



Journal of Regional Medical Campuses

Mapping Student-Generated Learning Objectives Against USMLE Core Content

L. Mica Yoder; Michael Flanagan, MD; Britta Thompson, MS, PhD; Mark Stephens, MD

DOI: <https://doi.org/10.24926/jrnc.v7i2.5703>

Journal of Regional Medical Campuses, Vol. 7, Issue 2 (2024)

z.umn.edu/JRMC

All work in JRMC is licensed under CC BY-NC



Mapping Student-Generated Learning Objectives Against USMLE Core Content

L. Mica Yoder; Michael Flanagan, MD; Britta Thompson, MS, PhD; Mark Stephens, MD

Abstract

Purpose:

To compare the content covered by student-generated, case-based, learning objectives with United States Medical Licensing Exams (USMLE) core-content guidelines, both in terms of range of topics covered and time spent with different topics. Secondly, to examine the impact of remote learning during the COVID-19 pandemic on the content covered by student generated learning objectives (SGLOs).

Methods:

The data used in this study was drawn from university records of SGLOs over the course of five years, including approximately 1,600 individual SGLOs, organized by semester and year. SGLOs were coded to correspond to topics on the USMLE core content guidelines. Two lists of core content provided by the USMLE were used in this study. The first consisted of 18 broad topics and 222 nesting subtopics tested on STEP 1. The second consisted of 11 broad topics with a corresponding percent range of how many questions on STEP 1 address that topic.

Findings:

Percent Coverage: 50-60% of USMLE core content topics are covered within the first year. Multiple regression analysis showed this number remaining consistent between first year classes, between semesters, and during COVID.

Topic Weight: 7 out of 11 broad topics fell within the same ranges of the USMLE, with Social Sciences being the greatest outlier (significantly more coverage). 2 out of 11 topics were addressed less by SGLOs than by the USMLE.

Gaps: 53 individual USMLE core content sub-topics were not addressed by a University Park (UPC) program first year class in any learning objective. Notable trends in the identified content gaps included topics relating to congenital disorders, embryonic development, male and female reproductive systems, endocrine disorders (other than thyroid disorders and diabetes), normal aging and age-related changes, psychiatric disorders and behavioral health, and drug adverse effects.

Conclusions:

SGLOs covered consistent amounts of material from year to year, suggesting curricular stability over time. The same standard of SGLO creation was also maintained during COVID 19 remote learning activities. The agreement in weighting of topics between our student-driven curriculum and the USMLE core content indicate that students prioritize topics effectively. Identified gaps in coverage represent areas for improvement. This study further supports successful collaborations between faculty and medical students in regards to curriculum development and execution.

Conflicts of Interest: None.

This study (Study ID: STUDY00015600) was deemed exempt by the Institutional Review Board (IRB) at the Penn State College of Medicine.

L. Mica Yoder; Penn State College of Medicine University Park Campus, State College PA, USA

Michael Flanagan, MD; Penn State College of Medicine University Park Campus, State College PA, USA

Britta Thompson, MS, PhD; Penn State College of Medicine, Hershey PA, USA

Mark Stephens, MD Penn State College of Medicine University Park Campus, State College PA, USA

Corresponding author: L. Mica Yoder (lyoder2@pennstatehealth.psu.edu), Dr. Mark Stephens (mstephens3@pennstatehealth.psu.edu)



Introduction

Learning objectives (LOs) are used to set educational goals and direct learning (Mager, 1998; Neville, 2009). Traditionally, faculty develop topical LOs to guide student learning. Recently however, the use of student-generated learning objectives (SGLOs) has been shown to be an equally effective model for medical education (Laux et al, 2021).

The University Park Regional Medical Campus (UPC) of the Penn State College of Medicine was organized in 2012. It is located at a community-based rural, medical center 100 miles from the tertiary academic medical center in Hershey, Pennsylvania.

After an initial period as a 2-year clinical clerkship campus, the program was expanded to incorporate all 4 years of medical education in 2017. The UPC program accepts twelve students per year, maintaining the total at 48 learners to match local educational resources. UPC uses SGLO to cover core content and promote retention of knowledge (Thistlethwaite et al, 2012; UPC Key Principals 2021). Continued analysis of measures, such as board scores, match data, Alpha Omega Alpha selection, and exam pass rates are monitored to ensure comparability between UPC and the main medical campus at Hershey. While comparability has consistently demonstrated between campuses, tracking of the correlation between SGLO and USMLE content has not been investigated previously.

Using the principles of design thinking, in 2016 a collaborative community of faculty and students set to co-create an immersive, experiential learning community. Five Student Design Partners (SDP) from the 2016 class were selected to participate in a one-year paid program to co-create the curriculum. Over the year, the SDP prototyped multiple curricular activities, leading to a unique curricular structure whereby first-year students are immersed in local primary care clinics several times a week. From this, "Inquiry Group (IQ)" sessions are developed from actual cases the students had seen in the clinic the week prior. During the IQ groups, students generate their own learning objectives to explore each of Penn State College of Medicine's four curricular pillars: Foundational Science; Clinical Science; Health Humanities and Health Systems Science. These

student-generated learning objectives (SGLO) serve as the foundation for learning in the UPC program.

The curriculum at UPC transitions to clinical training clerkships in the second year, then returns to the classroom in third year in preparation for boards. Third year learning is more didactic, including a combination of lectures from faculty and fourth year students and small group study sessions leading up to approximately eight weeks of dedicated study before students sit for STEP 1. Third year represents an opportunity to review content covered in first year and to supplement topics which were not fully covered by SGLOs.

This study focuses exclusively on the SGLO generated by five classes of medical students during their first year at the UPC program.

Initial data (analyzed after the program's first year of existence), showed SGLO to be equivalent (if not superior) to faculty-generated learning objectives (FGLO) (Laux et al, 2021). What is less clear, however, is to what degree the UPC model addresses USMLE core content. One goal of this study was to examine the extent to which SGLO in our immersive first-year curriculum covers USMLE core content. A secondary goal was to analyze what impact, if any, different classes, different semesters, and COVID-19 remote learning had on coverage of core content at the UPC.

Methodology

University Park Curriculum

The first year curriculum at the UPC is structured around case-based student-generated learning objectives, supplemented by a weekly didactic lecture on basic science. First year medical students meet in small groups every Monday to present cases they have seen in clinic. During the two semesters which took place during the height of the COVID-19 pandemic (Spring of 2020 and Fall of 2021), however, learning was exclusively remote. For this period of time, problem-based learning (PBL) paper cases were assigned by faculty. The process of SGLO creation, however, remained the same throughout.

Two cases per week are used to construct SGLO. Students collaboratively create four LOs per case, one in each of the broad categories of foundational

science, clinical science, health systems, and health humanities. This results in roughly eight SGLO per week. In practice, students often create more than one LO per category, or create multi-level LOs. For the sake of consistency in coding, bullet-pointed or multi-part LOs were treated as a single unit.

Data Acquisition

From the outset, UPC has maintained a relational database to longitudinally track SGLO. For the present study, the database included approximately 1,600 individual learning objectives over the course of five years (2017-2022). The database is organized by class year and academic semester (e.g., first semester—fall of the first year of medical school; second semester—spring of the first year of medical school).

Analysis

The SGLO database was independently coded by the principle investigator (LMY) using NVivo™ software. For the first round of coding, each SGLO was mapped to a corresponding USMLE core content topic. The results of this initial pass categorized learning objectives into 18 broad topics and 222 sub-topics covered on the USMLE (www.usmle.org/sites/default/files/2021-08/USMLE_Content_Outline.pdf).

Topics are nested by the USMLE. As an example, a learning objective coded to the subcategory “Hyperlipidemia” would also automatically be coded under the broader topic of “Cardiovascular Disease.” Many SGLO covered multiple topics. In these instances, these LO would (by necessity) be coded multiple times. After this coding process was completed the end-result was approximately 1600 student-generated LOs yielding 4170 individual codes.

Differences between the organization of the USMLE’s list of topics and SGLOs were identified early in the coding process and decisions about coding remained consistent throughout the process. The most significant of these differences related to the categorization of drug adverse effects, and is discussed in greater detail in the results section.

Once SGLO were categorized against USMLE core content, they were compared to a second, broader list provided by the USMLE consisting of 11 topic

categories, this time with associated percentages (<https://www.usmle.org/prepare-your-exam/step-1-materials/step-1-content-outline-and-specifications>). This second list represents the weight a particular organ system or topic is given on the USMLE Step 1 exam in terms of the percentage of questions addressing a particular topic. All coding decisions were reviewed in biweekly meetings between the principle investigator (LMY) and faculty advisor (MBS). Changes to categorization strategies were discussed, agreed upon and recorded to ensure internal consistency.

Once coded, SGLO were broadly compared by academic year and semester. Additionally, SGLO were examined as a whole to see the percentage of USMLE content covered and also what percentage of learning objectives were dedicated to individual organ systems. Gaps (sub-topics with no corresponding LO in five years) were identified. On aggregate, data were examined for trends in content coverage over time, across different classes, between remote learning and in-person, between semesters and between academic years. Multiple regression analysis was performed (LibreOffice™) to identify trends over time.

Results

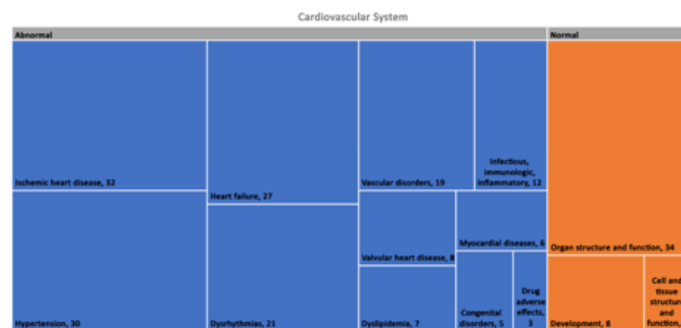


FIGURE 1: A visual representation of 1 broad topic (Cardiovascular System) with nested subtopics, and the total number of LOs that were coded into each topic from all five classes.

Representative SGLO: “Compare and contrast two fundamental causes of edema (heart failure vs. nephrotic syndrome), illustrating the pathophysiology and clinical presentation of each.” This LO would be coded to the subcategory “heart failure,” a subcategory which falls under the broader categories of “abnormal

cardiovascular” and “cardiovascular system.” This topic equally addresses Nephrotic syndrome, so it was also coded as “infectious, immunologic, and inflammatory disorders of the renal system,” which falls under “abnormal renal,” and “renal and urinary system.” Broadly, the LO asks students to learn about causes of edema, so it was also coded to “multi-system processes and disorders,” under the subcategory “fluid, electrolyte, and acid-base balance disorders.”

Drug Adverse Effects

The most significant difference between the USMLE’s list of topics and SGLOs is related to the categorization of drug adverse effects. SGLOs typically addressed the topic of drug adverse effects by naming a drug and asking students to discuss its mechanism of action and the mechanism behind its various adverse effects. (Ex. “Track the mechanism of action of methylphenidate in the body, while taking into account its symptoms and side effects.”). The USMLE topics, however, categorized first by organ or organ system, and then by “adverse effects of drugs on the kidney.” In brief, SGLOs sorted starting from the drug, while the USMLE topics sorted starting from the organ system. The decision was made not to code LOs that mentioned drug adverse effects into every organ system affected by the named drug. Instead, LOs that specifically addressed medications were placed into pharmacodynamics and pharmacokinetics, under Foundational Science.

USMLE core content coverage in first year

Over time, the UPC approach results in slightly more than half of USMLE core content coverage during the first year. The lowest percentage of subtopics covered by a first-year class was 54% and the highest was 64%, representing 144 to 171 of the 222 subtopics listed by the USMLE. Multiple regression analysis showed no significant difference in amount of content covered between different first year classes, across semesters, or during COVID remote learning.

Topic Weight

TOPIC	USMLE % COVERAGE	LO % COVERAGE*	NUMBER OF LO	LO CORRECTED % COVERAGE
GENERAL PRINCIPLES	12-16%	10%	415	13%
BLOOD & LYMPH & IMMUNE SYSTEMS	7-11%	8%	325	10%
BEHAVIORAL HEALTH & NERVOUS SYSTEMS	9-13%	10%	410	12%
MUSCULOSKELETAL & SKIN	6-10%	7%	301	9%
CARDIOVASCULAR SYSTEM	5-9%	5%	225	7%
RESPIRATORY & RENAL/ URINARY	9-13%	10%	420	13%
GASTROINTESTINAL	5-9%	5%	227	7%
REPRODUCTIVE & ENDOCRINE	9-13%	6%	249	8%
MULTISYSTEM	6-10%	7%	309	9%
BIOSTATISTICS & EPIDEMIOLOGY/POPULATION HEALTH	4-6%	10%	415	13%
SOCIAL SCIENCES	6-9%	21%	874	N/A

TABLE 1: Comparison of USMLE STEP 1 broad topic coverage to LOs.

*Due to rounding, columns may not add up to 100%

The percent of time spent on specific topics showed that eight out of eleven broad topics fell within the ranges given by the USMLE, with Social Sciences as the greatest outlier (Table 1). Two out of eleven topics were addressed less frequently by SGLOs than by the USMLE. These included General Principles, and Reproductive and Endocrine. Two out of eleven topics were given more weight by SGLOs than by USMLE, including Biostatistics and Epidemiology, and Social Sciences.

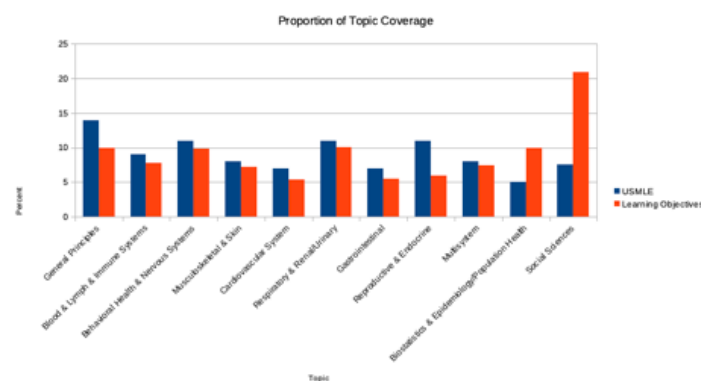


FIGURE 2: A graph comparing the proportion of SGLOs that addressed a broad topic with the proportion of STEP 1 questions that addressed that same topic.

*The percentages provided by the USMLE are given as a range, for effective visual comparison the median of the percentages was used.

Discussion

This comprehensive examination of the use of SGLOs to guide curricular coverage in an immersive first-year curriculum is innovative and yields several interesting findings that will help to ensure comparability between campuses and enrich student engagement and learning. These elements broadly include content coverage (number of subtopics covered by LOs) and content engagement, or weight (number of LOs addressing each broad topic).

Topic Coverage

Over the course of several years, there was no significant change in volume of content covered in terms of number of subtopics covered by students, demonstrating that different groups of students are able to cover similar amounts of material via SGLOs. Volume of content coverage also remained consistent from the first semester (when the process was new and students are acclimating to medical school), through the second semester (when they have more experience with the process and are accelerating their approach to student-directed learning). This indicates that students are capable of quickly adapting to create student-generated LOs in the context of relevant case materials. Students quickly optimize their LO creation and discussion processes early in the first semester, and continue to perform at a consistent level throughout the first and second semester. The semesters spent in remote learning due to COVID restrictions (2019-2020 Spring and 2020-2021 Fall) also show no significant differences. This suggests that students were able to maintain a standard of learning even remotely, and that SGLOs remained an effective educational strategy.

In terms of 'volume' of coverage, LOs generated by UPC medical students during their first year classes consistently covered over half of USMLE Step 1 core content. This figure is generally consistent with pre-clinical curricula at traditional two-year pre-clinical programs. The consistency of content coverage from year to year suggests that the unique approach of using student-generated LO system is stable across time. The fact that the students themselves drive the topic and quantity of the content they cover, and can make adjustments from week to week supports this interpretation. However, these numbers could also

suggest that the program is missing an opportunity to re-address areas of content coverage. Our results specifically call out several areas where improvements appear to be necessary in terms of breadth and depth of coverage, in particular reproductive health and general principles of basic science.

In terms of gaps in coverage, no broad categories were left unexplored. Overall, however, there were 53 individual USMLE core content sub-topics that were not addressed by any SGLO by any first year class. These gaps included sub-topics related to: *congenital disorders (of any organ system); embryonic development; male and female reproductive systems including pregnancy, childbirth, and the puerperium; endocrine disorders (other than thyroid); normal ageing and age-related changes; immunodeficiency (other than HIV); psychiatric disorders and behavioral health (specifically personality, facetious, somatoform, and psychosocial disorders); drug adverse effects**.

*A note on drug adverse effects: This is believed not to be a true gap, but instead to be a byproduct of differences in the way that the SGLOs and the USMLE categorize topics, as explained above in the results section. Due to these differences, the true frequency with which students studied drug adverse effects cannot be represented accurately by the coding system.

Due to the nature of SGLOs, content coverage varies from class to class. While one class may not end up discussing psychotic disorders during IQ sessions, another class might spend multiple LOs on it. The gaps listed above, however, are present in the SGLOs of all five different classes of medical students, indicating that these are common blind spots. This makes these gaps (aging, embryology, behavioral health, pregnancy, childbirth, and the puerperium) more generalizable to a wider population. The topics that fall into these gaps are consistent with gaps medical students have reported at other campuses (Khalil, Wright, Spearman & Gaspard, 2019).

These gaps represent an opportunity for improvement, to help guide medical students during

LO generation and ensure these topics are addressed.

Topic Weight

The UPC program spends significantly less time on Reproductive and Endocrine topics and on General Principles, while spending significantly more time on Biostatistics and Social Sciences. See Figure 2.

Social Sciences was the significant outlier at 21% coverage, a result which was expected due to the deliberate focus the UPC places on the social sciences, requiring students to generate LOs that address Health Humanities and Health Systems Sciences for each case discussed (UPC Key Principals 2021). Despite this outlier, most of these topics were given similar weight by the USMLE and SGLOs, with only two categories given less focus than the USMLE. These percentages were recalculated without the outlier. Without Social Sciences, the only remaining topic under-addressed by SGLOs was Reproductive and Endocrine.

The low result in Reproductive and Endocrine corresponds to the sub-topic gaps in coverage around reproductive health and endocrine disorders. It is consistent with other studies that show medical students consider pregnancy, childbirth, and the puerperium to be under-addressed by their medical school (Khalil, Wright, Spearman & Gaspard, 2019).

It may also be a reflection of UPC students' limited experience with obstetrics during their first year, when clinical experience is restricted to the family medicine clinic. Students who do not see patients with reproductive health concerns do not, under the case-based learning curriculum of the UPC, go on to address these cases in class. This explanation cannot account for the entirety of the gap, however, as it remains present even after student learning transitioned to remote, and began creating LOs from paper cases assigned by preceptors.

The low result in General Principles should be concerning to educators, as that is the most heavily weighted category on the USMLE and therefore demands a significant amount of student focus. Both General Principles and Reproductive and Endocrine, therefore, represent categories where facilitators can

step in to direct student learning by encouraging the selection of cases and LOs that address these topics. Facilitators can also supplement SGLOs with teaching and additional lectures, a strategy that the UPC has adopted in order to address General Principles.

Despite the identified gaps, these results are reassuring, with the prioritization of different broad topics mostly in agreement between SGLOs and the USMLE. This indicates that SGLOs are able to cover not just a wide range of content, but to accurately assess which topics will be the most important for the future, and dedicate more class time to addressing those topics identified as significant. It may also be an indication of the effectiveness of case-based learning, where student content coverage is driven by real cases they encounter during clinical immersion. The prioritization of topics may be a reflection of the most common illnesses encountered and the medical care students participate in in clinic.

Overall, these results are promising for the future of innovative medical education programs like the UPC program, where students co-create the curriculum in collaboration with the faculty, and where clinical experience drives content coverage. In addition, internal data show NBME shelf scores and STEP 1 and 2 scores between campuses are comparable.

Limitations

This study was necessarily limited by the data available, which includes only the planned and recorded SGLOs. Therefore, it cannot perfectly represent what students actually discussed in class. Studies have shown that self-regulated learning, such as the type modeled by SGLOs, is wide-ranging (Loyens, Magda & Rikers, 2008). In practice at UPC, student discussion is based on learning objectives but often covers more material than stated in the LO, either because students themselves expanded their research and then shared with their classmates, or because preceptors took an opportunity to provide focused instruction.

Similarly, we must take all the SGLOs in good faith, and assume students successfully covered all the material expected of them. In some ways, this assumption is backed up by the fact that these LOs are student generated. This gives students an

opportunity to course-correct, if they feel they cannot successfully cover all the material expected from an LO, then the next week they can write LOs that expect less from them, or vice versa.

Only one researcher made coding decisions. Due to the volume of data to analyze, and the limited pool of student researchers available, only one researcher coded the LOs. While broader coding decisions, such as the choice to categorize drug side effects under pharmacodynamics and pharmacokinetics rather than multiple organ systems, were discussed in meetings with advising and decided on collectively, individual coding decisions were made by a single researcher.

Future Directions

This study has immediate applications, as faculty can use this information to guide student learning and facilitate SGLOs that fill the gaps identified in this study. It also presents the possibility of future investigation into the blind spots of incoming medical students, and weaknesses that may be inherent in their approaches to self-directed learning. The reasons behind the identified gaps and ways in which student LO generation can be optimized are worthwhile directions for future investigation. Similarly, comparison between the planned SGLOs that this study examined and actual content covered by student discussions of those LOs could be a fruitful area for analysis, and help to understand the learning process. Continued research into collaborative medical curriculums, with an emphasis on co-creation between students and faculty, is necessary to the continued evolution of the field of medical education.

At a time when more medical schools are exploring novel and alternative curriculums, and our understanding of medical education is changing, it is important for schools to continually reassess the strengths and weaknesses of their programs (Cooke, Irby & O'Brian, 2012). There is still, unfortunately, a limited pool of research on medical education, and a great deal of the current curriculum standards have remained unchanged for decades. For campuses with unique curriculums, like the UPC, sharing the information gained through self-assessments can have benefit for the broader medical education community.

References

1. Accreditation Council for Graduate Medical Education. ACGME Outcomes Project Toolbox of Assessment Methods. ACGME. <https://www.slideshare.net/pedgishih/toolbox-of-acgme-assessment-methods>. Published September 2000. Accessed August 29, 2022.
2. Binks, A. P., LeClair, R. J., Willey, J. M., Brenner, J. M., Pickering, J. D., Moore, J. S., ... Schwartzstein, R. M. (2021). Changing Medical Education, Overnight: The Curricular Response to COVID-19 of Nine Medical Schools. *Teaching and Learning in Medicine*, 33(3), 334–342. <https://doi.org/10.1080/10401334.2021.1891543>
3. Cooke, M., Irby, D. M., & O'Brian, B. C. (2012). Summary of Educating Physicians: A Call for Reform of Medical School and Residency | Carnegie Foundation for the Advancement of Teaching. *Carnegie Foundation for the Advancement of Teaching*. Retrieved from <http://www.carnegiefoundation.org/elibrary/summary-educating-physicians#summary>
4. Khalil, M. K., Wright, W. S., Spearman, K. A., & Gaspard, A. C. (2019). Relationship between students' perceptions of the adequacy of M1 and M2 curricula and their performance on USMLE step 1 examination. *BMC Medical Education*, 19(1). <https://doi.org/10.1186/S12909-019-1796-3>
5. Laux, T., Stephens, M., & Meka, J. (2021). Student-generated learning objectives and curricular innovation. *Journal of Regional Medical Campuses*, 4(2). <https://doi.org/10.24926/JRMC.V4I2.3637>
6. Liaison Committee on Medical Education. Standards, Publications, & Notification Forms - LCME. (n.d.). <https://lcme.org/publications/#Standards>. Retrieved August 30, 2022.
7. Loyens, S. M. M., Magda, J., & Rikers, R. M. J. P. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review*, 20(4), 411–427.

<https://doi.org/10.1007/S10648-008-9082-7/METRICS>

8. Mager RF. *Preparing Instructional Objectives*. 3rd ed. London, UK: Atlantic Books; 1998.
9. Neville, A. J. (2009). Problem-based learning and medical education forty years on. A review of its effects on knowledge and clinical performance. *Medical Principles and Practice: International Journal of the Kuwait University, Health Science Centre*, 18(1), 1–9.
<https://doi.org/10.1159/000163038>
10. Thistlethwaite, J. E., Davies, D., Ekeocha, S., Kidd, J. M., MacDougall, C., Matthews, P., Clay, D. (2012). The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Medical Teacher*, 34(6).
<https://doi.org/10.3109/0142159X.2012.680939>
11. Torda, A. J., Velan, G., & Perkovic, V. (2020). The impact of the COVID-19 pandemic on medical education. *The Medical Journal of Australia*, 213(4), 188-188.e1.
<https://doi.org/10.5694/MJA2.50705>
12. Torda, A., & Shulruf, B. (2021). It's what you do, not the way you do it - online versus face-to-face small group teaching in first year medical school. *BMC Medical Education*, 21(1).
<https://doi.org/10.1186/S12909-021-02981-5>
13. University Park Program Key Principals and Key Features 2021 Revision. Accessed August 29, 2022.
14. USMLE Step 1 Content Description and General Information. A Joint Program of the Federation of State Medical Boards of the United States, Inc., and the National Board of Medical Examiners®; 2022:1–11. Available from: https://www.usmle.org/pdfs/step-1/content_step1.pdf Accessed August 30, 2022.