

Can virtual reality improve traditional anatomy education

programmes? A mixed-methods study on the use of a 3D skull model

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Supplementary file 1

QUESTIONS: Test on cranial anatomy

1. Theory test

Directions: For each question, you must choose the best answer from the four choices marked A, B, C, and D.

No.	Questions	Answers
1	How many pieces of cranial bones (including facial cranium and cerebral cranium) do human have? A.18 B.20 C.23 D.28	
2	Which of the following does not belong to the cerebral cranium? A. frontal bone B. zygomatic bone C. parietal bone D. ethmoidal bone	
3	Which of the following does not appear in pair? A. parietal bone B. occipital bone C. temporal bone D. zygomatic bone	
4	Lambdoidal suture is made up of ____ and ____. A. parietal bone, occipital bone B. parietal bone, frontal bone C. frontal bone, sphenoid bone D. left parietal bone, right parietal bone	
5	Inferior orbital foramen is located on ____. A. maxilla B. zygomatic bone C. nasal bone E. mandible	
6	Hypophyseal fossa locate on ____. A. lamina cribrosa B. orbital plane of frontal bone C. petrosal part of temporal bone D. body of sphenoid bone	
7	Which of the following structures does not participate in the composition of anterior cranial fossa? A. orbital plane of frontal bone B. lamina cribrosa C. greater wing of sphenoid bone D. lesser wing of sphenoid bone	
8	Which cranial bones participate in the formation of pterion? A. frontal bone, sphenoid bone, parietal bone and temporal bone B. frontal bone, occipital bone, parietal bone and temporal bone C. zygomatic bone, sphenoid bone, parietal bone and temporal bone D. zygomatic bone, frontal bone, occipital bone and temporal bone	
9	Which of the following statement about mandible is false ? A. It is composed by ramus of mandible and body of mandible B. Angulus mandibulae is palpable from the body surface C. Foramina mandibulae are lateral to rami mandibulae D. Foramina mentale are anterior lateral to corpus mandibula	
10	Which of the following structure is located in the middle cranial fossa? A. internal acoustic meatus B. trigeminal impression C. clivus D. petro-occipital fissure	
11	Which of the following structure is connected with carotid canal? A. foramen lacerum B. foramen ovale C. petro-occipital fissure D. foramen spinosum	
12	Which of the following structure is not located on the greater wing of the	

	sphenoid bone? A. foramen spinosum B. foramen ovale C. foramen rotundum D. optic canal	
13	Which of the following structure connect cranial cavity with nasal cavity? A. optic canal B. foramina ethmoidale C. foramen rotundum D. foramen spinosum	
14	Which of the following structure is not located in the posterior fossa? A. internal acoustic meatus B. foramen lacerum C. hypophyseal fossa D. jugular foraramen	
15	Which of the following structure does not belong to the sphenoid body? A. carotid sulcus B. optic canal C. tuberculum sellae D. chiasmatic sulcus	
16	Which of the following structure is not located on the occipital bone? A. hypoglossal canal B. foramen magnum C. sulci sigmoideus D. cavernous sinus	
17	Which of the following structure is not located on the occipital bone? A. foramen stylomastoideum B. occipital condyle C. hypoglossal canal D. culivus	
18	Which piece of bone is connected with all cranial bones? A. ethmoid bone B. sphenoid bone C. temporal bone D. parietal bone	

2. Identification test

Directions: All structures are on cadaveric skulls.

No.	Answer	No.	Answer
1		14	
2		15	
3		16	
4		17	
5		18	
6		19	
7		20	
8		21	
9		22	
10		23	
11		24	
12		25	
13			

3. Subjective evaluation questionnaire

Direction: 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree

Evaluation to the learning material they used	
Enjoyment	①I enjoyed studying with the help of the learning material in our group very much.

	②It aroused my interests in anatomy study
Authenticity	①It present authentic and integral basal cranial features.
Learning efficiency	①It aided in memorizing.
	②It aided in spatial comprehension.
Attitude	①It's the best materials in all three groups.
Intention to use	①It should be promoted to standard basal cranial anatomy education.

ANSWERS: Test on cranial anatomy

1. Theory test

No.	1)	2)	3)	4)	5)	6)	7)	8)	9)
Answers	C	B	B	A	A	D	C	A	C
No.	10)	11)	12)	13)	14)	15)	16)	17)	18)
Answers	B	A	D	B	B	B	D	A	B

2. Identification test

1	foramina mandibulae	14	olfactory foramina
2	foramen lacerum	15	optic canal
3	lesser wing of sphenoid bone	16	inferior nasal concha
4	petrion	17	external occipital protuberance
5	foramen rotundum	18	mastoid process
6	palate bone	19	carotid canal
7	lacrimal bone	20	medial pterygoid plate
8	hypoglossal canal	21	inferior orbital fissure
9	sigmoid sinus	22	occipital condyle
10	jugular foramen	23	zygomatic bone
11	internal acoustic pore	24	mandibular fossa
12	pituitary fossa	25	vomer
13	petrosal bone		

Supplementary file 2

1. Self-reported discomforts during the learning session

	VR Skulls (N = 25)	Cadaveric skulls (N = 25)	Atlas (N = 23)	p-value
Dizziness	5	3	1	0.309
Blurred vision	1	0	0	1.000
Nausea	2*	0	1	0.528
Overall	6	3	2	0.357

***Two participants reported dizziness and nausea at the same time.**

2. Comparison between participants with discomforts and the participants without discomforts in VR group

		Participants with discomforts (N=6)	Participants without discomforts (N=19)	p
Total score [Median (IQR)]	Post-intervention test	30 (19.25-32.5)	30 (22-34)	0.726
	Difference between pre- and post-intervention test	20 (15.5-23)	17 (14-21)	0.339
Score of theory test [Median (IQR)]	Post-intervention test	15 (10.5-16)	15 (13-16)	0.747
	Difference between pre- and post-intervention test	8.5 (6-9.25)	7 (5-9)	0.460
Score of identification test [Median (IQR)]	Post-intervention test	14 (8.75-17.5)	15 (10-18)	0.725
	Difference between pre- and post-intervention test	12 (8.75-13.75)	12 (7-12)	0.579