring of the presented material is an essential and effective means to master the necessary information. The successive layering of structured information will improve awareness of the interrelations between the dependence of the functioning of organs and their systems, the controlling link of which is a linear or non-linear component.

The term "structuring" in computer science indicates location of various information volume components and creating the necessary connections between them in order to perceive the information easier, quicker and better by users. It is the simplest and the most effective way to improve the quality of analysis of the information obtained. Structuring determines location of the information in a certain order, according to a definite algorithm, for example,

according to the sequence of events or a coding element describing an appropriate information block [1].

In Medicine, and Biology and Physiology in particular, computer modelling is widely used as an instrument of research and learning. In the process of performing work using modelling elements, well-known physiological patterns are applied, and new modernized ones are developed. They are adapted to solve specific tasks. Physiology as a science about dynamics of vital processes, studies functioning of the organs and systems and the processes occurring in them. The use of appropriate methods and measuring devices, synthesis and analysis of the patterns of system functioning, enables to investigate certain aspects of human vital activity. The results obtained will be an excellent foundation for practical implementation of the modelling results in medical diagnostics and treatment.

To make up a computer model it is necessary to develop a mathematical pattern of a physiological process. In addition to the object and pattern, the subject – a person, for whom this pattern is developed, is basic for mathematical modelling. A physiological model is developed for effective work and human needs in practical medicine. Computer model demonstrates a conditional image of an object or the system of processes. It is described by means of diagrams, charts, tables, animation components, and reflects the structure and interrelations between the elements of processes or objects [2].

A person, like any living organism, can be an object of computer modelling. It is intended for research for the purpose to diagnose a disease, quickly receive information data for further planning of treatment or prevention. Application of modelling elements of physiological processes in studying the subject Human Physiology teaches students to use up-to-date technologies in their professional activity, and allows formation the skills of analysis of the medical information obtained.

Physiological processes of the human organism are characterized by a cyclic course (respiratory cycle, cardiac cycle, menstrual cycle, sleep etc.). They are manifested by the repition of the sequence of changes in the functions of the components of a certain system under the control of changes in the activity of the nervous and humoral system or as result of self-regulation mechanisms [3]. Therefore, introduction of interactive tasks for students' independent work under the teacher's supervision promotes an active formation of the skills to analyze the processes occurring during various physiological cycles.

Student get their main knowledge on the respiratory processes during lectures and through independent preparation for practical classes. Therefore, we think it is reasonable to do the tasks in student's workbooks. The tasks include designation of breathing stages

schematically in the figures. The tasks should be done subsequently depending on the order of learning respiratory stages during practical classes.

Gas exchange in the lungs occurs due to breathing movements – inspiration and expiration constituting the respiratory cycle [4]. Therefore, at first students learn the names of respiratory stages, processes of inspiration and expiration, sign appropriate structures and components in the figures according to their subsequence. The next step is determination of the major respiratory volumes according to the stages of respiratory cycle [5].

When teaching respiratory processes a teacher can use other methods of visualization such as educational videos, schematic images of the respiratory passages, chest X-ray during inspiration and expiration. Later filled in charts, schemes and diagrams are supplemented with marks according to percussion and auscultation findings accompanying the respiratory cycle and combining this task with spirogram registration.

During the following classes, students continue to fill in their notes with new data concerning calculation of the respiratory volume, illustrating them with linear diagrams and mark cyclic changes of the respiratory volume in the lungs. Layer by layer, different visualization methods create logically structured information and enable the students to master the material stage-by-stage. These methods improve the use of classroom hours and make the assessment of students' knowledge and skills much easier.

Schematic representation of the respiratory cycle is interesting including explanation in the table on pressure changes during inspiration and expiration. The material found on the internet page (https://basicmedicalkey.com/physiology-of-the-respiratory-system/) (Fig. 1, Table 1). Students fill in a similar blank table with interest, but they require more detailed explanation of dynamic changes in the process of respiration.

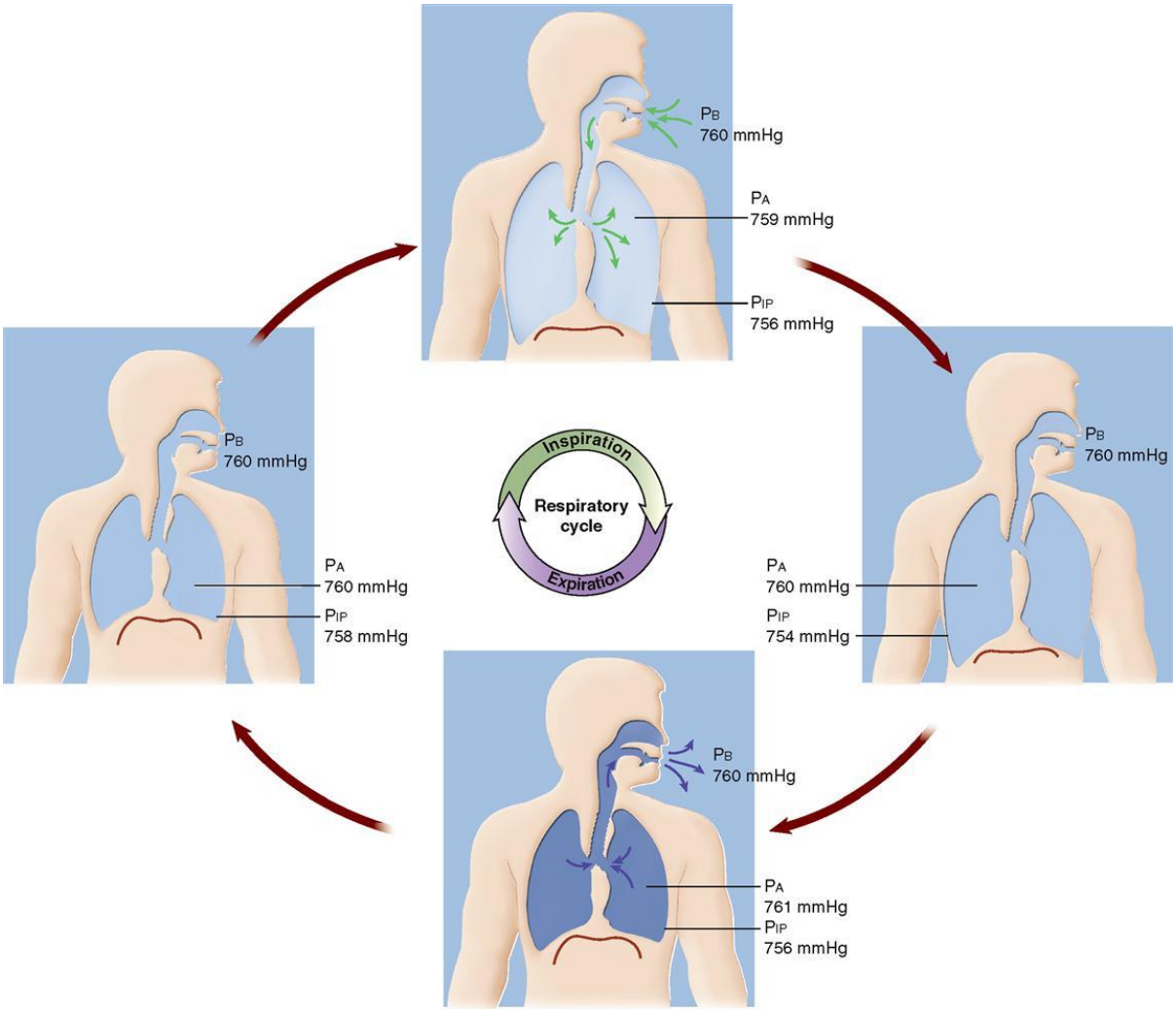

Figure 1. Changes of intrapleural, alveolar and atmospheric pressure during respiratory cycle

Table 1

Description of the changes of intrapleural, alveolar and atmospheric pressure during respiratory cycle

P_{IP}	P_A	P_B	DESCRIPTION
Inspiration			
758	760	760	The diaphragm is relaxed, putting the thoracic cavity at low volume. At the beginning of inspiration $P_{IP} < P_A$, keeping alveoli open. Since $P_A = P_B$, no air is flowing yet.
756	759	760	The diaphragm contracts, increasing the thoracic volume and reducing P_{IP}. A decrease in P_{IP} causes a decrease in P_A. Now $P_A < P_B$, and air flows down the pressure gradient (into the lungs).
754	760	760	Eventually, the alveoli fill with air and P_A equilibrates with P_B. Inward airflow stops. The cycle is now ready to shift to the expiration phase. Note that P_{IP} is still dropping but P_A has not yet "caught up" with the drop.

P_{IP}	P_A	P_B	DESCRIPTION
Expiration			
754	760	760	As expiration is about to begin, the diaphragm is contracted maximally. Since $P_A = P_B$, there is no airflow.
756	761	760	The diaphragm relaxes, and elastic recoil of the thoracic walls and alveoli increases P_{IP} and P_A. Now, $P_A > P_B$. Air moves (outward) down the pressure gradient.
758	760	760	The diaphragm eventually relaxes fully, so the decrease in volume stops. P_A equilibrates with P_B, and airflow ceases. The system is now ready for another inspiration phase.

Note.
P_{IP} = intrapleural pressure (air pressure in the intrapleural space);
P_A = alveolar pressure (air pressure inside the alveoli);
P_B = atmospheric (barometric) pressure (air pressure of the external environment [atmosphere]).
*All P values are expressed in *mmHg* and are examples only.

The respiratory cycle demonstrated in the slide show by Shauna Richard (source: https://slideplayer.com/slide/16254301/) combines respiratory stages and respiratory volumes with indication of the oxygen partial pressure in the inspired and expired air (Fig. 2).

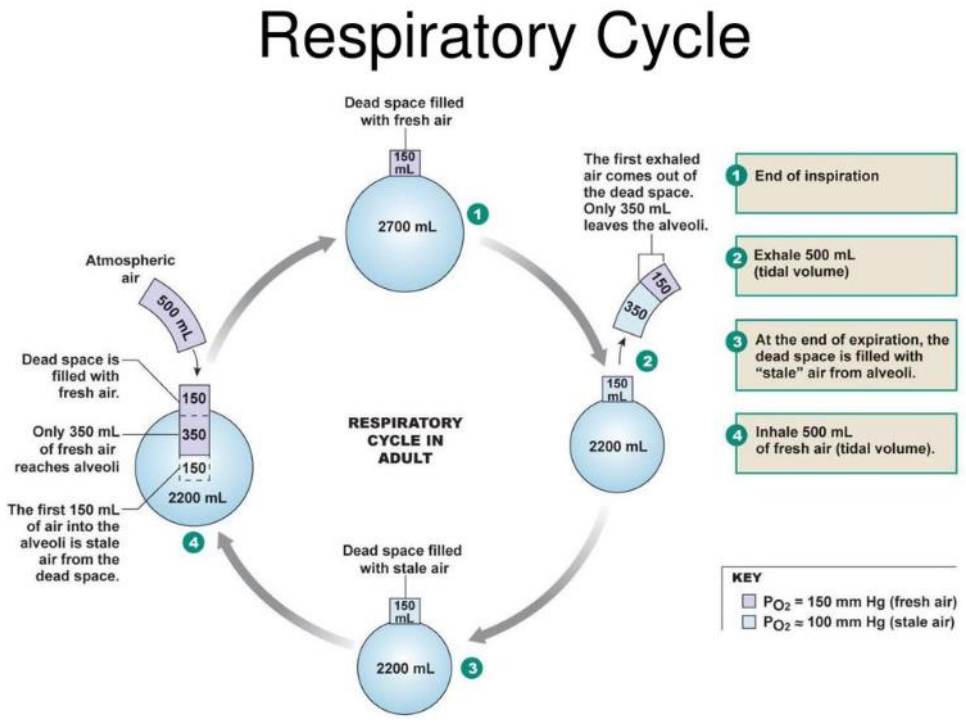

Fig. 2. Respiratory volumes during respiratory cycle

Application of the above visualization methods of the cyclic processes in the course of teaching Physiology resulted in better mastering and reproduction of theoretical knowledge by students. The percentage of correct answers in solution of complicated situational tasks became higher including questions from the international exams on theoretical subjects.

Based on a positive dynamics of the used method, we consider that this approach will enable to improve the students' progress not only during the final module test on Physiology, but it will become fundamental for learning and mastering clinical subjects. In its turn, it will improve the quality of education of future doctors.

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