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RESEARCH ARTICLES

The Impact of Accessibility to Images of Disease Prevention on Skin of Color in Facilitating Content Delivery by Faculty in the First- and Second-Year Curriculum

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ABSTRACT

Introduction

The representation of darker skin tones in academic medical literature is inadequate, hindering education and accurate diagnoses. Skin conditions can present differently in high versus low pigmented skin types, leading to misdiagnosis and delayed treatment if diverse images are not included in medical education. The lack of comprehensive representation directly impacts patient outcomes, perpetuating disparities in health care delivery. This inconsistency in depicting diverse skin presentations in educational resources impairs cultural competency, perpetuates stigma, and reduces patient trust. Ensuring that disease presentations are accurately represented across all skin tones is essential for improving diagnostic accuracy and equitable patient care. This study aimed to evaluate the integration and effectiveness of skin of color (SOC) resources in medical education at the University of Nevada, Reno School of Medicine (UNR Med).

Methods

A pre-post study design conducted at UNR Med evaluated the utilization of SOC resources by faculty teaching curricular blocks 1–10 between July 2022 and June 2023. Curricular blocks encompassed pre-clerkship educational modules focusing on foundational medical sciences and clinical skills. Pre- and post-surveys assessed the effectiveness of SOC resources. Faculty teaching these blocks rated their integration of disease presentations with SOC images. A SOC Medical Education Database, containing diverse dermatological images and curated teaching materials, was developed to support faculty. Statistical analyses, including Fisher's exact, Z tests, Wilcoxon rank-sum, and Kruskal-Wallis H tests, were performed using SPSS 25.0.

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Results

In the pre-survey, 41 participants were asked about SOC image usage in medical education: 53.7% reported using SOC images, while 46.3% did not, with no significant differences across curriculum levels. A critical finding was that 85% of respondents identified a gap between clinical settings and textbook resources, indicating that students are often underprepared to diagnose skin conditions in SOC patients. SOC image utility received positive ratings on a 5-point Likert scale (Year 1: 3.77, Year 2: 4.56, Combined: 4.05). Among 29 follow-up respondents, 96% agreed that SOC disease presentations enhanced student learning. Although no significant statistical differences were found across curriculum levels, 66.7% of faculty reported that the SOC Medical Education Database facilitated the integration of diverse images into their teaching.

Conclusion

This study highlights the underrepresentation of SOC images in medical education and its implications for clinical competence. The failure to incorporate diverse skin presentations in training risks perpetuating misdiagnoses and contributing to health care disparities. The SOC Medical Education Database was developed to address this gap, but its adoption by faculty remains limited. To bridge the disparity between clinical and textbook teaching, UNR Med should enhance the pre-clerkship curriculum with targeted faculty training, incentivizing database usage, and incorporating diversity-focused workshops. Ensuring that future physicians are equipped to recognize disease presentations across all skin tones is essential for equitable health care. Continued initiatives, including a freely accessible database, aim to promote diversity in medical education and foster cultural competency in future health care providers.

Introduction

Academic medical literature enriches medical students' grasp of disease identification. However, medical literature significantly underrepresents skin of color (SOC). Louie et al. conducted an analysis of 4,146 images from widely used medical textbooks and found that 74.5% of the photographs depicted patients with light skin tones, while only 4.5% were of those with darker skin tones.[1] In another study, Alvarado and Feng revealed that online resources exhibited a significantly higher prevalence of images depicting dark skin tones, accounting for 22.1% of the content, in stark contrast to the representation found in printed texts, which stood at 10.3%.[2] This deficiency in adequately representing darker skin tones hinders medical students' ability to recognize disease presentations in diverse populations.

The U.S. Census estimates that, by the year 2044, more than half of all Americans will belong to a minority group other than non-Hispanic white.[3] While the population of patients treated in the United States continues to diversify, medical school curricula have failed to keep up with the growing needs of a diverse population.[4] The absence of visual diagnostic aids creates

challenges in pattern recognition across varying skin tones when caring for patients from diverse backgrounds. This imbalance carries significant consequences demanding attention from medical practitioners, including medical students.

A deficiency in the education of medical students regarding the diverse presentation of dermatologic conditions across various skin tones creates a significant gap in medical training. Perlman et al. emphasized the ongoing lack of adequate representation of darker skin in key medical education resources such as AMBOSS, Boards and Beyond, Firecracker, First Aid, Pathoma, and the AAD Basic Dermatology Curriculum.[5] In fact, only 14.9% of the images in these resources depicted SOC. Furthermore, medical student question banks, including UWorld, AMBOSS, Kaplan, and USMLERx, are similarly lacking in diversity when testing pathology in people with SOC. Jones et al found that only 11.1% to 24.3% of images in these question banks represented SOC.[6] At our institution, dermatology is taught as a one-week block within the Musculoskeletal System course during the second year of the four-year Medical Doctor program. The pre-clerkship curriculum includes one didactic lecture and an open discussion session with a practicing dermatologist. However, like many other medical school curricula across North America, there has historically been minimal focus on dermatologic conditions in individuals with darker skin tones. The majority of images used in the pre-clerkship dermatology curriculum featured Caucasian patients.[7,8] This highlights the urgent need for more inclusive and representative visual content in dermatological training materials, reflecting the full spectrum of skin types encountered in clinical practice.

Ongoing efforts to address these inequities include the work of researchers like Jenna Lester at UCSF Dermatology, who is actively advancing the understanding of dermatological disparities in skin of color. Initiatives such as the VisualDx compilation and the American Academy of Dermatology's task force on the Skin of Color Atlas (JAAD) are making significant strides to improve representation and educational resources for clinicians. The University of Nevada, Reno School of Medicine (UNR Med) had not yet assessed the use of images on SOC within their curriculum. These authors created and implemented a data reference resource that could be used to enhance lecture material by including images on SOC, which we titled the SOC Medical Education Database. The resource was evaluated with the implementation of a survey. This survey's goal was to evaluate the teaching faculty's utilization of SOC resources while identifying improvement opportunities.

Methods

We conducted a before-and-after research study to evaluate the effects of introducing the SOC Medical Education Database on professor attitudes surrounding medical school didactic curriculum (**Figure 1**). Prior to survey

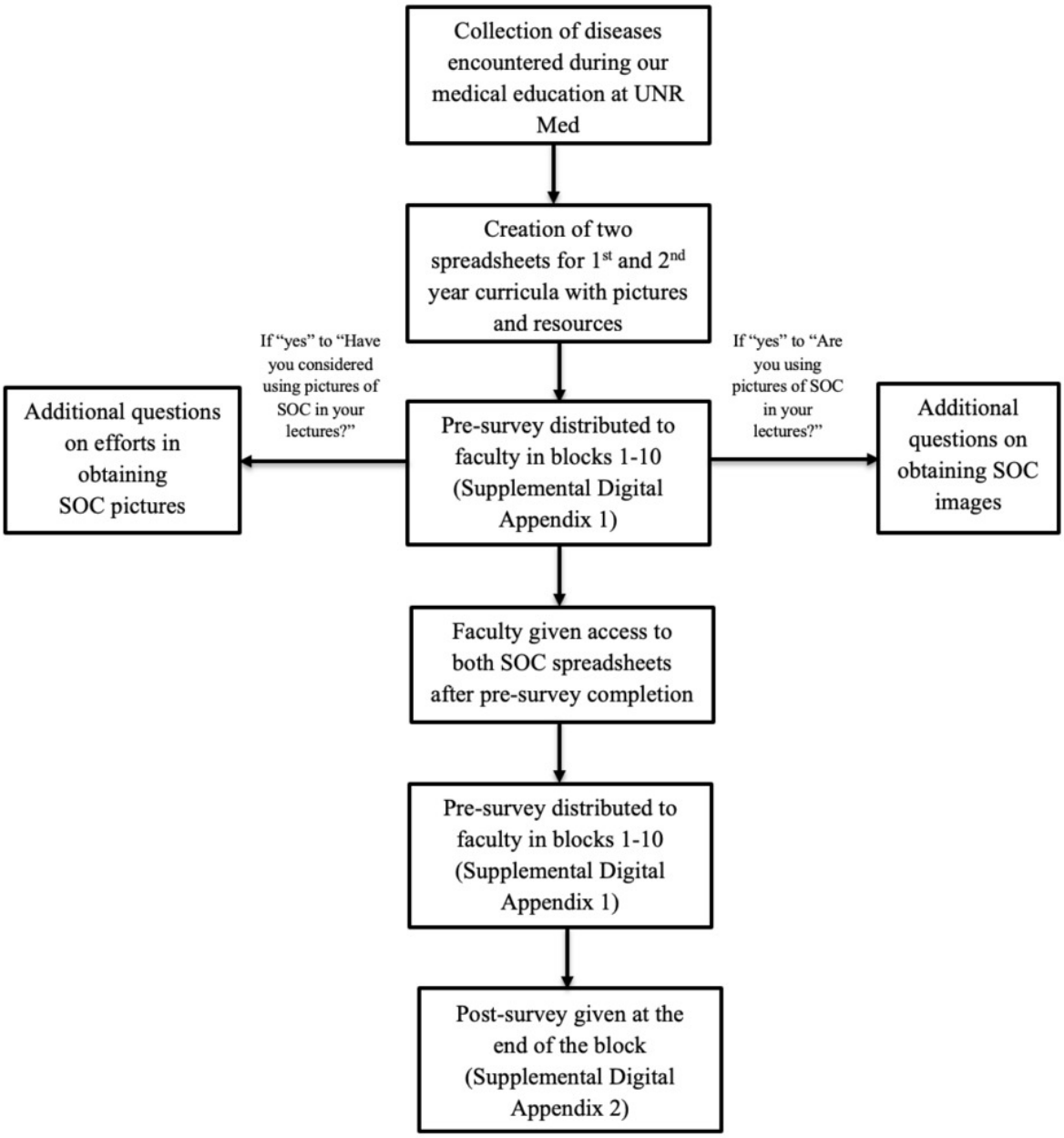

Figure 1. Sequential process involved in the creation of a Skin of Color (SOC) database and the distribution of pre- and post-surveys to University of Nevada, Reno School of Medicine (UNR Med) faculty. The process encompassed database development and survey administration.

distribution, we specified our hypotheses to assess the impact of the intervention on faculty attitudes and usage of SOC images. We hypothesized that the introduction of the SOC Medical Education Database would lead to an increase in faculty knowledge and usage of SOC resources. To assess these hypotheses, faculty responses from pre-surveys were compared to post-surveys, utilizing intra-individual paired data when possible.

The intervention of interest is the SOC Medical Education Database, which was created by compiling images from publicly available open-access medical image repositories, dermatology atlases, and licensed resources where

permitted. We sourced images of diseases encountered during medical education, with an emphasis on both SOC and lighter skin tones. The database was developed by the authors and distributed via a secure online platform accessible to UNR Med faculty.

A pre-survey (**Supplemental Appendix 1**) evaluating the skin of color resources used by teaching faculty at UNR Med was administered to faculty teaching curricular blocks one through 10 between July 2022 and June 2023. The faculty were then given access to the SOC Medical Education Database spreadsheets after completing the pre-survey. This was followed by a post-survey (**Supplemental Appendix 2**) at the conclusion of each block for the faculty involved. To increase participation in the survey, reminders were scheduled for both the pre-survey and post-survey. The block directors were also informed about the project and helped to emphasize the surveys, SOC Medical Education Database spreadsheets, and encourage participation.

Supplemental Appendix 1. Pre-Survey Questionnaire

1. Which curriculum do you teach?

   a. Year 1

   a. Year 2

   a. Both Year 1 and Year 2 2. Are you using pictures of skin of color (SOC) in your lectures?

   b. Yes/No

2. If yes, how have you obtained pictures on SOC for your lectures?

   a. Own patients, web, other

   b. Does that source provide examples of disease presentation on SOC?

   i. Yes/No

3. How difficult is it for you to obtain disease presentation pictures on SOC?

   a. Scale of 1-5 4. If no, have you considered using pictures of skin of color (SOC) in your lectures?

   b. Yes/No

   i. If yes, have you tried to obtain pictures on SOC for your lectures?

1. Yes/No

ii. If yes, what have you tried?

1. Book, web, own patients, other

4. If you have not considered using SOC pictures, why not?

   a. Open answer

5. Do you think there is a gap in the presentations students see today in the clinical setting versus what is taught in medical textbooks?

   a. Yes/No

6. Do you think including pictures on SOC would add educational value for medical students?

   a. Yes/ No

7. On a scale of 1-5, how much value do you think adding pictures on SOC can have for medical students?

8. Is there any additional information you would like to provide?

   a. Open answer

Supplemental Appendix 2. Post Survey Questionnaire

1. Which curriculum do you teach?

   a. Year 1

   b. Year 2

   c. Both Year 1 and Year 2 2. Did you use the Skin of Color (SOC) Medical Education Database in preparing your lectures?

   d. Yes/No

2. If yes, on a scale of 1-5, how useful was the SOC Medical Education Database in preparing your lectures?

3. If yes to 2, on a scale of 1-5, how much benefit do you think medical students gained from having access to the SOC Medical Education Database?

4. If yes to 2, did the SOC Medical Education Database help you incorporate more skin presentations in your lectures?

a. Yes/No

5. If yes to 2, do you feel that this was a successful way to incorporate SOC disease presentations into medical education?

   a. Yes/ No

6. If yes to 2, were there errors in the database?

   a. Yes/No

      i. If yes, did it prevent you from using the database for lecture material?

         1. Yes/ No

7. If yes to 2, What are your suggestions for improving the database?

   a. Open answer

8. If no to 2, what was your reason for not utilizing the SOC medical education database?

   a. Open answer

9. Do you think medical students benefit from having access to disease presentations on SOC in lecture?

   a. Yes/ No

10. Is there any additional information you would like to provide?

    a. Open answer

The inclusion criteria involved professors at UNR Med (clinical and non-clinical) who gave lectures to students during the didactic curriculum. Instructors were recruited through email invitations, which emphasized the importance of their participation for improving SOC representation in medical education. All responses to the surveys were recorded in our results without exclusion of those who did not complete the surveys. Survey responses from instructors who did not use the SOC database were still considered valuable, as they provided insight into barriers to incorporating clinical photos in teaching materials. This study design was reviewed by the Western Institutional Review Board (IRB) and was deemed to be exempt from a full IRB review.

In our analysis, we compared three groups of instructors: those who taught Year 1, those who taught Year 2, and those who taught both years. The rationale for this comparison was to determine if there were differences in the use of the SOC database based on the year of curriculum taught. We hypothesized that instructors teaching Year 1 students may have different needs or perspectives on SOC images than those teaching Year 2 students. Additionally, demographic factors (e.g., medical subject, personal background) could influence how faculty incorporate SOC content into their teaching.

To measure the impact of the intervention, we used a Likert-type scale to assess subjective attitudes and knowledge. The 1-5 scale ranged from strongly disagree (1) to strongly agree (5). We acknowledge the limitations of using subjective data and potential biases introduced by leading questions. Numerical values alongside p-values are reported in the text to reflect the tables. The p-value columns also include the statistical test used for each comparison (e.g., Fisher's exact test, Z tests, Kruskal-Wallis H tests).

Nominal variables were described in the form of frequency and percentage. All continuous data were tested for normal distribution. Ordinal variables were described in the form of mean and standard deviation if normally distributed; otherwise, median and interquartile range (IQR) were used. Fisher's exact tests were used to compare nominal variables between groups. Z tests were used for pairwise comparisons. Kruskal-Wallis H tests were used to compare ordinal variables between three groups. The significance level was set at 0.05. The statistical software is SPSS 25.0.

The survey questions primarily focused on subjective faculty perceptions of SOC representation in medical education. While this provided valuable qualitative insights, future studies could benefit from re-developed questions incorporating objective measures to assess engagement with SOC materials and their impact on student learning outcomes.

Results

Pre-Survey

The pre-survey included a total of 41 participants. Instructors self-reported the curriculum they participated in including year one, year two, or both year one and year two (**Pre-Survey, Table 1**). Participants were also asked about their use of SOC in lecture, perceived gaps in student medical textbooks, and educational value of pictures on SOC (**Pre-Survey, Table 1**). Analysis of SOC image usage, gaps in medical student education, and the perceived value of incorporating pictures on SOC for medical education were evaluated with a breakdown based on the curricular year taught (**Pre-Survey, Table 2**). The comparison of picture usage between the curriculum levels did not reveal a statistically significant difference ($p = 0.284$). The comparison between the curriculum levels regarding the perceived gap in skin presentations that

Pre-Survey, Table 1. Pre-survey results on curriculum, inclusion of skin of color images, and perceived educational value. This illustrates the responses from a pre-survey conducted among 41 participants regarding the curriculum they teach, the usage of skin of color (SOC) images, and their perspectives on the educational impact of such images for medical students.

Which curriculum do you teach?	
Year 1	13 (31.7%)
Year 2	9 (22%)
Both Year 1 and Year 2	19 (46.3%)
Are you using pictures of skin of color (SOC) in your lectures?	
Yes	22 (53.7%)
No	19 (46.3%)
Do you think there is a gap in the skin presentations students see today in the clinical setting versus what is taught in medical textbooks?	
Yes	34 (85%)
No	6 (15%)
Do you think including pictures on SOC would add educational value for medical students?	
Yes	40 (97.6%)
No	1 (2.4%)
On a scale of 1-5, how much value do you think adding pictures on SOC can have for medical students?	4.07±0.755

students see in the clinical setting versus what is taught in textbooks showed a statistically significant difference detected between "year two" and "both year one and year two" (p=0.029). A scale of one to five, where higher values indicate greater perceived value, was used to rate the value of adding pictures on SOC and the comparison between the curriculum levels did not reach statistical significance (p = 0.051). Subsequently, participants were asked to express their opinions on the value of adding pictures on SOC for medical students, on the same one-to-five scale. A statistically significant difference was not detected between the "year two" curriculum and the "both year one and year two" curriculum in this regard (p=0.051).The groups were further analyzed to compare the answers the instructors provided about their usage of SOC in their lectures, with their opinion regarding whether there was a gap in the skin presentations seen in the clinical setting versus in the medical textbooks (**Pre-Survey, Table 3)**. There was no statistically significant difference between curricular years (p=0.673). Also analyzed were the answers the instructors provided about their usage of SOC in their lectures to their answer about their assigned value of adding SOC images for medical students. The difference in mean value ratings between the two groups was statistically significant (p = 0.025).

In the subset of 22 participants (n=22) who responded "yes" to using pictures of SOC in their lectures, data was collected on how they obtained pictures of SOC, whether that source provided examples of disease presentations on SOC, and the perceived difficulty of obtaining disease presentations on SOC

Pre-Survey, Table 2. Analysis of SOC image usage, perceived gap in skin presentations, and value rating by curriculum year. This presents an analysis of data related to the usage of skin of color (SOC) images in lectures, perceptions of a gap in skin presentations, and value ratings provided by participants from different curriculum years as denoted by the pre-survey.

	Year 1	Year 2	Both Year 1 and Year 2	P value
Are you using pictures of skin of color (SOC) in your lectures?				0.284
Yes	6 (46.2%)	7 (77.8%)	9 (47.4%)	
No	7 (53.8%)	2 (22.2%)	10 (52.6%)	
Do you think there is a gap in the skin presentations students see today in the clinical setting versus what is taught in medical textbooks?				0.029
Yes	10 (76.9%)	6 (66.7%)	18 (100%)	
No	3 (23.1%)	3 (33.3%)	0	
On a scale of 1-5, how much value do you think adding pictures on SOC can have for medical students?	3.77±0.725	4.56±0.726	4.05±0.705	0.051

Pre-Survey, Table 3. Relationship between SOC image usage, perceived gap in skin presentations, and value rating. This illustrates the interplay between the usage of skin of color (SOC) images in lectures, perceptions of a gap in skin presentations, and value ratings attributed to the inclusion of SOC images for medical students as noted by the pre-survey (n=41).

	Are you using pictures of skin of color (SOC) in your lectures?		
	Yes	No	P value
Do you think there is a gap in the skin presentations students see today in the clinical setting versus what is taught in medical textbooks?			0.673
Yes	18 (81.8%)	16 (88.9%)	
No	4 (18.2%)	2 (11.1%)	
On a scale of 1-5, how much value do you think adding pictures on SOC can have for medical students?	4.32±0.153	3.79±0.713	0.025

(**Supplemental Digital Appendix Table 1**). For the subset of participants who answered "yes" to considering the use of SOC images in their lectures (n=6), they were asked if they tried to obtain pictures on SOC and what they had tried including textbooks and the internet (**Supplemental Digital Appendix Table 2**). Of those who reported not considering using disease presentations on skin of color, 100% (n=10) indicated it was because the curriculum they teach does not involve skin presentations.

Post-Survey

In the post-survey, a total of 29 participants responded and they were asked what curriculum they participate in, whether they used the SOC database, and the perceived benefit of medical students having access to disease presentations on SOC (**Post-Survey, Table 4**). While seven instructors reported using the SOC medical education database, six completed the feedback portion of the survey. The SOC Medical Education Database was

Post-Survey, Table 4. Post-survey results on curriculum, usage of the SOC medical education database, and perceived benefits for medical students. This presents the outcomes of a post-survey conducted among 29 participants, focusing on the curriculum they teach, their usage of the SOC medical education database, and their perceptions regarding the benefits of disease presentations on SOC for medical students.

Which curriculum do you teach?	
Year 1	6 (20.7%)
Year 2	10 (34.5%)
Both Year 1 and Year 2	13 (44.8%)
Did you use the Skin of Color (SOC) Medical Education Database in preparing your lectures?	
Yes	7 (24.1%)
No	22 (75.9%)
Do you think medical students benefit from having access to disease presentations on SOC in lecture?	
Yes	24 (96%)
No	1 (4%)

Post-Survey, Table 5. SOC image usage across curriculum years as reported from the post survey including 29 participants. This figure illustrates the distribution of skin of color (SOC) image usage in lectures among different curriculum years, accompanied by the associated p value.

	Year 1	Year 2	Both Year 1 and Year 2	P value
Are you using pictures of skin of color (SOC) in your lectures?				0.621
Yes	2 (33.3%)	3 (30%)	2 (15.4%)	
No	4 (66.7%)	7 (70%)	11 (84.6%)	

reported to have helped 66.7% (n=4) of participants who used it to incorporate more skin presentations in their lectures and inspired instructors to seek out more diverse pictures for their lectures (**Supplemental Digital Appendix Table 3**). No significant differences were found in SOC image usage between curriculum levels (**Post-Survey, Table 5**). When asked why they did not use the database, 16 instructors reported not using SOC images in their lectures, while six did not have access or were unaware of the resource.

Discussion

A significant gap exists between what students learn during the didactic years and what they encounter in clinical practice, especially when it comes to SOC presentations.[2,9,10] Several institutions have taken steps to address this issue. For example, Mayo Clinic Alix School of Medicine launched a curriculum review led by their Diversity, Equity, and Inclusion Curriculum Review Committee. This process aimed to improve SOC representation in preclinical education by identifying areas where SOC images were lacking and recommending updates to lectures and resources.[11] Similarly, Loyola University Chicago Stritch School of Medicine collaborated with the White Coats for Black Lives organization to compile resources and secure funding

for SOC research, advocating for the inclusion of diverse skin tones in their dermatology curriculum.[12] These initiatives highlight the importance of curricular changes and the role of online resources in facilitating these updates.[7] However, few institutions have fully implemented targeted changes. Our study sought to assess faculty attitudes toward using SOC images and introduce a resource to address this gap at UNR Med. Similar studies have shown that institutions that made these changes have seen positive outcomes, including improved diagnostic skills among students exposed to a broader range of skin presentations.[12,13] Our study confirms this gap, as the majority of faculty in both pre- and post-surveys acknowledged it.

The pre-survey indicated that faculty across all curricular years recognized the benefit of incorporating SOC images into the curriculum. Faculty in the second year who teach pathology expressed a particularly high value for including these images, likely due to the prevalence of dermatologic diseases in their curriculum. Additionally, faculty already using SOC images rated their inclusion more highly, highlighting the importance of aligning the curriculum with real-world disease presentations to enhance clinical competence.[14]

However, our study had some limitations. The low participation rate in using the SOC database, with only six out of 29 post-survey respondents completing the full survey, limited our ability to assess the full impact of the database. Additionally, the discrepancy between the pre-survey (41 respondents) and post-survey (29 respondents) responses may have hindered our ability to detect significant differences. Many faculty members reported not using the database due to the absence of skin disease content in their curriculum (e.g., molecular biology, psychiatry), which reduced the resource's reach.

Moving forward, we plan to focus on faculty teaching dermatologic conditions to better assess the utility of the resource and guide the further development of the online database. Collaboration with other institutions actively working on similar initiatives could provide valuable insights into the impact of these changes and help refine best practices for curriculum integration.

Our study also underscores the effectiveness of online resources, which, due to their dynamic nature and greater representation of SOC diseases, have been shown to be more effective than traditional textbooks.[4] Most faculty reported obtaining SOC images from online sources, suggesting that an online resource could facilitate curricular changes.

The post-survey revealed that faculty who used the SOC Medical Education Database found it helpful in incorporating more SOC disease presentations and were motivated to seek additional images. This highlights the importance of introducing such resources to encourage medical educators to integrate

more diverse images into the curriculum.[12,13] Qualitative feedback from instructors also revealed that some had never considered including SOC disease presentations before this project, emphasizing the importance of elevating this conversation both institutionally and nationally.

Conclusion

Medical school resources still lack diversity when it comes to photographic illustrations of pathology on SOC. Our study is the first at UNR Med to create a searchable database to improve accessibility to images of disease presentations on SOC. Survey results showed a clear consensus among UNR Med faculty, with the majority agreeing that a disparity exists between the skin presentations students encounter in the clinical setting compared to what is taught in medical textbooks. Curricular interventions should aim to bridge the gap in pre-clerkship curriculum at UNR Med, with an emphasis on diverse populations. Unfortunately, despite the need for increased inclusivity, the majority of UNR Med faculty did not utilize the SOC Medical Education Database this year in preparing their lectures. It is important to note that this database is part of an ongoing program to improve our curriculum, and we remain hopeful that our efforts will encourage faculty to integrate this valuable resource into their lectures.

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