JMSR
Journal of Medical and Surgical Research

ISSN: 2351-8200

Research Article

JMSR 2021 Vol. VIII, n 2: 1003- 1008

EVALUATION OF NEW TOOLS FOR EMBRYOLOGY TEACHING: -EXPERIENCE OF TANGIER MEDICAL SCHOOL IN MOROCCO-

K. Idrissi Serhrouchni [1], Mariame Chraibi [2], Jalil Elhangouch [3], A. Oulmaati [4], Mohamed Ahallat [5]

[1-] Laboratory of Histology-Embryology-Cytogenetic, Faculty of Medicine, Abdelmalek Assaâdi University, Tangier, Morocco.
[2-] Laboratory of pathology, Faculty of Medicine, Abdelmalek Assaâdi University, Tangier, Morocco.
[3-] Laboratory of Physiology, Faculty of Medicine, Abdelmalek Assaâdi University, Tangier, Morocco.
[4-] Department of pediatrics, Faculty of Medicine, Abdelmalek Assaâdi University, Tangier, Morocco.
[5-] Faculty of Medicine Tangier, Abdelmalek Assaâdi University, Tangier, Morocco.

ABSTRACT

Introduction: During embryonic development, all systems undergo rapid dynamic changes in 3D and over the time. These make learning embryology difficult and very passive through a classic lecture. The objective of this work is to report on the experience of the Faculty of Medicine and Pharmacy of Tangier (FMPT) to improve human embryology teaching by adopting new interactive and effective teaching methods. **Materials and methods**: During the lectures of the year 2021, illustrative videos of embryonic development were integrated. In addition, as part of the practical sessions, we used for the first time nationally an innovative educational material made of models designed and dedicated especially for the practical application of all the theoretical concepts developed in the course. This material allowed learners to manipulate the three-dimensional aspects of different embryonic structures via plastic 3D models. The effectiveness of these learning tools is assessed in two subjective and objective ways. **Results:** 216/228 students participated in the satisfaction survey with a predominance of females (65.7%). 80.1% were able to follow the videos. 98.6% attended the practical sessions. Illustrative videos and practical courses were a great help in understanding embryonic development (73% and 73.6% respectively). They facilitated the memorization of embryonic development (64.3% and 67.6%). They increased students' interest in embryology (65.7% and 63.8%). They also showed the medical interest of the practice of embryology (37% and 44 %). Compared with the grades of the 2020 class, these methods improved the results of the 2021 class with an increase in the Mean of 0.732 and a reduction in the Standard Deviation of 1.067. **Conclusion:** These tools are effective in initiating a reflective attitude in students on knowledge transmission methods and allowed them to emerge from a form of passivity for better learning of human embryology.

Key Words: Embryology, Teaching, Tools, Innovation.

Corresponding Author:
Idrissi Serhrouchni Karima, **MD**.
Affiliation: Laboratory of Histology-Embryology-Cytogenetic, Faculty of Medicine, Abdelmalek Assaâdi University, Tangier, Morocco.
E-mail: karima.idrissi.serhrouchni@gmail.com
ORCID:

*****Published in December 31, 2021.*

doi: 10.46327/msrjg.1.000000000000204
doi url: https://doi.org/ 10.46327/msrjg.1.000000000000204

INTRODUCTION:

During embryonic development, all systems undergo rapid dynamic changes in 3D and over the time. These are hard to understand and make learning embryology difficult and very passive through a classic lecture. Teaching embryology requires explanation of all these dynamic changes [1]. Embryology is taught in preclinical biomedical science during the two first years in medical education. Regarding the curriculum, there is so much content, and what's worth understanding in all of it? Moreover, for the students, it appears to be far from the concrete reality. A link between this

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2021 Vol. VIII, n 2: 1003- 1008

fundamental discipline and concrete appearance could increase the interest of students for the discipline [2]. The main goal of this work is to report on the experience of the Faculty of Medicine and Pharmacy of Tangier (FMPT) in improving the teaching of human embryology by adopting new interactive and effective teaching methods.

MATERIALS AND METHODS

During the lectures in human embryology for the 2021 academic year at the FMPT. Illustrative videos of embryonic development have been integrated. These videos focused on important steps on reproduction biology (ovulation, sperm motility, fertilization) and early period of developmental biology (segmentation, hatching, implantation, gastrulation and neurulation). In addition, the lectures were followed by practical courses, during which we used for the first time nationally, an innovative educational material made of models designed and dedicated especially for the practical application of all the theoretical concepts developed in the course. This material allowed learners to manipulate the three-dimensional aspects of different embryonic structures via plastic 3D models (**Figure 1**).

Figure 1: Picture of a group of first year medical education students during an embryology practical course at the Faculty of Medicine and Pharmacy of Tangier.

To illustrate the efficiency and the impact effectiveness of this learning method, subjective and objective evaluation methods were done three weeks after the end of the embryology courses. In one hand, all students enrolled in the first year of our faculty were asked to respond to an online survey questionnaire using a Likert scale and developed by Google Forms. The questionnaire remained accessible for three days. It enabled the collection of information relating to the assessments of the teaching methods used. On the other hand, the performance of these educational tools is evaluated by carrying out a mock exam also executed by Google Forms.The aim was to compare the results of the concerned class (2021) to the previous class (2020) which had lectures exclusively. This comparison was made using identical multiple response questionnaire (MRQ). This last was corrected automatically for the two years. For the concerned class (2021), test questions were classed in three categories showing the related tools used for each one. Herein, we described: category 1 that include question treated by lecture only (8 questions), category 2 treated by lecture and videos (6 questions) and category 3 treated by lecture +videos + practical courses (6 questions).

Statistical analysis: Results have been analyzed using IBM SPSS Statistics V21. To compare the averages of correct answers between the two 2020 and 2021 classes for each category, a Student's tests have been used. A difference was estimated as significant if the P value was less than 0.05 with a 95% Confidence Interval.

On sight this paper, we described different experiences and perceptions of teaching and learning embryology in medical education, most interesting and most confusing aspects of teaching or learning embryology. Through a short literature review carried out by a documentary research made on Medline database using PubMed, KlinicalKey and Google Scholar. The following keywords were used:

- (embryology OR development biology OR embryo)
- AND (teaching OR education OR medical OR 3D)

RESULTS:

In our study, 216 students among 228 participated in the survey with a predominance of females (65.7%) compared to males (34.3%). The presence in the lectures and indeed monitoring videos was noted by 80.1% while 98.6% of students were present at the practical courses. In these last, students were divided into 8 small groups accounting about 25 students per group and underwent 2 hours of teaching for each one. It's important to highlight that the three-recorded absences were allied to health circumstances of the COVID19 pandemic.

In the light of our result, students thought that illustrative videos were a great help in understanding embryonic development in 73% (97 certainly and 61 enormously). These videos facilitated the memorization of embryonic development in 64.3% (87 certainly and 52 enormously). They increased the students interest in embryology in 65.7% (85 certainly and 57 enormously). Illustrative videos also showed the medical interest of embryology

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2021 Vol. VIII, n 2: 1003- 1008

practice in 37% (47 certainly and 33 enormously). They got students to spend more time studying embryology in 59.7% (85 certainly and 44 enormously). Regarding future approaches, students wanted to integrate and develop illustrative videos in practical classes (74%) more than in lectures teaching of embryology (69.4%) (**Figure 2**).

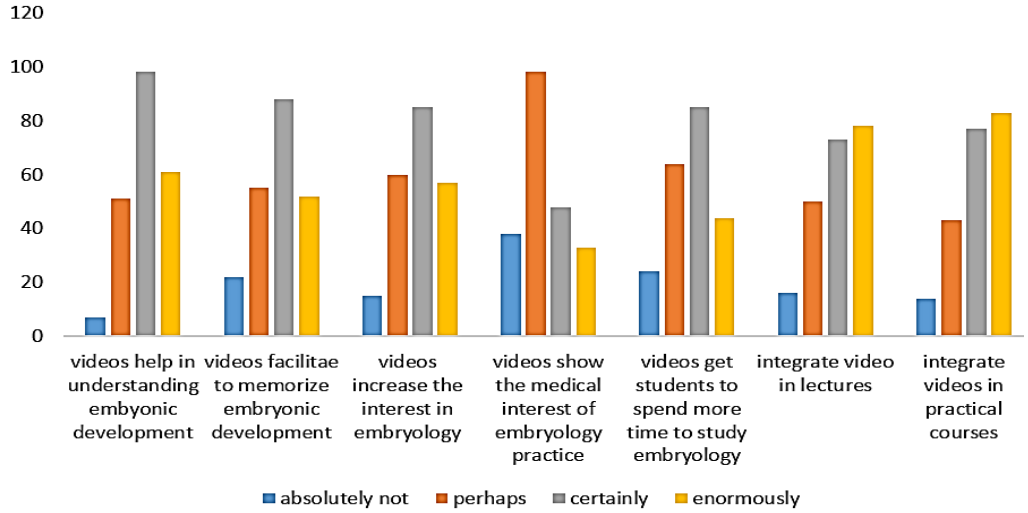

Figure 2: Results of the satisfaction survey concerning the illustrative videos

On the subject of practical courses, we didn't notice a great difference about the first three items asked, because students pronounced that practical courses helped them in understanding embryonic development in 73.6% (93 certainly and 66 enormously). These courses eased the memorization of embryonic development in 67.6% (90 certainly and 56 enormously). They increased students interest in embryology 63.8% (83 certainly and 55 enormously). However, in the opposite of videos, they showed more medical interest of embryology practice for students in 44% (62 certainly and 33 enormously) and got them to spend more time studying embryology in 62.5% (89 certainly and 46 enormously). That is why students wanted to develop practical courses within a large hourly covering 68 % (75 certainly and 72 enormously) (**Figure 3**).

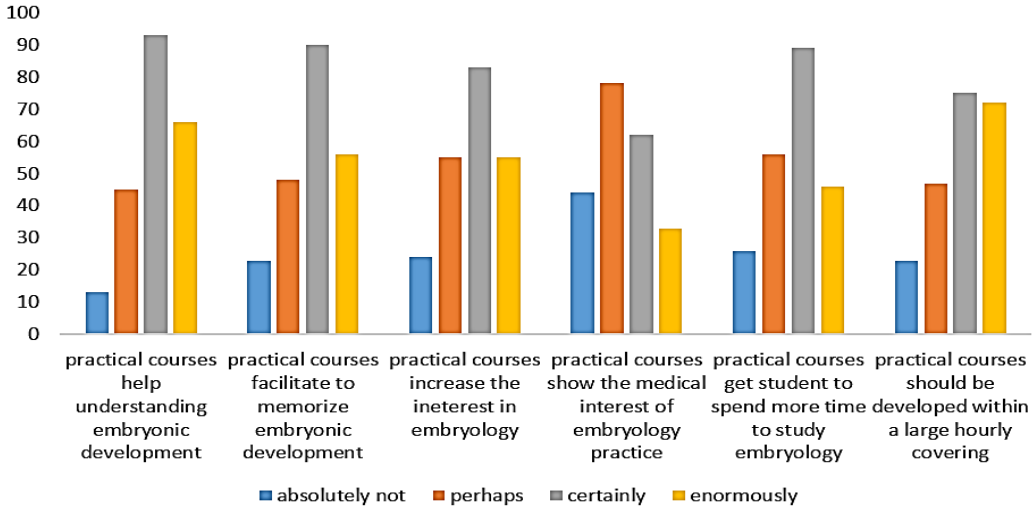

Figure 3: Results of the satisfaction survey concerning the practical courses

Compared with the grades of the 2020 class, these methods improved the results of the 2021 class with an increase in the Mean of 0.732 and a reduction in the Standard Deviation of 1.067. When we compared the average of the percentages of students who were able to answer the questions according to their categories between the year 2020 and the year 2021. We noted a clear advancement for category 3 (44.5 to 79) with a statistically significant difference ($p = 0.0014$) (ddl=5). An increase in the average

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2021 Vol. VIII, n 2: 1003- 1008

percentage of correct answers concerning category 2 (54 to 78.8) (p = 0.025) (ddl=5). We also noted an improvement for category 1(36.7 to 66.6) with a statistically significant difference (p = 0.014) (ddl=7) (**Figure 4**). Regarding the limits of this comparison, it is important to note that the 2020 class benefited online courses due to the covid-19 pandemic. However, the course of this teaching was ensured by the same content and the same time volume.

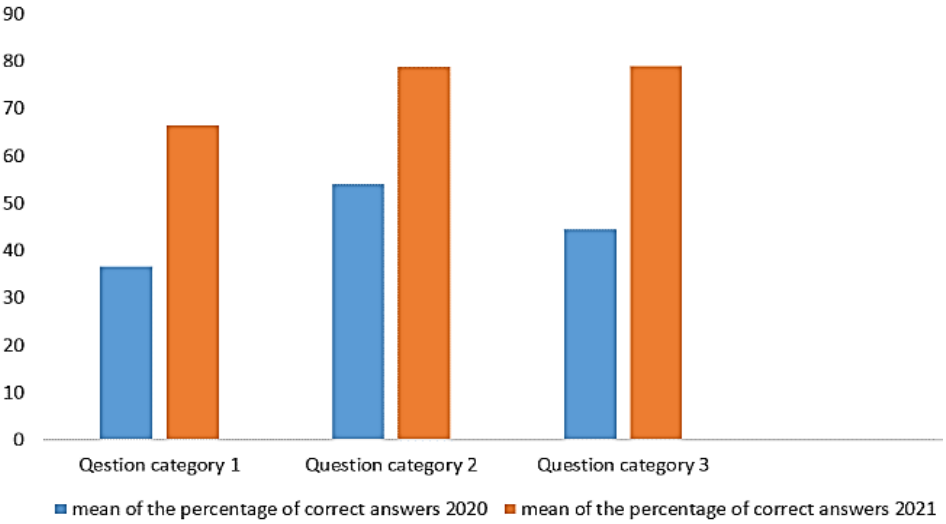

Figure 4: Comparative diagram of the percentage means of correct answers according to the questions categories between the years 2020 and 2021.

DISCUSSION:

Medical students do not access with at least the basic background of vocabulary and the conceptual outline of development, that's why teaching embryology is challenging. Developmental principles in embryology as a starting point in human life was stated by Viktor Hamburger, who affirmed that "Our real teacher has been and still is the embryo who is, incidentally, the only teacher who is always right" [3]. Teaching embryo, need to offer students the chance to become acquainted with embryology and to convey to them how many changes take place dynamically during development. Given this explosion in knowledge is clearly important, however, a crucial steps remains [4]. During their medical education, students get lectures and study text books on embryology, illustrated by drawings and other 2D images. The importance of these tools is evident for proper understanding but it fall short in bringing across the topography of the developing 3D embryonic structures in a realistic and intuitive fashion [5].

Using constructed embryo in three dimensions, through an examination of serial sections of embryos at various stages in their development in a laboratory was a classical way for teaching embryology. That forces students to develop a three-dimensional (3D) understanding of the embryo by mentally reconstructing such sections, an activity aided by classic atlases of developmental biology [6, 7]. The use of artificial models enables learning, since students can appreciate the three-dimensional (3D) aspects of the structures [8, 9]. Some authors compared the significant differences between the cognitive domain scores in the pre- and post-tests. They indicated that the cognitive domain scores increased when 3D embryology models were used [1].

Using videos in embryology courses increase the students' motivation to learn. They lead to a better comprehension. However, they not optimize the memorization of embryology caused by presentation of very high concentration of information in a short time. For an optimal teaching, it should be associated to an explanatory pedagogical tool to more insightful representations of the internal components of embryos as they change over time that such movies will aid 4D thinking regarding the early embryo [10]. The morphogenesis process is a four-dimensional (4D) progression in both time and space that allows for new interactions between differentiated parts of the embryo [11]. Nevertheless, the cited way of teaching does not usually lead to a 4D understanding of the embryo. Artificial non digital 3D models and video materials have rarely been exploited to aid genuine 4D understanding. Therefore, developmental biology researchers had recognized another method using 4D microscopy in their research to chart the cells' positions as they move within the embryo [7]. As a result, a promising avenue would seem to pursue the teaching of the 4D

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2021 Vol. VIII, n 2: 1003- 1008

nature of embryonic development over modern computer and animation technology. The technology already exists to depict embryos on the computer as true 3D objects in 4D space [12, 13], and needs the application of instructional materials development resources to product such models. Authors discussed that the possibility of training in 4D thinking at the undergraduate level aided understanding embryos in different axes [7, 14]. The spatial visualization is an extremely important skill in many fields in science and mathematics. It is a complex process that involves visual processing beside the construction and manipulation of mental images [11]. It involves several related mental activities, including the ability to rotate objects about one or more axes [15], the ability to mentally manipulate objects [16], and the ability to see through the surface of an object into its interior [17].

Actually, many teams improve embryology learning through digital models. Leandro Guimarães and all presented an important work (VLE EMBRIO) to visualize transversal and longitudinal cuts of the conceptus for better understanding of the 3D-model. They create a virtual learning environment containing three-dimensional models of human embryos and fetuses [18]. They are based in extensive bibliographic research, to generate these models in an open source software called BLENDER, and group these virtual objects in a rational and sequential way with the objective to generate holistic and temporally connected knowledge about embryonic and fetal development [19]. In another experience reported by De Bakker and al. The authors used digital images of serial sections of 34 human embryos of the Carnegie Collection between Carnegie stages 7 and 23 to create 3D reconstructions of different organ systems. They stated the beneficial software package Amira to align the sections and to create the 3D reconstructions. More than 13.500 manually annotated sections of embryos were showed in their first results of the atlas. Also, we can view the 3D models interactively within a 3D-PDF [5].

Effectiveness of digital models is determined by the student's level of computer skills, [20] gender of the student, [21] inherent ability of the student to comprehend spatial anatomy, [22] level of orientation to 3D technology, [23] and cognitive burden on the student [24]. Although most commercially available digital embryology models are expensive. 3D printing (a process where a physical object is created from a three-dimensional computer model through successive material layering) has been used to produce 3D models for medical education [25].

Another way of teaching embryology is plasticine clay. In order to understand the 3D movements for example in gastrulation that transform a ball of cells in an early embryo to an embryo that has the external, middle and innermost germ layers for organ formation. Students are to use three different colors of plasticine clay to simulate the process of gastrulation and convince their-self that a ball can indeed be transformed into a 3-layered structure. After the molding process, they cut the "embryo" into halves and see how the three layers are positioned in relation to one another [26, 27].

These challenges overdrawn up student's objections ranged from the difficulty of the topic, and the lack of perceived relevance seen in relation to medical practice. Through these tools, they began to see the relevance of embryology to learning gross anatomy, clinical aspects, physiology and pathology. They came to appreciate the complexity of the processes that must occur in order for the human body to correctly develop.

In our study, the student's assumption to the strong help of these innovative tools (videos and practical courses) in the improvement of the embryology learning is statistically proven by the upgrading output. Therefore, having excellent grades in questions related to the subsequently use of videos and practical courses lead us to think about integrating the videos in the practical course and not in the lecture as well as to widen the hourly covering devoted to them. That what students brightened by their opinion through the satisfaction survey.

However, comparative result obtained in category 1 demonstrates that lecture still keeps an interest in initial training of embryology, because it is the first way to prime the basic background of vocabulary and the conceptual outline of development for students.

CONCLUSION

Illustrative videos and practical courses are effective in initiating a reflective attitude in students on knowledge transmission methods and allow them to emerge from a form of passivity for better learning of human embryology. Actually, student's abilities like training in 4D thinking or using videogames led our guess to looking for new tools to improve teaching embryology. We will search further for more online embryology animations, and if the department team procured the financial support, we would consider starting to develop a line of new embryology animations that are computer generated, convey three-dimensionality, and enable the viewer to move through time in an interactive format.

JMSR
Journal of Medical and Surgical Research

ISSN: 2351-8200

Research Article

JMSR 2021 Vol. VIII, n 2: 1003- 1008

FINANCIAL SUPPORT & SPONSORSHIP:

None.

CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

ACKNOWLEDGEMENTS

The authors would like to thank Othmane Aouad for his technical help in the practical courses.

REFERENCES:

1- Kamkhedkar SG, Malgaonkar AA, Kartikeyan S. Three - Dimensional embryology models as teaching aids for first-year medical students. International Journal of Biomedical Research ISSN: 2017; 8(04): 177-181. doi: https://dx.doi.org/10.7439/ijbr

2- Scott KM, Charles AR, Holland AJA. Clinical embryology teaching: is it relevant anymore? ANZ J Surg. 2013; 83:709-12. doi http://dx.doi.org/10.1111/ans.12213.

3- Holtfreter J. Address in honor of Viktor Hamburger. In: Locke M., editor. The Emergence of Order in Developing Systems; The Twenty-Seventh Symposium of the Society for Developmental Biology; New York: Academic Press; 1968. pp. ix–xx.

4- William B W. Teaching Concepts versus Facts in Developmental Biology. CBE life sciences education. 2008; 7: 10–16, Doi: http://dx.doi.org/10.1187/cbe.07-12-0106.

5- Bernadette SB et al. Towards a 3-dimensional atlas of the developing human embryo. The Amsterdam experience Reproductive Toxicology. 2012; 34: 225–236. Doi http://dx.doi.org/10.1016/j.reprotox.2012.05.087.

6- Schoenwolf, G. Atlas of Descriptive Embryology, 2007; 7th ed., SanFrancisco,

7- Jeff H. The Missing Dimension in Developmental Biology Education. CBE-Life Sciences Education. 2008; Vol. 7, No. 1: 1-162. doi: https://doi.org/10.1187/lse.7.1.cbe13.

8- Freitas LAM et al. Construction of embryonic models with recycled material for didactic using. Bioscience Journal. 2008; 24(1): 91-97.

9- Aziz MA et al. The human cadaver in the age of biomedical informatics. Anat Rec. 2002; 269: 20-32. doi: https://doi.org/10.1002/ar.10046.

10- Koscinski I et al. Videos for embryology teaching, power and weakness of an innovative tool. Morphologie 2019;103: 72-79. doi: https://doi.org/10.1016/j.morpho.2019.04.001.

11- Mathewson J. H. Visual-spatial thinking: an aspect of science overlooked by educators. Sci. Educ. 1999; 83: 33–54. doi: https://doi.org/10.1002/(SICI)1098-237X(199901)83:1<33::AID-SCE2>3.0.CO;2-Z.

12- Lazar B et al. Hybrid 3D pregnant woman and fetus modeling from medical imaging for dosimetry studies. Int J CARS. 2009 Online. doi: https://doi.org/10.1007/s11548-009-0381-3.

13- Azkue J.J. A digital tool for three-dimensional visualization and annotation in Anatomy and Embryology learning. European Journal of Anatomy, 2013; 17: 146-154.

14- Hardin J. Confocal and multi-photon imaging of living embryos. In: Handbook of Biological Confocal Microscopy, 3rd ed. 2006. J. Pawley, New York: Springer, 746–768.

15- Shepard RN, Metzler J. Mental rotation of three-dimensional objects. Science 1970; 171: 701–703. doi: https://doi.org/10.1126/science.171.3972.701.

16- Ekstrom RB et al. Manual from Kit of Factor-Referenced Cognitive Tests. Princeton, NJ: Educational Testing Service. 1976; p173.

17- Kali Y, Orion N. Spatial abilities of high-school students in the perception of geologic structures. J. Res. Sci. Teach. 1996; 33: 369–391. doi: https://doi.org/10.1002/(SICI)1098-2736(199604)33:4<369::AID-TEA2>3.0.CO;2-Q.

18- Leandro G G et al. EMBRIO v2.0-A Virtual Learning Environment for Embryology Teaching. International Journal of Information and Education Technology. 2017; 7(4): 297-300. doi: https://doi.org/10.18178/ijiet.2017.7.4.884.

19- Kakusho K et al. Illustrating human development by computer graphics for education in embryology. In Proc. The International Conference on Computers in Education. 2001; pp. 412-415.

20- Nguyen N et al. Visuospatial anatomy comprehension: the role of spatial visualization ability and problem-solving strategies. Anat Sci Educ. 2014; 7(4): 280-288. doi: https://doi.org/10.1002/ase.1415.

21- Guillot A et al. Relationship between spatial abilities, mental rotation and functional anatomy learning. Adv Health Sci Educ Theory Pract 2007; 12(4): 491-507. doi: https://doi.org/10.1007/s10459-006-9021-7.

22- Nguyen N, Nelson AJ, Wilson TD. Computer visualizations: factors that influence spatial anatomy comprehension. Anat Sci Educ. 2012; 5(2):98-108. doi: https://doi.org/10.1002/ase.1258.

23- Tworek JK et al. The LINDSAY Virtual Human Project: An immersive approach to anatomy and physiology. Anat Sci Educ. 2013; 6(1):19-28. doi: https://doi.org/10.1002/ase.1301.

24- Khot Z et al. The relative effectiveness of computer-based and traditional resources for education in anatomy. Anat Sci Educ. 2013; 6(4): 211-215. doi: https://doi.org/10.1002/ase.1355.

25- Abou HY et al. The application of 3D printing in anatomy education. Med Educ Online. 2015; 20: 29847. doi: https://doi.org/10.3402/meo.v20.29847.

26- Tit ML. Learning developmental biology has priority in the life sciences curriculum in Singapore. The International Journal of Developmental Biology. 2003; 47: 117-121.

27- Scott FG. All I Really Needed to Know I Learned during Gastrulation. CBE Life Sci Educ. 2008; 7(1):12-3. doi: https://doi.org/10.1187/lse.7.1.cbe12.