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Honoring donors: medical students' reflections on cadaveric dissection

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Abstract

Background Cadaveric dissection is an essential practice for medical students to understand human anatomy and internalize professional attitudes toward death, such as empathy and respect for the deceased. Previous studies have focused on emotional responses such as shock, anxiety, and fear at the start of dissection practice. However, limited research exists on students' reflective thinking and perceptions before practice. This study aims to understand premedical students' perceptions and attitudes before dissection by analyzing their reflective writing.

Methods Text network analysis of essays written in 2022 by 136 s-year premedical students before cadaveric dissection was performed. Keywords were preprocessed to extract significant themes. Centrality analysis and topic modeling were performed to analyze students' perceptions and attitudes.

Results Centrality analysis identified "cadaveric dissection," "donation," and "gratitude" as major keywords, indicating the students' deep appreciation and respect for donors. Two main topics emerged from topic modeling. The first, "gratitude and respect for donors," included keywords such as "gratitude" and "donation." The second, "growth and responsibility of doctors through medical study and practice," included keywords such as "study" and "medical school."

Conclusion The participants had profound gratitude and respect for donors before cadaveric dissection, which increased their motivation to learn. Analyzing reflective writing is an effective approach to understanding students' initial perceptions and attitudes toward cadaveric dissection; further, it can inform educational strategies that aid students in forming their professional identity.

Keywords Cadaveric dissection, Reflective writing, Text network analysis, Topic modeling, Professional identity

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Introduction

Cadaveric dissection is a fundamental practice in medical training, providing students with a comprehensive understanding of human anatomy, facilitating the internalization of attitudes toward death, and shaping their professional identity [1, 2]. It significantly influences students' emotional experiences and reflections, contributing to their sense of responsibility, understanding of their professional roles, and emotional resilience [3, 4]. However, at the beginning of dissection practice, students often experience negative emotional or physical reactions, such as shock, anxiety, fear, nausea, or dizziness; these generally become manageable over time and



students eventually perceive cadaveric dissection as a challenging yet significant task [3, 5].

Medical educators recognize the importance of acknowledging and addressing students' diverse and difficult emotional responses, in order to foster a positive learning environment during cadaveric dissection [6]. Several studies have explored students' emotional reactions to cadaveric dissection through surveys and interviews, reporting a range of emotions from initial anxiety and discomfort to eventual acceptance and appreciation for the learning opportunity [3, 7–9]. Additionally, interventions such as memorial ceremonies have been shown to foster respect, altruism, and a sense of responsibility among students [10–13]. Despite these efforts, there is a research gap with regard to utilizing students' reflective writing to examine their perceptions and attitudes toward dissection practice. Reflective writing can provide deeper insights into students' thoughts and feelings, as it allows for personal expression and introspection that may not be captured through surveys or interviews.

In medical education, reflective writing is a valuable tool that offers insights into students' emotions and thoughts as they navigate their professional development [14, 15]. Specifically, it fosters outcomes such as empathy, which can potentially reduce moral distress among healthcare providers, help manage challenging clinical situations, support healthy grieving, and enhance intimacy with patients [16–20]. This introspective process allows students to reflect on significant experiences, such as cadaveric dissection, further deepening their professional values and empathy.

In comprehensive anatomy courses, reflective writing has been employed to assess and promote critical self-reflection on professionalism [21]. According to Kissler et al. [19], providing students with opportunities for reflective writing in anatomy education offers valuable insights into their professional identity formation. Specifically, textual analysis of students' essays allows for a systematic examination of their emotions and thoughts, which are naturally expressed in writing, making it an effective tool for understanding their reflective thinking [22, 23]. These insights can significantly contribute to enhancing medical school curricula and teaching methods, ultimately supporting the formation of students' professional identities. The focus in this study is on premedical students' reflections before they begin cadaveric dissection, providing a unique perspective on their initial perceptions. The specific objectives are as follows:

- 1) To identify students' perceptions and emotional responses during dissection practice through centrality analysis.
- 2) To systematically analyze the themes and patterns of students' reflective writings using topic modeling

(latent Dirichlet allocation; LDA) to understand their evolving perceptions and attitudes during dissection practice.

- 3) To propose educational approaches to improve medical school curricula and teaching methods.

Materials and methods

Study design and context

In this study, conducted in 2022 at a medical school in South Korea, text network analysis was performed to examine reflective essays written by second-year premedical students who were about to begin full-body cadaveric dissection as part of their curriculum. Before beginning with dissection, students participated in an orientation session and a memorial ceremony to honor the donors.

Data collection

Data collection involved the writing of reflective essays by 136 s-year premedical students before the start of cadaveric dissection. A memorial ceremony was conducted to honor the donors before the initiation of cadaveric dissection. The ceremony commenced with a moment of silence, followed by a student representative reading a message expressing respect and gratitude toward the donors. Subsequently, the students personally prepared the cadavers they would use in dissection by carefully cleaning them and shaving any remaining hair. After this, the students returned to their seats to contemplate on their assigned cadavers, reflecting on the significance of the donors' contributions. As part of the ceremony, the students then composed personal memorial messages or tributes, writing essays reflecting their feelings and thoughts about the upcoming dissection. The entire process was carried out by the students, with minimal guidance, thereby allowing them to take full ownership of the ceremony and deeply engage with the experience. The essays were handwritten and participation was voluntary, with all students choosing to participate. As the focus was on the collective perceptions and attitudes of the cohort, demographic details such as age or gender were not collected.

To ensure anonymity, all the essays were de-identified. The students were given a thorough briefing prior to the study, assuring them that participation was voluntary, with the option to decline without repercussions. Nevertheless, all students elected to participate. Before collecting and analyzing the essays, informed consent was obtained from each student.

The reflective writing assignment had no bearing on students' grades and no feedback or evaluation was administered on submissions. To ensure impartiality and uphold academic integrity, the research team, including the anatomy professor, did not review the essays until the course was completed. This procedural safeguard

minimized potential bias and maintained the integrity of the academic assessment process.

Keyword selection and data preprocessing

Preprocessing involved preparing the textual data for analysis by cleaning and organizing the content. The students' essays were transcribed digitally using Microsoft Excel. The first review conducted during preprocessing used Excel's spell-check feature, followed by manually correcting typographical errors. Text network analysis using NetMiner 4.5.1.c (CYRAM Inc.) involved the automatic removal of pronouns and adverbs to extract nouns. For word extraction, 10 defined words, 19 synonyms, and 211 exclusion words were pre-registered. The defined words had two or more terms representing a single definition [24], for example, "cadaveric dissection," "Mr. or Ms.¹," and "medical school." Synonyms were terms grouped into word clusters of similar meanings and processed as a single representative term [25]. For example, "gross anatomy practice," "anatomy practice," and "dissection practice" were grouped under "cadaveric dissection." Exclusion words were terms irrelevant to the research objectives or common ones not required for interpretation, for example, "little," "today," "front," and "outside." Two professors in emergency medicine and three professors in medical education performed all word extraction and refinement processes and the entire research team confirmed the final selection.

Keyword extraction and network construction

Keyword extraction was based on the term frequency-inverse document frequency (TF-IDF), where TF represented the frequency of each word in the document [26] and IDF was calculated considering the logarithm of the inverse of document frequency [27]. TF-IDF was calculated by multiplying TF with IDF, indicating that important high-value words appeared frequently in a specific document but rarely in others [28]. A two-mode word-document network was converted into a one-mode word-word network with a minimum co-occurrence frequency of two and a window size of two based on previous text network analysis [29]. This part of the process was automated. Subsequently, the research team reviewed and validated the process to confirm that the network accurately reflected the key relationships among terms.

Network connectivity and centrality analyses

Network connectivity and centrality analyses help identify the most significant keywords and their relationships

within the text. The primary purpose of text network analysis is to extract a set of keywords representing the main literature content. The network structure is characterized by the relationships between nodes (keywords) and their connections (edges) [30]. The network size, density, average degree, and average distance at the nodal level were examined to identify the overall network characteristics. Centrality analysis consisted of evaluating the degree, betweenness, and eigenvector centralities. Degree centrality measures the number of direct connections of each keyword, indicating its prominence within the network [31]. Betweenness centrality assesses the extent to which a keyword acts as a bridge between other keywords, highlighting its role in connecting different concepts [32]. Eigenvector centrality evaluates the influence of a keyword based on its connections to other highly connected keywords [31]. Visualizing the critical words and their connections in the network using the Spring mapping framework, the top 30 words each for degree, betweenness, and eigenvector centrality were extracted.

Topic modeling

Topic modeling, a sophisticated text mining technique, views a document as an aggregation of words, comprising multiple topics with unique probability distributions [33–35]. To discern the topic keywords representing the central themes in the collection of essays, LDA, an established machine learning algorithm, was employed [33, 34]. LDA was used in this context to validate and enhance a cohesion analysis that systematically categorized the themes identified by the researchers. To ensure methodological rigor, LDA was executed using NetMiner 4.5.1.c, which facilitated a comprehensive and structured examination of the textual data.

Keywords extracted from students' essays were used to create a matrix for LDA analysis. Combinations of 3–8 topic models and iterations=1,000 were tested to determine the optimal number of topics. The best-fitted model was selected based on the coherence score (u_mass), which was used to validate and enhance the cohesion analysis, systematically categorizing the identified themes [36–38].

Results

All 136 s-year premedical students participated in the study, resulting in a 100% response rate. The collected essays constituted a comprehensive dataset for analysis, encapsulating the cohort's collective reflections and attitudes toward the impending cadaveric dissection.

Keyword analysis

Table 1 presents the major keywords identified from the participants' essays. In the TF analysis, the most

¹ The original Korean word "*seonsaengnim*," which can be translated as mister or miss, is commonly used as an honorific title to show respect and reverence, particularly when addressing professionals such as doctors or nurses.

Table 1 Top 20 keywords of TF and TF-IDF

Rank	TF		TF-IDF	
	Keywords	Frequency	Keywords	TF-IDF
1	Gratitude	300	Corpse ²	68
2	Donation	277	Body	67
3	Cadaveric dissection	270	Decision	59
4	Heart	192	Study	58
5	Doctor	138	Heart	54
6	Corpse	131	Student	49
7	Body	110	Thought	49
8	Mr. or Ms. ¹	107	Person	48
9	Study	89	Best	45
10	Thought	84	Self	44
11	Decision	80	Medical School	43
12	Deceased	79	Time	39
13	Person	75	Effort	39
14	Student	64	Memory	38
15	Medical School	63	Deceased	38
16	Self	58	Meaning	37
17	Meaning	52	Medical Student	36
18	Effort	51	Doctor	35
19	Best	50	Opportunity	35
20	Time	48	Medicine	34

TF: term frequency; TF-IDF: term frequency-inverse document frequency

frequently occurring keywords were “gratitude” (300 occurrences), “donation” (277 occurrences), and “cadaveric dissection” (270 occurrences). Among the top 20 words, the TF-IDF analysis highlighted keywords such as “corpse²,” “body,” “decision,” and “study.”

Text network analysis

Network structure

A network was constructed considering a co-occurrence frequency of two or more times and a proximity distance of within two phrases between words. The network formed under these criteria included 118 nodes and 198 links. The network's density was 0.029, average degree was 3.356, and average distance was 3.344.

Centrality analysis

Table 2 shows the top 20 keywords based on degree, betweenness, and eigenvector centrality. The keywords “cadaveric dissection,” “donation,” and “gratitude” were the most prominent in the degree centrality analysis. The betweenness centrality analysis also identified “cadaveric dissection,” “study,” and “donation” as key terms. In the eigenvector centrality analysis, “donation,” “corpse,” and “gratitude” showed high centrality. Additional keywords that appeared in the eigenvector centrality analysis included “words,” “sincerity,” “decision,” “bereaved family,”

² In this study, “corpse” is a translation of the Korean word “*sisin*,” commonly used as the object of the verb “*gijeung*” (donation), meaning “to donate.” Combined as “*sisin gijeung*,” it refers to “whole-body donation” for medical purposes. This phrase is a customary and respectful expression in Korean culture, conveying respect and gratitude toward donors.

Table 2 Top 20 keywords by centrality measure

Rank	Keywords	Degree Centrality	Keywords	Betweenness Centrality	Keywords	Eigenvector Centrality
1	Cadaveric Dissection	0.23076	Cadaveric Dissection	0.27733	Donation	0.62499
2	Donation	0.20512	Study	0.17027	Corpse	0.47534
3	Gratitude	0.17094	Donation	0.16402	Gratitude	0.41249
4	Mr. or Ms.	0.12820	Person	0.13503	Heart	0.27939
5	Study	0.11965	Body	0.12185	Body	0.20373
6	Deceased	0.10256	Gratitude	0.11097	Cadaveric Dissection	0.11561
7	Heart	0.10256	Mr. or Ms.	0.10259	Self	0.10684
8	Body	0.10256	Corpse	0.08573	Words	0.10660
9	Corpse	0.10256	Student	0.07625	Deceased	0.10085
10	Person	0.08547	Medicine	0.07417	Sincerity	0.09470
11	Thought	0.07692	Deceased	0.05780	Mr. or Ms.	0.08892
12	Student	0.07692	Medical Student	0.05071	Decision	0.08136
13	Memory	0.06837	Memory	0.04971	Bereaved Family	0.06248
14	Self	0.06837	Heart	0.04686	Thought	0.05516
15	Time	0.05982	Doctor	0.04239	Meaning	0.05100
16	Bereaved Family	0.05982	Time	0.04224	Cadaver	0.04591
17	Doctor	0.05982	Thought	0.03777	First Time	0.04421
18	Moment	0.05128	Help	0.03447	Physique	0.04119
19	Medical Student	0.05128	Medical School	0.03207	Respect	0.03888
20	Death	0.05128	Self	0.03115	Time	0.03227

meaning,” and “cadaver,” while “help,” “medical school,” “doctor,” and “medicine” were identified in the betweenness centrality analysis.

Figure 1 presents the network results of degree, betweenness, and eigenvector centrality analyses using the Spring mapping framework.

Topic modeling

The optimal number of topics was determined by examining 54 combinations of $\alpha = 0.01\text{--}0.03$, $\beta = 0.01\text{--}0.03$, topic models = 3–8, and iterations = 1,000. Applying a rigorous evaluation process, the coherence score (u_{mass}) was employed to assess and validate the optimal number of topics. The final number of topics was determined to be two, indicating the coherent and meaningful structure of the essays. After reviewing the keywords and contents of the original documents in a meeting with the entire research team, the modeling topics were named to reflect the tendencies of themes (Fig. 2).

Topic 1 accounted for 41% of the total topics and included keywords such as “gratitude,” “donation,” “thought,” “Mr. or Ms.,” “doctor,” “cadaveric dissection,” and “heart.” This topic centered on the students’ expressions of gratitude and respect toward the donors, emphasizing the personal impact of the donors’ generosity. As the focus was on emotional responses and the personal connection to the donors, the topic was named “gratitude and respect for donors.” Topic 2 accounted for 59% of the total topics and included keywords such as “cadaveric dissection,” “gratitude,” “donation,” “heart,” “doctor,” “study,” and “medical school.” While sharing some keywords with Topic 1, this topic emphasized the students’ reflections on their professional development and responsibilities as future doctors. The context of the keywords revolved around their growth and learning experiences through medical study and practice; hence, it was named “growth and responsibility of doctors through medical study and practice.” Despite overlapping keywords, the topics were distinguished by analyzing the co-occurrence patterns and thematic contexts in which the words appeared. By examining the students’ different associations of these keywords in their essays, LDA enabled the identification of distinct themes. Figure 2 represents the entire topic modeling network. Topics 1 and 2 are interconnected through keywords such as “corpse,” “doctor,” “gratitude,” “cadaveric dissection,” “body,” “heart,” and “donation.”

Essays reflecting topic modeling themes

Four essays were selected as representative examples of the two main topics identified and chosen based on their clarity, depth of reflection, and alignment with the respective themes.

Topic 1: Gratitude and respect for donors

The following essays reflect the profound impact of cadaveric dissection on medical students, capturing their deep gratitude and respect for the donors who made this critical aspect of their education possible.

Essay 1:

I wish to convey my deepest gratitude. Donating your body must have been a profoundly difficult decision, and I am sincerely grateful for your remarkable generosity. I pledge to honor your decision by dedicating myself to ensuring that it is not in vain, and by striving to contribute meaningfully to the advancement of medical science. Furthermore, I wish to express my heartfelt appreciation to your family for their invaluable support of this noble act.

Thank you once again for your selfless donation to our anatomical studies. I am committed to making the most of this invaluable experience, ensuring that every moment is used wisely and respectfully. As I pursue my path to becoming a compassionate and skilled physician, I will forever remember this extraordinary gift. May you rest in eternal peace. (Student 68)

This essay expresses profound gratitude for the donor’s selfless act, emphasizing the donor’s generosity and the writer’s commitment to honoring this gift through their dedication to medical science. It acknowledges the support of the donor’s family and pledges to use the experience respectfully and wisely.

Essay 2:

Before commencing our anatomical studies, I wish to offer a eulogy to Mr. X (the donor’s name), who graciously donated his body for our cadaver dissection practice. Your selfless donation allows us to better understand the intricacies of the human body, for which we are deeply grateful. [...]

As the days of cadaver dissection approached in my second year, I became acutely aware of the significance and gravity of this responsibility. [...]

Once again, I extend my deepest gratitude to the donor and their family, and I pray for the donor’s eternal peace. (Student 99)

This essay opens with a tribute to the donor, emphasizing their critical role in advancing medical education. It underscores the significance of the donation in understanding human anatomy, the associated responsibility,

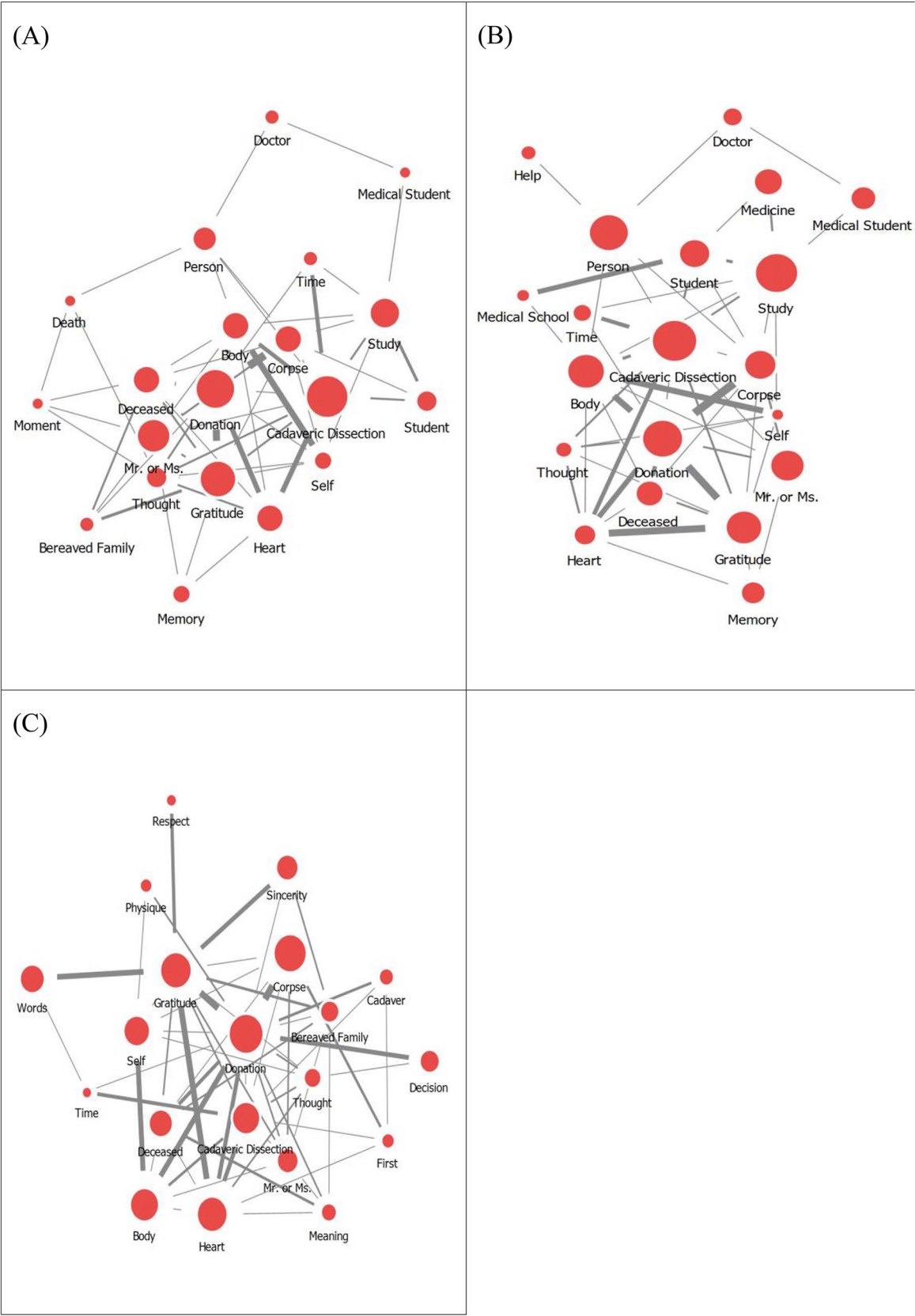


Fig. 1 Spring network mapping of centrality measures: **(A)** Degree centrality, **(B)** Betweenness centrality, **(C)** Eigenvector centrality

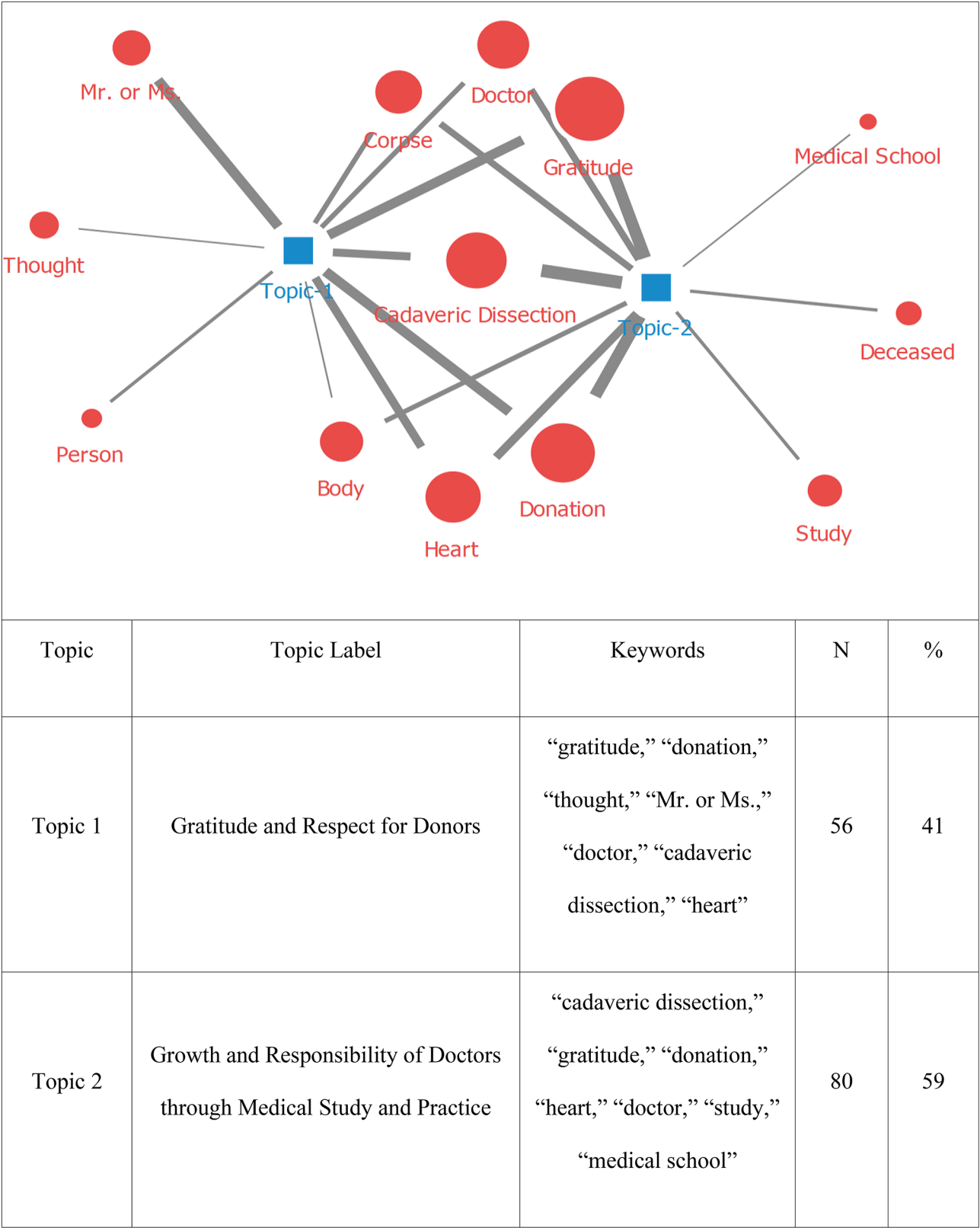


Fig. 2 Semantic keywords of topic modeling

and the writer's dedication to becoming a skilled, compassionate doctor. The essay concludes with gratitude to the donor and their family and a prayer for the donor's eternal peace.

Topic 2: growth and responsibility of doctors through medical study and practice

The following essays illustrate the essential role of anatomical studies in shaping the professionalism and compassionate practice of future doctors.

Essay 1:

I wish to extend my sincerest thanks. I am deeply honored by your decision to donate your precious body for the advancement of medical knowledge. Your magnanimous act will serve as a foundational step for us, aiding in our growth into true medical professionals. Your noble spirit will be forever remembered in the annals of medical history. [...] Through this anatomical study, we will become proficient medical practitioners capable of saving countless lives in the future. We will inherit your invaluable spirit and treat our patients with warmth and compassion. Moreover, this noble spirit will propagate and contribute to the future advancement of medicine. We pledge to carry forward this legacy and lead with positive influence. We will always remember this moment with reverence and carry it in our hearts throughout our careers. [...] (Student 132).

This essay conveys deep gratitude for the donor's selfless act, recognizing their vital role in the growth of medical students into professionals. It emphasizes the students' commitment towards becoming compassionate doctors, carrying forward the donor's noble spirit, and contributing to medical advancements.

Essay 2:

Prior to our practical studies, I would like to extend our profound gratitude to those who have donated their bodies for our learning. Thank you for sacrificing for the future of medical students. [...] We will honor your noble intention by dedicating ourselves to our studies and applying the medical knowledge we gain to future practice. [...] We all commit to contributing to the accumulation of medical knowledge and vow not to engage in any actions contrary to your intentions.

Once again, we pay our deepest respects to your noble decision. Thank you. (Student 17)

This essay expresses profound gratitude for the donors, acknowledging their significant contribution to medical education. It pledges to honor their sacrifice through dedicated study and ethical practice, ensuring their noble spirit is preserved and their contributions are not in vain.

Discussion

In this study, the aim was to examine the reflections and perceptions of medical students toward donors prior to cadaveric dissection through a text network analysis of their essays. The major findings' implications are as follows.

First, the prominence of the keywords "cadaveric dissection," "donation," and "gratitude" in degree centrality indicates that students recognized whole-body donation as a primary element of dissection practice. This result aligns with previous research indicating that students deeply appreciate the learning opportunity provided by the donors' sacrifices [39, 40]. The high ranking of "cadaveric dissection," "study," and "donation" in the betweenness centrality analysis suggests that "cadaveric dissection" and "study" are key learning elements linked through the donors' sacrifices. Although these reflections were made before the actual dissection, the students anticipated closely associating the knowledge to be gained from dissection practice with donors' sacrifices, making it a core part of their learning process. This finding is consistent with studies indicating that dissection practice increases students' awe of the human body and motivation to learn [9, 41]. "Donation," "corpse," and "gratitude" ranked highest in the eigenvector centrality analysis, indicating that these terms are strongly interconnected and associated with other highly influential terms. This result suggests that students anticipated gaining a deeper learning experience by recognizing the importance of donors in dissection practice. Further, dissection practice helps students acknowledge the donors' significance, thereby providing a deeper learning experience and establishing the donor as an influential figure in the educational process [10, 42].

Second, the two primary themes identified through topic modeling were "gratitude and respect for donors" and "growth and responsibility of doctors through medical study and practice." The students' reflective writing demonstrated a thoughtful and earnest attitude, essential for positive learning motivation. This result indicates that, even before dissection, the anticipation of the practice significantly impacted students, fostering respect and gratitude toward donors beyond mere learning [43]. Notably, the overlap in keywords between the two themes suggests that gratitude and responsibility

are closely intertwined in the students' reflections. Their appreciation for the donors' sacrifices directly influences their sense of professional duty, indicating that gratitude serves as a catalyst for developing ethical responsibility and commitment to medical practice. Recognizing this interrelation is essential for medical educators aiming to foster both emotional engagement and professional development in their curricula. Such motivation can improve educational outcomes by enhancing students' engagement and dedication to their studies, ultimately molding them into competent and compassionate doctors [44, 45]. Additionally, these themes underscore the critical role of emotional engagement in medical education. By recognizing and reflecting on the donors' sacrifices, students develop a profound sense of ethical responsibility and humanistic values, which are vital to their future medical practice [8, 39].

Anatomical practice remains a vital aspect of medical education, providing students with opportunities to develop professional attitudes and navigate complex emotional responses [46–48]. As students internalize respect and gratitude for donors through anatomical practice, they develop a professional identity as doctors and learn to empathize with patients from a humanistic perspective [49, 50]. This process is not merely about technical skill acquisition; rather, it involves a deeper transformation that prepares students for the empathetic demands of patient care. By respectfully engaging with the reality of human mortality, students can better appreciate the human condition, which is essential for acquiring a bedside manner and communication skills. This approach helps them develop ethical responsibility and empathy, confirming that dissection practice supports holistic growth as a fundamental educational method [51–53].

Reflective writing allows students to process emotional responses and contextualize experiences within the broader scope of their professional development. As a result, enhancing these positive reflections through thoughtful ceremonies and educational practices can significantly enrich students' educational experiences, fostering deeper engagement with their studies and a stronger commitment towards professional development. Therefore, incorporating structured reflective writing exercises, together with memorial ceremonies and discussions about professional identity, can enhance the educational experience. Medical schools should consider integrating these activities into their curricula to support students' emotional processing and ethical development.

This study has some limitations, which need to be acknowledged. First, the sample was limited to students from a specific medical school, which restricts the generalizability of the results. In future research, individuals from more diverse cultural backgrounds and educational systems should be considered. Second, text network

analysis can involve subjective interpretation. Although efforts were made to ensure statistical rigor and a qualitative analysis of the essay content, future research should complement the findings using different methodologies such as in-depth interviews and surveys to enhance the reliability of the interpretations. Third, this study lacks focus on long-term effects, as only students' initial perceptions and attitudes were considered. Therefore, follow-up studies need to investigate the long-term impact of dissection practice on students' professional identity and empathy, incorporating strategies such as repeated assessments to thoroughly examine these enduring effects.

Conclusion

Reflective writing significantly enhances premedical students' experiences with cadaveric dissection by fostering gratitude, respect for donors, and a sense of professional responsibility. By integrating reflective practices with dissection, medical curricula can effectively nurture the "hidden curriculum"—the implicit lessons, values, and beliefs acquired through the medical training environment. This combination promotes the development of empathy, ethical awareness, and a strong professional identity, essential for compassionate patient care. Consequently, incorporating reflective writing alongside cadaveric dissection not only improves technical skills but also cultivates well-rounded, ethically responsible medical professionals. These findings advocate for educational strategies that embrace both reflective and hands-on experiences to support the holistic growth of future physicians.

Abbreviations

LDA	Latent Dirichlet allocation
TF	Term frequency
TF-IDF	Term frequency-inverse document frequency

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Author contributions

YGK: Conceptualization; Methodology; Investigation; Data curation; Formal analysis; Writing—original draft preparation; Writing—review & editing. MN: Conceptualization; Methodology; Investigation; Formal analysis; Writing—review & editing. SHP: Writing—review & editing. MKK: Writing—review & editing. CWK: Conceptualization; Methodology; Writing—review & editing; supervision. HHY: Conceptualization; Methodology; Writing—review & editing; supervision. All authors read and approved the final manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available owing to ethical constraints but are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to Participate

The Institutional Review Board of Chung-Ang University determined that this study met the criteria for exemption from review, as it was conducted in established or commonly accepted educational settings and involved normal educational practices with minimal risk to participants (approval number: 1041078-20240610-HR-142). Written informed consent was obtained from all participating students. All methods complied with relevant guidelines and regulations, including the principles outlined in the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

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