



Categorization Format for YouTube Medical Educational Videos: An Experience with Embryology

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Abstract

Background: Users of YouTube videos face considerable difficulty in handling the rapidly growing uploaded material. Videos can fall into various genres, and a single video can possess a number of characteristics. Rationale- Customized selection of the most appropriate videos for learning, teaching or research is hard to achieve. Appropriate tagging of videos for different characteristics by the uploaders for helping audience in their selection warrant meticulously designed structured format for categorizing the videos based on multiple characteristics. But no complete structured format is available for such categorization. **Material & Methods:** A cross-sectional analysis of 120 YouTube medical educational videos on Embryology selected through a multiphase systematic method using search terms chosen from selected focus areas of Embryology was done. This was aimed at identifying video characteristics of four functional natures: basic, academic, technical and esthetic. Using the 'identified' and related 'identifiable' characteristics, a "Proposed categorization format" was developed. Feedback on this document was obtained from five stakeholder groups i.e., anatomists, medical educationists, medical video creators, film/video/graphics experts and postgraduate students of Anatomy through a multiple-group discussion session. **Results:** Consensuses built on their opinions and lone voices were incorporated to develop the "Final version" of the format that possesses 38 Broad Characteristics, 179 Options, 59 Suboptions and fourteen Sub-suboptions. **Conclusion:** This format should be helpful in establishing a comprehensive database of medical educational videos on Embryology and with slight customization, on other anatomical subdivisions and other disciplines. But before that validation of the format by putting them into use should be justified.

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INTRODUCTION

The concept of learning environment has been evolving with time, and digital (virtual) environments of different sorts are increasingly

complementing physical environments like classrooms. Videos available online represent such a vibrant virtual learning environment apart from being a source of entertainment. YouTube has become the second most visited



website in the world.^[1] YouTube users can create and upload an unlimited number of videos, and most often their videos are open access. YouTube for Press 2022, the YouTube official blog, represented YouTube by some numbers, e.g., YouTube has over 2 billion monthly logged-in users and everyday people watch over a billion hours of video and generate billions of views. Members of the next generation of medical professionals are regular viewers in YouTube as it is easily available to them. and termed as 'digital natives'.^[2] So, if an educational material is uploaded on YouTube, the viewers of this new generation can be targeted in one of their familiar domains to be viewed at their suitable times and at their own pace. Considering the familiarity of students with YouTube as well as the existing paucity of teachers in Anatomy, against the backdrop of rapid proliferation of medical colleges in Bangladesh, the use of YouTube medical educational videos may be seen as a viable complementary input into the teaching-learning of the comparatively difficult topics of medical subjects like Embryology. While browsing YouTube, users must be concerned with some video characteristics upon which searching can be improved in terms of sensitivity and specificity. However, it is difficult to identify videos that can serve individuals' academic purposes, are technically sound and are esthetically attractive at the same time unless there are appropriate tools in hand for categorizing the videos based on their different characteristics. But no comprehensive "Categorization format" exists at present that would serve the purpose of sorting the videos on Embryology or, in a broader term, those on Anatomy. The present research was aimed at developing such a document Moraes & Pereira

(2010),^[3] considered Embryology as one of the difficult branches of Anatomy in terms of perception and understanding of processes. Although books and online sources use lots of illustrations for presenting embryological processes, such illustrations themselves can be difficult and frustrating for the students to understand because of their three-dimensional complex nature and of their sequential changes with time shown in them.^[4] Videos may be used as good complementary or substitute tools to the traditional tools used in the teaching-learning of these complex processes. by identifying different characteristics of YouTube medical educational videos on Embryology that can be used to develop a Categorization format for the videos. Such a document was supposed to be highly beneficial to the stakeholders like students, teachers, medical educationists, software engineers, video creators and researchers. Students and teachers can use the format for browsing through YouTube for selecting specific types of videos they need at specific points of learning or teaching respectively. The browsing time can also be reduced by the software engineers in their way towards upgrading the 'Filter' options of YouTube The Categorization format and a database built on it, if made inherent to the YouTube video display system, would be a great help to the people who like to use the videos. YouTube video creators of the next generation can focus on all the uploaded videos of different categories, and can get ideas about how a video can be made more useful, specified and targeted. Moreover, future researchers should be able to deal with YouTube medical educational videos for various purposes by identifying different populations of videos on the basis of different approaches, contents,



techniques etc. using this Categorization format in various ways. It was also realized that although based only on Embryology videos, this document developed as an outcome of a research like this should have broader implications in the analysis and categorization of YouTube videos in general (and of videos from other sources).

MATERIAL AND METHODS

This study was done in the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh, after getting clearance from the IRB of the university. The research materials were YouTube medical educational videos on Embryology whether under the YouTube category, 'Education', or under any other YouTube category. The calculated sample size was 96. Two "Focus areas" were selected purposively from 'General Embryology' and two from 'System-based Embryology' parts of the renowned textbook, Langman's Medical Embryology. One "Topic" from each focus area [Table 1] was selected in such a way that there was a possibility of finding a large number of videos with varying video characteristics. Three "Keywords/Tags" for each topic were collected from each of three sources: two "Web-based tools" ('Google Keyword Planner' and 'Tube Buddy'), and four Anatomy teachers. Each of these keywords/tags was used to browse YouTube for videos. The keyword/tag yielding the highest number of videos was selected as the "Final search term" for each of the three sources for each topic. These three topic-specific Final search terms were used to search for YouTube videos to be analyzed. The first ten videos found by each Final search term that met

specific "Inclusion and Exclusion criteria" [Table 2] were finally selected to be analyzed. Thus, 120 YouTube videos got the final selection. Each video was intensively watched multiple times for identifying various qualitative and quantitative "Characteristics" and also for determining characteristics that can be considered identifiable in the videos not watched in the study. Additional characteristics provided by the YouTube authority along with the video, e.g., in the 'Description box', were also noted.

A "Proposed categorization format" was then formulated for categorizing each selected video based on video characteristics of four "Functional natures": 1) basic, 2) academic, 3) technical and 4) esthetic. The terms for the characteristics (including those for the Broad Characteristics, Options, Suboptions, Sub-suboptions) were selected using the understanding of the following: 1) terms used by the YouTube authority; 2) terms found in relevant literature; 3) terms used by experts or revealed through personal communications with stakeholders and 4) understanding developed by watching the videos. These terms were used in the Proposed categorization format. The format comprised 21 Broad Characteristics along with 99 Options, 21 Suboptions and six Sub-suboptions structured according to their hierarchical levels. The Broad Characteristics were placed in a logical sequence, keeping comparatively more related ones close to one another. Some of the characteristics were named by using the default terms of YouTube. An example of the basic structuring process is shown in [Figure 1]. The process started at any level, and then the other levels were looked for. [Figure 2] shows how three findings in a video led to the naming of

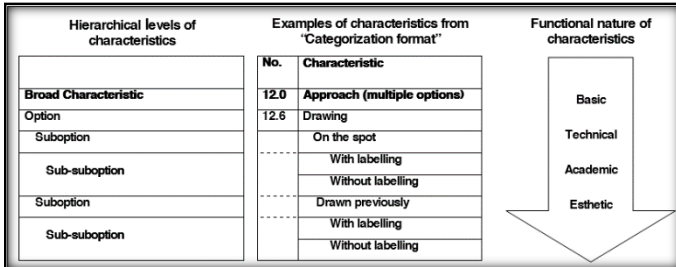


three characteristics. Apart from the named Options, Suboptions, and Sub-suboptions, 'any other' or 'none' were added where necessary.

A multiple-group discussion session was organized among five purposively selected 4-member stakeholder groups of YouTube medical educational videos: i) anatomists, ii) medical educationists, iii) medical video creators, iv) film/video/graphics experts, and v) students (residents of MS Anatomy course, BSMMU). Informed written consent was taken from each discussant. Before starting the discussion, a PowerPoint presentation was given to orient the discussants on how to scrutinize the Proposed categorization format, followed by a video presentation to show example(s) of every video characteristic used in the format. Then the format was given to each stakeholder group for scrutinizing the Broad Characteristics, Options, Suboptions and Sub-suboptions mentioned in terms of selection, organization, perceived effectiveness, and language. For this, the discussants were shown one video. Further time was provided, so that they can watch the video intensively and develop their own understanding/perception about the given video, and thereby about such videos in general. The discussants assessed the Proposed format and gave their feedback on a corresponding "Feedback format". Each group

had an "in-group" discussion on different aspects of the document and had a group presentation. Then a discussion among all five stakeholder groups was conducted on each group-presentation. This "among-the-group" discussion was recorded in an audio recorder and the important points were also noted on papers. Consensuses built through the discussion as well as the lone voices raised were utilized to develop the Final version of the categorization format. Based on the suggestions from the discussants, a total of six Broad Characteristics, 24 Options, 34 Suboptions and four Sub-suboptions were modified. Seventeen new Broad Characteristics along with their possible Options, Suboptions and Sub-suboptions were also proposed by the discussants. Incorporation of these coined newly terms in the Final version was also settled in the among-the-group discussion. [Figure 3] presents a cropped miniature sample of the Proposed format how modifications were made in it to reach the Final version. Ultimately, a total of 38 Broad Characteristics, under which 179 Options, under which 59 Suboptions and under which fourteen Sub-suboptions, giving a grand total of 287 characteristics, constituted the Final version of the categorization format [Figure 4].

RESULTS



[Figure 1] Structuring of the video characteristics at different hierarchical levels. The arrow shows the functional nature of the Characteristics being addressed through the whole process of structuring from 'Broad characteristic' to 'Sub-suboption'.

Identified characteristics in the video			
	Characteristic 1	Characteristic 2	Characteristic 3
Broad characteristic	Length of the video	Animation	Oral presentation
Option	6:20 min	Animation to show change in image	Presenter is present
Ultimate naming of the characteristics			
Broad characteristic	Duration	Animation	Oral presentation
Option	Near short	Animation to show changes in image only	Live action

[Figure 2] Examples of naming of characteristics from identifying them in a video to naming it for the Categorization format.

Proposed categorization format					Understanding after the Group discussion		Column 1 and 2 of the "Final version of the categorization format" after changes made in the "Proposed format"	
1	2	3			4		1	2
No.	Characteristic	Categorization			Comment/ Note		No.	Characteristic
		V1	V2	V3	V1	V2	V3	
11.0	Background music							23.0 File size
11.1	None							23.1 Up to 25 MB
11.2	Continuous							23.2 > 25 MB
11.3	Interrupted							24.0 Background music
								24.1 None
								24.2 Continuous
								24.3 Occasional

[Figure 3] Sample of modification of the "Proposed categorization format" and transformation into the "Final version".

Categorization format for YouTube medical educational videos													
Viewer's name		Video no.	Title of the video			Date of watching (dd / mm / yy)			Time of watching (hh:mm AM / PM)				
		V1											
		V2											
		V3											
Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.													
1	2	3	4	Categorization						Comment / Note			
				V1			V2			V3			
No.	Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	V1			V2			V3			Comment / Note		
1.0	Authority of the video channel												
1.1	Institution												
1.2	Organization												
1.3	Group												
1.4	Individual												
1.5	Any other (specify below and tick for V1/V2/V3)												
V1-													
V2-													
V3-													
2.0	Category												
2.1	Education												
2.2	Music												
2.3	People & Blogs												
2.4	Science & Technology												
2.5	Any other (specify below and tick for V1/V2/V3)												
V1-													
V2-													
V3-													
3.0	License and right ownership												
3.1	Standard YouTube License												
3.2	Creative Common- Attribution												
4.0	Privacy												
4.1	Public												
4.2	Unlisted												
4.3	Private												
4.4	Scheduled												
5.0	Time of publishing (Based on the date mentioned)												
5.1	Within 1 month												
5.2	Within 6 months												
5.3	Within 1 year												
5.4	Within 5 years												
5.5	Before 5 years												
6.0	Sequence of publishing												
6.1	New												
6.2	As part of a series												
7.0	Location												
7.1	None												
7.2	Bangladesh												
7.3	India												
7.4	Middle East												
7.5	UK												
7.6	USA												
7.7	Any other (specify below and tick for V1/V2/V3)												
V1-													
V2-													
V3-													
8.0	Monetary status												
8.1	Advertisement												
	With												
	Without												
8.2	Funding source												
	Government												
	Semi-autonomous												
	Private												
9.0	Feature in search result (multiple option)												
9.1	Video thumbnail												
	Contains the title												
	Shows the presenter												
	Gives idea about medium/materials												
	Any other (specify below and tick for V1/V2/V3)												
V1-													
V2-													
V3-													
9.2	Title												
	Search term's presence												
	None												
	Only the term												
	Under a broader term												
	With additional information												
	With technical information												
	With other information												
10.0	Presenter's identity												
10.1	Indeterminate												
10.2	Teacher/ Health Professional												
10.3	Patient/ Consultant												
10.4	Any other (specify below and tick for V1/V2/V3)												
V1-													
V2-													
V3-													
11.0	Titles, objective(s) & conclusion												
11.1	Title told/shown												
11.2	Objectives told/shown												
11.3	Conclusion told/shown												

[Figure 4] "Final version of the categorization format" for the YouTube medical educational videos.



Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1 No.	2 Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	3 Categorization			4 Comment / Note		
		V1	V1	V3	V1	V2	V3
12.0	Approach (multiple options)						
12.1	Reading Wincue/Autocue (reading from teleprompter)						
12.2	Description						
12.3	Discussion						
12.4	Demonstration						
12.5	Interviewing						
12.6	Drawing						
	On the spot						
	With labelling						
	Without labelling						
	Drawn previously						
	With labelling						
	Without labelling						
12.7	Writing by hand						
12.8	Software made visual only						
	Typed text only						
	Image only						
	Both						
12.9	Audio-visual						
	With text only						
	With image only						
	With both						
12.10	Audio only						
12.11	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
13.0	Pattern of learning session						
13.1	Session with students						
	Interactive						
	Mostly non-interactive						
13.2	Session without students						
13.3	Session with virtual students						
	Interaction through social media						
	Without interaction						
13.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
14.0	Oral presentation/ narration (multiple options)						
14.1	None						
14.2	Voice-over narration						
14.3	Live action (presence of the presenter)						
	Presenter only						
	Presenter with text only						
	Presenter with image only						
	Presenter with both						
14.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						

Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1 No.	2 Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	3 Categorization			4 Comment / Note		
		V1	V2	V3	V1	V2	V3
15.0	Medical specialty (considering the possibility that this document would be useful beyond Embryology)						
15.1	Basic (please specify the discipline)						
	V1-						
	V2-						
	V3-						
15.2	Para-clinical (please specify the discipline)						
	V1-						
	V2-						
	V3-						
15.3	Clinical (please specify the discipline)						
	V1-						
	V2-						
	V3-						
16.0	Targeted population						
16.1	Indeterminate						
16.2	Undergraduate students						
16.3	Post-graduate students						
16.4	Teachers / Facilitators						
16.5	Patients						
16.6	General people						
17.0	Educational domain and level of cognitive domain addressed (multiple options)						
17.1	Knowledge						
	Recall						
	Understanding						
	Application						
	Analysis						
	Evaluation						
	Creation						
17.2	Skill						
17.3	Attitude						
18.0	Content dealt with (multiple options)						
18.1	Gross structure (e.g., structure of a mature ovarian follicle)						
18.2	Molecular regulation (e.g., molecular regulation of lateralization)						
18.3	Event / Process (e.g., germ disc formation)						
18.4	Phenomenon (e.g., molecular regulation of lateralization)						
18.5	Procedure / Investigation (e.g., amniocentesis)						
18.6	Principle (e.g., principles of teratology)						
18.7	Mechanism (e.g., mechanism of monozygotic twin formation)						
18.8	Disease/Anomaly/Condition (e.g., formation of syndactyly)						
18.9	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						

Continued



Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1 No.	2 Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	3 Categorization			4 Comment / Note		
		V1	V2	V3	V1	V2	V3
19.0	Correlation (multiple options)						
19.1	None						
19.2	Structure-function correlation						
19.3	Gross-molecular correlation						
19.4	Correlation with time						
19.5	Clinical correlation						
19.6	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
20.0	Associated note with video (in description box)						
20.1	None						
20.2	Transcript						
20.3	Summarized description						
21.0	Language						
21.1	Bangla						
21.2	English						
21.3	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
22.0	Duration						
22.1	Short (<4 minutes)						
22.2	Near short (4-12 minutes)						
22.3	Near long (13-20 minutes)						
22.4	Long (>20 minutes)						
23.0	File size						
23.1	Up to 25 MB						
23.2	>25 MB						
24.0	Background music						
24.1	None						
24.2	Continuous						
24.3	Occasional						
25.0	Screen casting methods (multiple options)						
25.1	Video taken of a class /talk /demonstration etc.						
25.2	Filming						
	Casual						
	Semi-professional						
	Professional						
25.3	Program / Software (multiple options)						
	Screen capture program						
	Drawing program						
	Standalone program						
	Video editing software						
	Animation software						
25.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						

Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1 No.	2 Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	3 Categorization			4 Comment / Note		
		V1	V2	V3	V1	V2	V3
26.0	File format of the content of a video						
26.1	None						
26.2	pdf						
26.3	doc						
26.4	ppt						
26.5	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
27.0	Video format						
27.1	MP4						
27.2	4GP						
27.3	MPEG						
27.4	WEBM						
27.5	FLV						
27.6	AVI						
27.7	Flash video						
27.8	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
28.0	Instructional medium used (multiple options)						
28.1	None						
28.2	Traditional medium						
	Paper						
	Black board						
	Green board						
	White board						
28.3	Modern medium						
	Computer screen						
	Interactive white board						
28.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
29.0	Instructional material used (multiple options)						
29.1	None						
29.2	Living body						
29.3	Cadaver						
29.4	Prosected specimen						
29.5	Model						
29.6	Bone						
29.7	Illustration						
	Realistic illustration						
	Semi-realistic illustration						
	Diagram						
	Photograph						
	Diagnostic image						
	Conventional radiograph						
	CT scan						
	MRI scan						
	Ultrasonography & others						
29.8	Real time diagnostic image						
29.9	Histological slide						
29.10	Analogical material (e.g., to demonstrate the actions of a muscle, a stick and a rope can be used)						
29.11	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						

Continued



Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1	2	3			4		
		V1	V2	V3	V1	V2	V3
No.	Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	Categorization			Comment / Note		
30.0	Dimension of contents (multiple options)						
30.1	2D						
30.2	3D						
30.3	4D (time attached)						
31.0	Variations in shots and angle of filming						
31.1	None						
31.2	Not applicable						
31.3	Useful variation of shots						
31.4	360-degree video						
31.5	Useful variations in camera angle						
32.0	Special graphic presentation (multiple options)						
32.1	Chroma keying						
32.2	Inset						
	None						
	Narrator						
	Parts of the content						
32.3	Special effects						
32.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
33.0	Animation (multiple options) Please note that animations include only artificially produced moving images or texts. Videos of naturally moving things are not considered as animations.						
33.1	None						
33.2	Animations in transition of slides only						
33.3	Animations to show changes in images only						
33.4	Animations of texts only						
33.5	Animations of both texts and images						
34.0	Annotation (multiple options)						
34.1	Speech bubble						
34.2	Note						
34.3	Title						
34.4	Spotlight						
34.5	Label						
34.6	None						

Category of each video (V1, V2, V3 indicating the 1 st , 2 nd & 3 rd videos respectively) for each character (found in or along with the video watched) should be indicated by ticking (✓) one or more option(s), as applicable, in column 3. Comment or note may be added in column 4.							
1	2	3			4		
		V1	V2	V3	V1	V2	V3
No.	Characteristic (Broad characteristic/ Option/ Suboption/ Sub-suboption)	Categorization			Comment / Note		
35.0	Card						
35.1	Merchandise						
35.2	Fund raising						
35.3	Video						
35.4	Playlists						
35.5	Associated websites						
35.6	Fan funding						
35.7	None						
36.0	Caption (multiple options)						
36.1	None						
36.2	Subtitle						
36.3	Closed caption (sentences displayed at the bottom of the video within third bracket)						
	Autogenerated						
	Creator provided						
37.0	Video quality						
37.1	4K						
37.2	1080p						
37.3	720p						
37.4	480p						
37.5	360p						
37.6	240p						
37.7	144p						
37.8	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						
38.0	End screen						
38.1	Video						
38.2	Playlist						
38.3	Channel						
38.4	Any other (specify below and tick for V1/V2/V3)						
	V1-						
	V2-						
	V3-						

Author/ Video sharing site	Identical and non-identical naming (of categories)												Unmatched naming
	1	2	3	4	5	6	7	8	9	10	11	12	
Yang et al. (2007)	Animal	Autos & Vehicle		Entertainment	Film & TV		Music	News	People & Blog	Sports		Games	Cartoon Commercial
Cul et al. (2010)	Animals	Autos	Education	Entertainment	Film	Howto	Music	News	People	Sports	Tech	Games	Comedy Nonprofit Travel
Filipova and Hall (2011)					Film	Howto	Music	News		Sports			
Amin et al. (2019)			Education & Technology	Entertainment			Music	News		Sports			Adult Animation Documentary
YouTube	Pets & Animas	Autos & Vehicle	Education	Entertainment	Film & Animation	Howto & Style	Music	News & Politics	People & Blogs	Sports	Science & Technology	Gaming	Comedy Nonprofits & Activism Travel & Events

[Figure 5] Upper box: Comparison of the naming of the categories used by four groups of authors. The green names show identical naming and the red names show non-identical naming of similar categories among the authors. The black names do not match as categories among the authors.

Lower box: The existing categories mentioned by YouTube. These have been compared with similar categories named by the four authors. If identical with all authors dealing with a similar category, the YouTube category is shown in green. If not, it is shown in red.

Table 1: Selection of Topics on the basis of textbook contents from two parts of Embryology on four “Focus areas”

Focus area	Part of Embryology represented by the “Focus area”	Topic based on textbook contents
Basic developmental process	General Embryology	Gastrulation
Development by region	System-based Embryology	Development of limbs
Development by system	System-based Embryology	Fetal blood circulation
Clinical procedure	General Embryology	Amniocentesis

Table 2: Inclusion and exclusion criteria for the selection of videos

Videos included in the research	Videos excluded from the research
In the public domain Relevant to the search term Single video (not playlisted) Primarily based on humans Duration: <20 minutes Language: English Views: >1000	Displayed as thumbnails under the ‘Up next’ section on the right of the video originally clicked for Repeated in the search results available by using the same final search term Previously selected using another keyword

DISCUSSION

One strength of the present research was the systematic, multiphase procedure of choosing the videos by selecting the ‘search terms’ through three processes detailed in Methods. Categorization (or classification) helps us to identify different lesser entities under one

greater entity where each of them belongs. Conversely, it also helps to assort separate but similar lesser entities together as part of a greater entity. In the present research, the characteristics found to be provided along with the videos were noted and those in-built in the videos were identified. During these procedures, it was observed that some video



characteristics (e.g., 'Time of publishing', 'Associated note with video', 'Link' etc.) are already provided by the YouTube authority or video creator along with each video in the Description Box just below the video frame on the device screen. These characteristics could be noted even before playing the video. On the other hand, the presence of some characteristics (e.g., 'animation', 'voice-over', 'narration' etc.) are present in the video itself, and were identified only while watching the video. Again, some additional characteristics (e.g., 'approach', 'background music', 'cards' etc.) were also identified during watching of some videos. From such extensive noticing and identification, different characteristics were revealed. Among these characteristics, some are necessary to make the content theme understandable. Some others are necessary to make a video audio-visually enjoyable. Again, some characteristics represent necessary technical aspects. This approach has been addressed by researchers in different ways. Azer (2011),^[5] conducted a study to evaluate YouTube videos covering the field of surface anatomy. He browsed YouTube with four search terms and selected relevant video clips. He collected five types of information on each selected video: 'Title', 'Comment', 'Duration', 'Number of views' and 'Total number of days on YouTube'. Then he categorized the videos binarily into educationally 'useful' and 'non-useful' videos based on several major and minor criteria. Some of the terms used as 'information' by Azer,^[5] have been termed as 'characteristics' in the present study. There were 290 characteristics that could be thought of in the present study as 'identifiable' in YouTube medical educational videos on Embryology. These characteristics included Broad

Characteristics, Options, Suboptions and Sub-suboptions. That means, all these four are actually characteristics themselves. Using such terms was a necessity considering identification of video characteristics at different levels of experience (one under another), as exemplified in [Figure 1]. While sorting the characteristics and structuring them into a 'format' for the present research, mutual exclusiveness at the same level was meticulously maintained. These helped in getting maximum number of characteristics revealed under every Broad Characteristic. Moreover, multiple choices have been provided at the suboptional or the sub-suboptional levels of this format in some cases. Thus, a particular video can be described only as a 'short' video (indicating presence of one Option only) and another video may be described as a video of a 'Short Session without students having Voiceover narration containing Recall-based Knowledge' (indicating presence of four Options and one Suboption). The same searching pattern as of Azer (2011),^[5] was used by Muhammad et al. (2014),^[6] to determine the 'accuracy' of YouTube videos on the topic of 'seizure'. They studied the 'URL', 'number of views', 'video duration' and 'brief description' regarding each video. Information extracted by Lo et al. (2010),^[7] was on the 'URL', 'Title', 'date the video was posted on', 'number of hits', and 'number of comments'. Keelan (2007),^[8] collected information on the 'type of the video', 'clip length' and 'scientific claims made by the video'. It is obvious that about half the information/terms extracted by these authors were similar and the total number was on average five to six. By using their extracted information/terms, videos were binarily categorized as, for example, 'useful'/'non-useful', 'professional'/'amateur', 'positive'/'

'negative' for a particular topic like 'surface anatomy', 'seizure' and 'immunization'. This type of classification is very subjective and cannot be applied generally to all the medical educational videos. The present research tried to overcome this barrier, so that any medical educational video can be categorized using this extensive format by revealing its basic, technical, academic, and esthetic characteristics.

The term, 'title' had to be used both as a 'Broad Characteristic' and as an 'Option'. It has been considered as a Broad Characteristic where it is used as the Title of the video content, whereas it is considered as an Option of the Broad Characteristic named 'Feature in search result' which denotes the text provided as the identity of the video thumbnail. "Duration" was also one of the characteristics of the Categorization format of the present research for the purpose of making a category of the length of a video like 'short', 'near short', 'near long', 'long' etc. On the other hand, Azer (2011),^[5] described whether the 'time to download is reasonable' or not. Similarly, Muhammad et al. (2014),^[6] Lo et al. (2010),^[7] and Keelan (2007),^[8] used various characteristics. But their purpose was not to tag a video from an uploader's point of view or to select uploaded videos. Madden et al. (2012),^[9] designed a classification scheme based on only the 'Comments' addressing individual YouTube videos. They used 'category', 'sub-category' and 'description' as column headings. This pattern of classification showed the path for the present researchers to keep 179 characteristics as Options under the 38 Broad Characteristics. But the terms of the categories and sub-categories of Comments used by Madden et al. (2012),^[9] were not the same as those of the Broad Characteristics and Options

respectively used in the present categorization. In addition, while Madden et al (2012),^[9] put a 'description' for every subcategory, the present research used a qualitative term for every Option and used suboptional and sub-suboptional terms where needed (explained in a Selected Glossary at the end of this article).

The present Categorization format is made to be used by its user through individual decision making in choosing Options, Suboptions and Sub-suboptions. Thus, although the format is meticulously structured, some scopes of subjectivity are there. Yang et al (2007),^[10] and Cui et al (2010),^[11] on the other hand, have used digital 'Classifiers' for web video categorization. These are specifically designed software for classifying videos based on possible video features (training data set). Once the Classifier was made, the classifying decisions were made by the software rather than by the individual users. The common approach they used was as follows: 1. Video features were extracted; 2. A digital 'classifier' was built; 3. Videos were classified. Yang et al (2007),^[10] used on extraction of 'text features' but Cui et al (2010),^[11] exploited both 'visual content' and 'text features' to be considered for making their classifiers. Amin et al (2019),^[12] analyzed 'text features', 'audio features' and 'visual contents' for categorizing videos. Filipova and Hall (2011),^[13] found that all the text resources– Title, Description, Tags and Comments– were helpful for category prediction and five categories were revealed from the study of them. The categories of the videos obtained by them are shown in [Figure 5]. It may be noted that these four author groups have used the term 'Category' to denote variable numbers (5 to 15) of fields the videos



belong to, and the naming of the categories also varied [Figure 3]. Differences are also seen with those mentioned in the list of categories provided by YouTube. But it should also be realized that not all the videos used by Yang et al. and Cui et al. are YouTube videos. Che et al (2015),^[14] compared the categories of videos designed for YouTube in 2013 to those in 2007. They found that two new categories (e.g., Science & Technology and Education) were added and 2.9 percent of the total videos belonged to the category 'Education'— a newly coined term. In later years, the world has seen an exponential development of educational videos that have 'changed the way education is perceived'.^[15] Before being established as a separate category by YouTube, the term 'Education' was used as one of the categories made by Cui et al (2010),^[11] while Amin et al (2019),^[12] have used a combined term 'Education & Technology', Cui et al (2010),^[11] have used 'Education' and 'Technology' as two separate categories. The present study, on the other hand analyzed only YouTube videos and looked for medical educational contents on Embryology. Embryology is a very small segment of Medical Education, which again is a small field of 'Education'. The present researchers searched for embryological content, and most of the videos selected belong to the YouTube category, 'Education'. However, less than three percent of the selected videos were from YouTube categories, 'People & Blog' and 'Science and Technology'. Nevertheless, the videos from these two categories served the desired medical educational purposes of the present study. Thus, in the present research, the term 'Category' was used as one of the 'Broad Characteristics'.

By its structure, the present Categorization format contains a list of video characteristics including the Broad Characteristics and the Options, Suboptions and Sub-suboptions under them. This list is a virtually exhaustive account of what basic, technical, academic and esthetic functional attributes a YouTube medical educational video can possess. In the context of the scarcity of standardized terms and methods used in the available literature, the present article would possibly be able to act as a rich source of terms for categorizing YouTube medical educational videos. The multiple-group discussion conducted among five relevant stakeholder groups was designed to get feedback on the Proposed categorization format from their respective viewpoints. Through the in-group and among-the-groups discussions the format was analyzed from different functional angles: basic, technical, academic and esthetic.

The objectivity of the Categorization format has probably been increased by including a good number of individual characteristics in it separately. But the user's response can have some inherent subjectivity. For personal use and for situations where one must make quick decisions, a shorter handy working version of this document may be prepared. This may make people more interested in and more capable of using it by themselves in an effective way. Self-confidence built in this manner should pave the path for meaningful incorporation of ICT into the teaching-learning of Anatomy. Such a format can be instrumental in establishing a comprehensive database of YouTube educational videos. If good results come from using them for other subdivisions of Anatomy or for other disciplines, then one can say that



this will work for Anatomy as a whole and across disciplines. Customization may be needed for other disciplines though.

CONCLUSIONS

Although the sample size of this research seems small, it employed a thorough and systematic method for video selection and development of the video Categorization format. This is supposed to get a good representation of the video population. Moreover, relating the video characteristics with four specific functional natures has further increased representation of specific varieties of videos. For keeping the video-watching time within usual attention time, only the videos of up to 20 minutes length were selected. Whether this has affected the outcome is not certain. Only the videos in the field of Embryology were used. Inclusion of videos from other subdivisions of Anatomy and other fields of medical sciences as well could have increased and broadened the utility of the Categorization format, but using a large number of videos from the same anatomical subdivision was more likely to be more complete for one subdivision as well as able to distinguish between apparently similar characteristics. Opinions of the YouTube authority regarding this document could not be taken. Their opinions and suggestions might

have enhanced the completeness of the document. As the multiple-group discussion was conducted only once, the scope for any further correction of the Final version was not there. Although the format was subjected to a face validation through the Group discussion among five groups of stakeholders, no stronger validation technique like 'internal consistency' or 'interrater reliability' was used. Neither the format was put into use followed by analysis of its efficacy in terms of sensitivity and specificity. For ensuring expected use of this format, a short training module should be designed for making the stakeholders understand the different terms used in the format and identify specific video characteristics properly. For the use by authorities or for various work of research, the present form of the "format" may be useful in establishing a database. It is better that authorities of organizers like YouTube make substantial contribution in developing the database as well as in upgrading their 'Filter' option because this sort of categorization will be needed in every type of video in every field for sorting and easy retrieval of the videos. Mobile apps can be generated by using the database for reducing the search time to get a desirable video. However, further validation of this document by putting it into use is necessary for making it meaningful as well as keeping it dynamic with scopes for continual changes.

Selected glossary of terms used in the Categorization Format

Characteristic (with serial no. in the categorization format)	What it means
Annotations (34.0)	(Description is available in the link, https://bit.ly/3RxxNje).
Approach (12.0)	



Reading WinCue	It is the process by which the presenter looks at a series of written symbols and gets meaning from them, just what news readers do in television.
Authority of the video channel (1.0)	It is an independent public body having a YouTube channel to which the video belongs and who oversees the management of that channel and regulates the quality of that channel's output.
Card (35.0)	(Description is available in the link, https://bit.ly/3ceNjA3).
Caption (36.0)	It is used in YouTube videos for any subtitle or closed caption shown in the videos.
Dimension of contents (30.0)	
4D	When a 3D video content is shown in relation to time (4th dimension)
Educational domain and level of cognitive domain addressed (17.0)	Sood (1995)[16]
End screen (38.0)	It is a part of a video that is shown during the last 5 to 20 seconds of the video to point viewers to any other video, playlist, or channel on YouTube.
Instructional material used (29.0)	
Realistic illustration	
Semi-realistic illustration	A drawing which is drawn in a somewhat simplified way (in realistic or unrealistic colors), but maintains the structural interrelationships more or less as in reality.
Schematic Diagram	A drawing that presents anatomical features in a simpler stylized (and somewhat distorted) way that is based more on idea than on morphology.
License and right ownership (3.0)	(Description is available in the link, https://bit.ly/3aIsooF).
Oral presentation / narration (14.0)	
Voice-over	
Live action	
Privacy (4.0)	(Description is available in the link, https://bit.ly/3RvJqqO).
Screen casting method (25.0)	
Filming	
Amateur	The video is filmed in a relaxed and informal way (in a way that lacks sufficient care, thoughtfulness or formal knowledge of video making).
Professional	
Program/Software	(Description is available in the link, https://bit.ly/2J4E6XU).
Special graphic presentation (32.0)	

**Chroma keying**

It is a visual effects post-production technique for compositing (layering) two images or video streams together based on color hues (chroma range). The technique has been used heavily in many fields to remove a background from the subject of a photo or video particularly news casting, motion picture and videogame industries.

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