Unveiling a New Anatomy Mnemonics Subcategorization: An Analysis of Contents Extracted from Books, Websites, and Social Media

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ABSTRACT

Background: In the field of Anatomy, it often becomes necessary to remember any part of information by memorization, and later retrieve it. However, finding appropriate anatomical mnemonics and organizing them in a practical and universally acceptable system can be challenging for learners, teachers, and researchers. This research aimed to develop a subcategorization format for four selected categories of anatomical mnemonics according to different identified *characteristics* and to determine the frequencies of each category and subcategory.

Methods: This content analysis research was conducted in the Department of Anatomy, Bangabandhu Sheikh-Mujib Medical University (BSMMU), Dhaka, Bangladesh, from 2017 to 2018. Anatomical mnemonics were collected from various sources including books, websites, and social media. A qualitative and quantitative content analysis was used for data analysis. Each 272 extracted anatomical mnemonics was categorized according to any of the four selected mnemonic *techniques* (*Acronym*, *Acrostic*, *Rhyme*, and *Storytelling*). A subcategorization format was then devised based on seven *characteristics* considered to be identifiable in these mnemonics (*Meaningfulness*, *Meaningful relationship*, *Humor*, *Eroticism*, *Absurdity*, *Anatomical aspect dealt with*, and *Language*). Each mnemonic was then subcategorized, and the frequency of each of those *techniques* and *characteristics* was finally calculated.

Results: More than 70% of the 272 mnemonics used the *Acrostic* technique. Among the 59 identifiable options under the seven *subcategories*, 36 options were identified in the mnemonics, and the frequencies were finally reported. An eight-symbol *formula* was also devised to express the *techniques* used and the *characteristics* identifiable in individual mnemonics.

Conclusion: The findings can be used to develop a database of anatomical mnemonics, which could be useful in identifying and selecting appropriate mnemonics for teaching, learning, and research as well as attaching specific tags when adding new mnemonics to the database.

Keywords: Anatomical Mnemonics, Techniques, Methods, Characteristics, Subcategorization

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Introduction

Using 'mnemonics' or memory devices is a way of recalling information more easily with a longer retention time in the brain and retrieving it more easily later (1). The word 'mnemonic' originated from an ancient Greek word, 'mnemonikos', which was related to 'mnemosyne' or remembrance, the name of the goddess of memory (2). Modern technologies and newer integrated teaching modalities are expected to enhance anatomical knowledge retention and its clinical relevance (3). The time allotted to study Gross Anatomy in medical courses has been recently reduced (4). Proper understanding is considered the foremost technique for remembering anatomical information. However, a large amount of anatomical information still needs to be kept in one's memory in any attempt to develop clear-cut comprehension of the knowledge of anatomy in its basic and clinical domains. There is sometimes little anatomical aid available to understand such information. Moreover, information sometimes needs to be recalled instantly in clinical practice and examinations. Memorizing and integrating relevant authentic knowledge remains a challenge for physicians in training and practice because of forgetting retained basic science knowledge (5). In times of emergency, this problem becomes even more apparent and crucial. From ancient times, man has searched for various incantations, rituals, tricks, gimmicks, artifice, and methods to improve memories (6). It has been claimed that mnemonic techniques help people improve their ability to remember something by helping the brain to better encode and recall important information by associating information that is wanted to be remembered with an image, a sentence, or a word (7). The 'organizational' and 'encoding' devices are often considered as two major divisions of the mnemonic devices. Among the most used and familiar mnemonic 'techniques' are organizational mnemonics like 'Acronym', 'Acrostic', 'Rhyme', and 'Storytelling' (8).

It was the view of Bakken and Simpson that as fruitful reading material, mnemonic strategies can be applied to any type of content, but a suitable method and language must be chosen; otherwise, it will not benefit the learner (9). So, it is understandable that apart from international languages like English, in which Anatomy books are mostly written, why memory devices are in practice in different mother languages. Quite a few mnemonics in the Bangla language (the native language of Bangladesh) are also used by Bangla-speaking medical undergraduates sporadically, along with English mnemonics to memorize anatomical information. They also vary in their 'techniques' used and in different 'characteristics' identifiable in them. Any research on the use of mnemonics in Bangladesh would be incomplete without including the Bangla mnemonics in use. Qureshi et al. observed that using mnemonics led to a better understanding of the topic among students. In their research, they found the use of the 'method of loci,' a mnemonic device, more helpful in teaching-learning of the mechanism of action of insulin in diabetes mellitus than didactic lectures (10). Although many mnemonics are available in Anatomy, questions like how they fall into the general classification of mnemonics are still sketchy. No classification of anatomical mnemonics according to their 'techniques' and 'characteristics' has been in universal use. Such categorization and subcategorization are expected to provide the learners, teachers, and researchers in anatomy education a better insight into the field. Kunduru & Kandepu recognized that knowledge is a continuous spectrum but noted that it is "convenient and increasingly necessary to organize information by inferring boundaries between things" (11). This is categorization, a process in which ideas and objects can be recognized, differentiated, and understood (12). Thus, understandably, limiting redundant data, avoiding duplication, and locating and retrieving data should be consequential. The challenges of dealing with ever-increasing amounts of data have recently led to developing newer methodologies for

identifying, categorizing, and archiving data based on their reliable usage and other requirements (13). The everyday applied aspect of such categorization/ subcategorization of anatomical mnemonics is even more important in identifying and selecting appropriate mnemonics for teaching and learning specific anatomical knowledge. The present research was designed to develop a format to subcategorize anatomical mnemonics (belonging to any of the four most common categories of mnemonic 'techniques') based on different 'characteristics' identifiable in them, to 'describe' (express) each mnemonic with a newly created 'formula', and to determine the frequencies of each category and subcategory.

Methods
Study Design and Setting
This is a content analysis study with a qualitative and a quantitative part which has been carried out in the Department of Anatomy, BSMMU, Dhaka, from March 2017 to February 2018. We used the *Mnemonic Technique*, a term to denote the textual form (i.e., organizational scheme) in which an anatomical mnemonic is organized with the target of helping learners memorize one or more (a set of) anatomical information. The examples and exact definitions of this technique are shown in the supplementary file. For the present research, the 'category' of an anatomical mnemonic indicated the type of mnemonic 'technique' (already defined in literature) used to create it. On the other hand, the 'subcategory' indicated each option of any of the 'characteristics' identifiable in a mnemonic. The term "Characteristics" was used to denote any attribute/feature/property/ trait considered identifiable in any anatomical mnemonic.

Participants and Sampling
Each of the 272 mnemonics, already categorized based on the four selected known mnemonic 'techniques', was subcategorized according to the 'characteristics' identifiable in them. Seven such 'characteristics' were detected by the present researchers to be identifiable in the anatomical mnemonics: 'Meaningfulness', 'Meaningful Relationship', 'Humor', 'Eroticism', 'Absurdity', 'Anatomical aspects dealt with', and 'Language'. The different 'characteristics' with their examples are shown in the supplementary file.

Each anatomical mnemonic represented *one* 'technique' used (e.g., 'Acronym') and *one* option of each of the seven identifiable 'characteristics' (e.g., 'Sensible'). 'Formula' of a mnemonic is a *new way* of expressing the attributes of any anatomical mnemonic in terms of the mnemonic 'technique' used to create it and the 'characteristics' actually identified in it. Details are given in the supplementary file.

Data Collection
A systematic collection of anatomical mnemonics was done from different resources. All possible sources of anatomical mnemonics were considered due to their informal nature. Both printed and electronic books (14-16), and online resources such as websites (17-19) and Facebook (20) were used. Seven sources were finally chosen for sorting and analyzing the anatomical mnemonics. Among the three books chosen, 'Irving's Anatomy Mnemonics' was brought in from abroad (14). 'Mnemonics and Study Tips for Medical Students' and 'Medical Mnemonics' were available in PDF versions online (15, 16). Ultimately, a total of 472 mnemonics were collected from different sources. Sources of anatomical mnemonics and the details of the collected and analyzed mnemonics are presented in Table 1.

In browsing for mnemonics from online resources, the 'Google Keyword Planner' was used, first for searching for appropriate 'keywords' as 'search terms'. A total of 92 keywords were suggested by 'Google Keyword Planner'. Among them, seven were chosen that were found more relevant to anatomical mnemonics and to cover a broad range of them. Google Advanced Searches were made using these keywords as 'search terms'. The first few sources that seemed more

Table 1: Sources of anatomical mnemonics and the details of the collected and analyzed mnemonics.

	Type of source	Source	Anatomical mnemonics collected	Anatomical mnemonics analyzed **
1.	Printed Book	Irving's Anatomy Mnemonics (14)	150	147
2.	E-book	Mnemonics and Study Tips for Medical Students (15)	49	24
		Medical Mnemonics (16)	12	11
3.	Website	Oxford Medical Education (17)	28	6
		ValueMD Anatomy Mnemonics 1 (18)	70	20
		ValueMD Anatomy Mnemonics 2 (18)	90	24
		Wikipedia: List of Medical Mnemonics (19)	48	15
4.	Social media	Update on social network*: Facebook (20)	25	25
	Total		472	272

* Only the Bangla mnemonics were asked for on Facebook. ** To avoid repetition

relevant were opened from the search results for each 'search term', and the sources that contained a list of more than twenty anatomical mnemonics were selected. For using the Facebook source, a status was posted to 'Platform', the largest Facebook-based forum of doctors of Bangladesh, urging them to post anatomical mnemonics in the Bangla language they could remember. All the relevant responses were collected until the 'Platform' authority stopped receiving responses to the status (20).

Data Analysis
The Qualitative Part
Sorting and Categorization of Collected Mnemonics According to the 'Techniques' Used

A preliminary exploratory search for anatomical mnemonics by the present researchers revealed that the anatomical mnemonics had almost exclusively used any of the four following mnemonic 'techniques': 'Acronym', 'Acrostic', 'Rhyme', and 'Storytelling'. To make the research more specific, only the anatomical mnemonics that have used any of these four 'techniques' were selected as the mnemonics population for the present research. Thus, the selection was stratified from the beginning. Individual mnemonics were categorized and sorted based on the 'techniques' used in them. For some topics, more than one mnemonic was found. For a particular topic, not more than

one mnemonic was selected for a particular 'technique'. However, the mnemonics on the same topic that have used different 'techniques' were kept in the selection of the mnemonics population. A population of 472 mnemonics was thus found. Then, any repetition was excluded from the population. Finally, a population of 272 anatomical mnemonics was left to be analyzed. The frequency of each category (i.e., each technique) was then calculated.

Subcategorization of the Already Categorized Mnemonics

The already categorized 272 mnemonics were analyzed for defining the identifiable 59 'characteristics' they present or could have presented, Thus, 7 subcategories were defined, each having 2 to 47 options under them. Each of them was then subcategorized according to the 'characteristics' identified in them. The frequency of each subcategory (i.e., each 'characteristic') was then calculated.

Development of a 'Formula' that Describes Individual Mnemonics

The 'formula' of a mnemonic was designed to use a hyphenated expression of eight double-lettered symbols (shown in the supplementary file). Each symbol is meant for one attribute of the mnemonic. The first symbol denotes the 'technique' used in that particular mnemonic. Each of the other

seven symbols is to express one of the seven 'characteristics' identified in that mnemonic. Four options of mnemonic 'techniques' were used for the present research. For the 'characteristics', 59 identifiable options were defined. The symbol for each 'characteristic' represents two important words or two obviously pronounced letters in its name so that the symbol becomes easy to translate in terms of the characteristic. Thus, for the eight characteristics for each mnemonic, the formula contains 8×2 or 16 letters. By filling out the formula for any individual anatomical mnemonic, it can be labeled (classified) for eight attributes. This should be very helpful in tagging any mnemonic so that it can be entered into a database and retrieved easily and meaningfully if needed. In the supplementary file, you can see an example of the selections of symbols for different attributes of an individual mnemonic.

The Quantitative Part

In the quantitative part of the research, we aimed to broadly estimate the distribution of the 4 mnemonic 'techniques' and 7 'characteristics' in the relevant population of anatomical mnemonics. After collection, the quantitative content analysis was carried out, and the frequencies of each category (technique) and subcategory (characteristic) in the analyzed mnemonics were calculated. The 7 subcategories and their 59 options with symbols have been identified. It may be recalled that each option regarding any characteristic was mutually exclusive with the other options in their qualifications. For example, in the table, 'Humorous' is one option regarding the subcategory, 'Humor'. It is mutually exclusive with 'Not Humorous'. Regarding the subcategory, 'Anatomical aspects dealt with' the option, 'Boundaries', is mutually exclusive with option, 'Layers', and all the other 45 options.

Results
The Qualitative Part

For each anatomical mnemonic, the category ('technique'): 'Acronym', 'Acrostic', 'Rhyme' or 'Storytelling' was noted. Then the subcategories ('characteristics') of the mnemonic were identified. They were noted under each of the four categories. A total of 7 subcategories were identified as shown in Table 2. Under each subcategory, two 'options' were identified in the present research except for the subcategory - 'Anatomical aspects dealt with', where 47 options were identified.

The Quantitative Part
Categories (Techniques) and Their Frequencies in the Analyzed Mnemonics

Of the 272 analyzed anatomical mnemonics, more than 70% have used the 'Acrostic' technique. The frequencies of all the four 'techniques' are shown in Table 3.

Subcategories ('Characteristics') and their Frequencies in the Analyzed Mnemonics

Table 4 presents the frequencies of different 'characteristics' (options) under each 'technique' (category). In the subcategory, 'Meaningfulness', all the 'Acrostics', 'Rhymes', and 'Storytelling'- were meaningful, but all the 'Not Meaningful' mnemonics were found as 'Acronyms'. Regarding the subcategory, 'Meaningful Relationship', less than one-fifth of the analyzed anatomical mnemonics were 'Meaningfully Related' to the topics. About 80% of 'Rhymes' and all the 'Storytelling' mnemonics were 'Meaningfully Related'. In the subcategory, 'Humor', only 10% of anatomical mnemonics were 'Humorous'. All the humorous mnemonics were found to use 'Acrostics' except the one that used 'Storytelling'; while looking for the subcategory, 'Eroticism', about 10% of the analyzed anatomical mnemonics were found 'erotic' in nature. Regarding the subcategory, 'Absurdity', less than 10% of all analyzed anatomical mnemonics were 'absurd' in terms of possibility. All the four 'Storytelling' mnemonics were 'sensible', not 'absurd'. While analyzing the 'Language' used in the mnemonics, more than 90% of the mnemonics were in 'English', with only 10% being in

Table 2: Subcategorization of mnemonics identifiable based on their 'characteristics' and the options under the subcategories.

Technique / Characteristic		Option under each technique/characteristic and the specific symbol used		
Technique (Category)	An	Acronym	Rh	Rhyme
	As	Acrostic	St	Storytelling
Characteristic (Subcategory)				
1. Meaningfulness	Mn	Meaningful	Nm	Not meaningful
2. Meaningful relationship	MR	Meaningfully Related to the topic	NR	Not meaningfully Related
3. Humor	Hm	Humorous	NH	Not Humorous
4. Eroticism	Er	Erotic	NE	Not Erotic
5. Absurdity	Ab	Absurd in terms of the possibility	Ss	Sensible in terms of possibility
6. Anatomical aspects	AB	Artery- Branches	JN	Joint- Nerve supply
	AD	Artery- Distribution	LA	Lymph vessel- Areas drained
	Ar	Arrangement (gross) of structures in a location	Lc	Locations
	AS	Artery Supply of a structure/ part	LD	Lymphatic Drainage of a structure/part
	At	Attachments of muscle/fascia	Lv	Level
	Bd	Boundaries	Ly	Layers
	BF	Bone- Features	NB	Nerve/plexus- Branches
	BO	Bone- Ossification	ND	Nerve- Distribution
	CA	Clinical Anatomy	Nm	Names
	CB	Cell Biology	NR	Nerve- Roots/formation
	Cp	Composition/ components	NS	Nerve Supply of a structure/part
	Cn	Contents	Pr	Preservation
	Cs	Course/pathway	Ps	Passage
	DA	Developmental Anomalies	Pt	Parts (gross)
	DI	Diagnostic Imaging	Rn	Relations
	DS	Developmental Sources	SA	Surface Anatomy
	FA	Functional Anatomy	SE	Special Embryology
	Fm	Formation	SH	Special Histology
	Fr	Forensic aspect	Tp	Types
	GA	General Anatomy	VA	Vein- Areas drained
	GE	General Embryology	VD	Venous Drainage of a structure/part
	GH	General Histology	VT	Vein- Tributaries
	JA	Joint- Artery supply	Os	Others
	JB	Joint- Bones involved		
7. Language	Bn	Bangla	En	English

*Each double-letter set preceding each 'Option' represents the symbol assigned to the respective option (attribute) by the present researchers.

'Bangla'. Considering the subcategory, 'Anatomical aspect dealt with', not all the identifiable 47 options were found among the 272 analyzed mnemonics. Only 24 options were present. Of them, 22 options used the 'Acrostic' technique. The options identified under 'Acronym', 'Rhyme', and 'Storytelling' were 16, 3, and 5, respectively.

Table 3: Frequencies of selected 'techniques' used in the analyzed anatomical mnemonics.

Technique and the symbol used		Frequency (n=272)	
		Absolute	Percentage
Acronym	(An)	68	25%
Acrostic	(As)	196	72%
Rhyme	(Rh)	4	1.5%
Storytelling	(St)	4	1.5%

n: The total number of anatomical mnemonics analyzed was 272.

Discussion

In this study, we carried out a qualitative part initially and then analyzed the data in a quantitative part. We developed a new format for subcategorizing anatomical mnemonics, which appears to be the first of its kind. The main purpose of categorization is to classify things into a certain number of pre-defined categories, simplifying the process of sorting things. Marzano et al., in their book *"Classroom Instruction that Works",* cited several research showing that the ability to identify similarities and differences is basic to human thought (21). In their study, when items were grouped into more than one subcategory depending on specific distinguishing 'characteristics' and the groups were carefully named, these names became descriptors for the members of the particular groups, like 'Meaningful'. The group members were related to each other through the similarity of 'characteristics' (21). By relating the group members to each other, we can group our thoughts, and thus, processing information becomes easier. At the same time, this group becomes segregated from the other groups with dissimilar characteristics, like 'Not Meaningful'. Therefore, categories remain an important foundation in language for how we learn, relate, store, and recall words (22). The anatomy of the brains of world-class memory performers is not different from that of the usual population. However, the difference lies in how their brain cells are interconnected (23). In this paper, the seven 'characteristics' on which the mnemonics were suggested to be subcategorized represent different viewpoints from which any mnemonic can be selected and used for various teaching-learning requirements for

different audiences. In subcategorizing, the mnemonics already categorized (based on the techniques) were classified based on different identifiable 'characteristics'. More than one option was provided for each characteristic; thus, for the 7 'characteristics', there were 59 identifiable options (though for 6 of them, there were 2 characteristic options). For students and teachers of Anatomy, identifying and selecting mnemonics specific to the characteristic options for their learning and teaching, respectively, by using this vast resource are likely to be easier and more fruitful. Another important aspect of the present research was developing a 'formula' for 'describing' (expressing) every anatomical mnemonic. It was a new creation expected to work as a representative of the 'technique' used and 'characteristics' identified in a particular mnemonic. Thus, the 'formula' would act as a shortened version of the complete picture of the mnemonic from different perspectives. One useful specialty of the formula is that it would indicate one of the 47 very specific 'Anatomical aspects dealt with' in the mnemonic. Thus, the retrieval of the mnemonic of a specific choice from a database by learners and teachers can be made easier. Its research potential is also understandable. Therefore, it poses long-lasting implications.

While categorizing the analyzed anatomical mnemonics, it was observed that about 70% were 'Acrostic' in nature. The next most common technique was 'Acronym'. Among a population of psychology students, McCabe et al. found that most of the participants could define mnemonics and were familiar with 'Acronym' and 'Acrotic' techniques but not with other techniques like 'pegword' (24).

Table 4: Frequencies (%) of different 'characteristics' (options) under each 'technique' (category) used in the analyzed anatomical mnemonics.

Percentage of characteristics

Selected Mnemonic technique	n	Meaningfulness		Meaningful relationship		Humor		Eroticism		Absurdity		Language		The anatomical aspects					
		Mn (Meaningful)	Nm (Not meaningful)	MR (Meaningfully Related)	NR (Not meaningfully Related)	Hm (Humorous)	NH (Not Humorous)	Er (Erotic)	NE (Not Erotic)	Ab (Absurd in terms of possibility)	Ss (Sensible in terms of possibility)	Bn (Bangla)	En (English)	AB (Artery- Branches)	Ar (Arrangement of structures)	At (Attachments of muscle/fascia)	Bd (Boundaries)	CA (Clinical Anatomy)	Cp (Composition/ components)
Acronym (An)	68	94.1	5.9	4.4	95.6	-	100.0	1.5	98.5	2.9	97.1	1.5	98.5	14.8	7.4	2.9	2.9	2.9	-
Acrostic (As)	196	100.0	-	17.3	82.7	10.0	90.0	12.8	87.2	8.7	91.3	11.7	88.3	15.8	7.6	2.6	-	0.5	0.5
Rhyme (Rh)	4	100.0	-	75.0	25.0	-	100.0	25.0	75.0	25.0	75.0	25.0	75.0	25.0	-	-	-	-	-
Storytelling (St)	4	100.0	-	75.0	25.0	25.0	75.0	75.0	25.0	-	100.0	-	100.0	-	-	25.0	-	25.0	-

Percentage of characteristics

Selected Mnemonic technique	n	The anatomical aspects																	
		Cn (Contents)	Cs (Course/pathway)	DS (Developmental Sources)	FA (Functional Anatomy)	Ly (Layers)	Lc (Locations)	Lv (Level)	Nm (Names)	NB (Nerve/plexus- Branches)	ND (Nerve- Distribution)	NS (Nerve Supply of a structure/part)	Ps (Passage)	Pt (Parts (gross))	Rn (Relations)	Tp (Types)	VA (Vein- Areas drained)	VT (Vein- Tributaries)	Os (Others)
Acronym (An)	68	8.8	-	-	2.9	1.5	4.4	-	10.3	5.9	4.4	5.9	2.9	-	20.6	-	-	-	1.5
Acrostic (As)	196	4.0	2.0	0.5	2.0	-	2.5	2.5	9.2	13.8	1.0	0.5	4.6	0.5	23.0	0.5	0.5	2.0	1.5
Rhyme (Rh)	4	-	25.0	-	-	-	-	-	-	-	-	50.0	-	-	-	-	-	-	-
Storytelling (St)	4	25.0	25.0	-	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*n: the number of mnemonics for which a percentage value has been calculated. Out of the 59 identifiable characteristic options, 36 were identified in the analyzed mnemonics.

Regarding subcategories, most of the anatomical mnemonics analyzed were 'Meaningful (Mn)', 'Not meaningfully Related (NR)', 'Not Humorous (NH)', 'Not Erotic (NE)', 'Sensible in terms of possibility' (Ss)', and made in 'English (En)'.

All the analyzed mnemonics using the 'Acrostic', 'Rhyme', and 'Storytelling' techniques were 'meaningful'. The most common 'Anatomical aspect dealt with' was 'Relations'. Therefore, it can be assumed that meaningful mnemonics are more popular than those not sound meaningful. It may be noted here that three main processes characterize how mnemonics may work. The process through which information is learned is called 'encoding'. 'Semantic encoding' (what something means) is one of the four methods through which information encoding occurs (8). Thus, meaning is an important component of information encoding. Several 'Bangla'-language mnemonics were found in the present research sample, ranging from 0% to 25% among the four categories, mostly representing the 'Acrostic' technique. The question of "whether Bangla mnemonics work better than English mnemonics for the Bangla-speaking", was not addressed. However, Safi et al. worked on a Pakistani Urdu-speaking population on the issue. The participants learned faster when the mnemonics were in Urdu (25).

Points to Ponder Regarding the Relevance of Mnemonics in Anatomy

The relevance of mnemonics in learning, teaching, or applications in different situations has been debated in absolute and relative terms, but researchers have been trying to explore their potential. Jurowski et al. noted that the huge amount of information that medical students and residents must deal with might be compared to "drinking water from a fire hydrant." This learning can be facilitated by using creative memory devices, they added (26). The Advanced Trauma Life Support (ATLS) training program of the American College of Surgeons is run in more than eighty countries worldwide. It uses several mnemonics mandatorily to help remember information on what principles to follow, what to look for, and what to do in emergency trauma care. These mnemonics also help the emergency trauma team retrieve essential information from memory in stressful emergencies, especially in terms of executing tasks in their exact life-saving sequences. For example, ABCDE addresses *Airway*, *Breathing*, *Circulation*, *Disability*, and *Environment* sequentially regarding what may be lifesaving (27). Although cultivation in the field of mnemonics is not tremendously frequent, it has often been revisited from different perspectives yielding newer potentials in various medical disciplines. Summarization of elaborate surveys and multiple reviews on ten widely used memory techniques have shown that 'mnemonics' had been among the more effective ones than techniques like 'highlighting' and 'rereading' materials (28). However, it should be noted that using integrated multiple techniques rather than any single technique can only lead to better-recalling capability (29). A recent study by Tullis and Fraundorf reported that self-generated cues are effective at supporting memory, in part, because learners select cues that are tailored to their specific memory needs (30). In Anatomy, the habit of creating own mnemonics by students is a familiar picture. It is crucial to note that Sella (2019) feels that a solid foundation of lower-level learning skills, like recalling material in hand, is needed to develop a deep understanding of the material of Anatomy (31). McPherson reminds us that mnemonic techniques "do not help in understanding the meaning of facts or developing expertise in a subject" (22).

Limitations and Suggestions

Several limitations were encountered and could not be avoided in the present research. While looking for anatomical mnemonics, collecting them, and especially considering the philosophical and functional aspects of mnemonics in Anatomy, a scarcity of them was faced. No scholarly literature was available on mnemonics related directly to Anatomy.

Researchers relied solely on Facebook to collect Bangla mnemonics as no authorized resource was available in Bangladesh from which the anatomical mnemonics most used by Bangladeshi medical undergraduates or teachers could be collected. Students often tend to create their own mnemonics, especially in their mother tongue and these mnemonics often go unrecorded. Furthermore, there were plenty of repetitions of mnemonics in the resources used. In selecting the mnemonic techniques for the research, only four were studied in the present research. Others, including a strong one that is believed to have been developed more than 2000 years ago, the 'method of loci' (32), had not been examined because those four were the most common among the anatomical mnemonics.

Conclusion

In addition to categorizing an adequate sample of anatomical mnemonics population according to four of the known mnemonic 'techniques', the present research has shown a new way of subcategorizing the mnemonics that have used any of the four 'techniques' by identifying seven 'subcategories' with 59 options ('characteristics') altogether. A 'formula' for expressing every mnemonic category and subcategory has also been devised. The results also provide useful data regarding the frequencies of anatomical mnemonics based on these 'techniques' and 'characteristics'. Accordingly, the methods and the findings of the present research can contribute to the development of a database of anatomical mnemonics that should be useful in the identification and selection of appropriate mnemonics for teaching-learning and research and in attaching specific tags when adding new mnemonics to the database.

Authors' Contribution

Both the authors (NA and KMS) conceptualized and designed the study. NA performed the search for the mnemonics, collected data and analyzed them. KMS supervised the process and drafted the manuscript. Both NA and KMS contributed in writing the manuscript and providing critical revisions. NA finalized the manuscript. Both authors reviewed the manuscript and approved the final version.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Consideration

The research was approved by the Institutional Review Board (IRB) of the Bangabandhu Sheikh Mujib Medical University, with the code BSMMU/2017/9906, on 28 September 2017.

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