Advancing Medical Education by Optimizing the Use of Formal and Informal Curriculum Resources

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ADVANCING MEDICAL EDUCATION BY OPTIMIZING THE USE OF FORMAL AND INFORMAL CURRICULUM RESOURCES

by

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ABSTRACT

Current and aspiring medical school students are inundated by curriculum resources. To optimize the curriculum resources that are offered in medical education, the present work examines both institutionally and commercially developed resources from the lens of various stakeholders through three separate, yet related, studies. The first study, a scoping review, synthesizes and recognizes gaps in scholarship regarding obstacles that underrepresented, pre-medical students encounter in applying to medical school, specifically focusing on the impact of access to commercial test preparation resources. A review of existing literature regarding this population’s medical school admission difficulties yielded a majority of non-empirical, deficit-focused articles that repeated previous findings. The second study describes a pedagogical analysis of medical education commercial resources, to identify their alignment with evidence-based design and facilitate future improvement. The analysis found that nearly half of the investigated resources failed to mention guidance by a specific theory or theoretical movement; yet all resources mentioned similar functions, instructional strategies, and features. Lastly, this dissertation reports a mixed-methods study that examines undergraduate medical students’ perceptions and use of formal and informal resources, to optimize the design of formal resources and integrate informal resources. Qualitative and quantitative data analyses revealed that students have more positive perceptions and frequent use of informal curriculum resources, which is largely explained by greater confidence in conducting their related educational activities.
This dissertation is dedicated to gracious God, who has continued to bless me with health, fortitude, a wonderful family, and a positive outlook. I would also like to dedicate this dissertation to my beloved parents, Gordon & Patricia, who gave me the support, courage, and inspiration to embark on my doctoral journey.
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GENERAL INTRODUCTION

Previous scholarship regarding various aspects of medical education curriculum resources is either dated, scarce or not grounded in research and theory. Literature examining underrepresented pre-medical students’ obstacles to medical school admission, including the impact of access to commercial test preparation resources, has not been updated to account for new challenges resulting from the release of the new Medical College Admission Test (MCAT). There is a lack of literature examining the pedagogical underpinnings of popular medical education commercial platforms. Finally, although previous investigations have examined medical students’ use and perceptions of curriculum resources, none have been guided by theoretical frameworks.

As a result, the following dissertation aims to examine the use, perceptions, and pedagogical foundations of medical education curriculum resources by reporting three separate, but related investigations. The investigations are related by two factors. First, all three seek to advance research, theory, and practice regarding medical education curriculum resources. Second, each investigation expands upon inquiries that were developed based on the findings of that which preceded it. In the following paragraphs of this section, I summarize each investigation and describe how it relates to that which came before it.

Paper 1: Lack of Empirical Progress in Revealing Novel Barriers to URM Medical School Admission: A Scoping Review with Implications

With an impending increase in the number of diverse, racial and ethnic groups in the U.S., a corresponding augmentation in representation among physicians is needed to rectify issues with national population health and societal well-being. To achieve such
augmentation, it is necessary to identify the challenges that people of these racial and ethnic groups encounter on their paths to becoming physicians, which starts with undergraduate medical school. Thus, a scoping review was utilized to glean the barriers that underrepresented minorities (URMs) face in gaining admission to medical school following the publication of the revised MCAT in 2015. Subsequently, results were analyzed using Bandura’s theory of self-efficacy. The scoping review was guided by two research questions: (a) What is the scope of scholarly literature regarding barriers that URMs face in their attempts to gain admission into undergraduate allopathic medical school in the U.S.? (b) What is the scope of scholarly literature regarding URM students’ access to and use of commercial resources regarding the most recently revised MCAT? In response to the first question, a review of twenty-six relevant articles revealed that URMs encounter obstacles pertaining to insufficient academic qualifications, a lack of peer mentoring, and exclusive practices of medical school admissions committees. In response to the second research question, a review of four articles revealed that URMs lack access to MCAT commercial test preparation resources.

**Paper Two: Pedagogical Analysis of Medical Education Commercial Off-the-Shelf Resources (MedEd-COTS)**

Findings from the first study suggested that future research should investigate the pedagogical foundations of medical education commercial curriculum resources. A better understanding of the pedagogical underpinnings guiding the design of these resources is necessary to help medical schools and their faculty make informed decisions regarding their effective use. The MedEd-COTS examined in this analysis were chosen from student survey data regarding highly rated medical education review sources. The analysis was guided by the
following research questions: (a) What are the distinguishing functions of popular MedEd-COTS? (b) What are the distinguishing features of popular MedEd-COTS? (c) What theories and theoretical movements are used to guide the design of popular MedEd-COTS? (d) What instructional strategies do popular MedEd-COTS use to facilitate learning? Relevant data was drawn from MedEd-COTS’ websites, publications or via e-mail with their representatives. Specifically, theories, theoretical movements, instructional strategies, functions and features that publishers claimed to utilize in the design of their platforms were identified. Results revealed that almost half of the analyzed MedEd-COTS neglected to publish any information regarding the theories or theoretical movements used in the design of their platforms. However, the majority of publishers provided information regarding instructional strategies, features, and functions. Among the most popular strategies, features, and functions were individualized instruction, feedback, and review, respectively.

**Paper Three: Undergraduate Medical Students’ Curriculum Resource Use and Perceptions**

The second study revealed that a plethora of curriculum resources are available to medical school students. The wide array of learning materials prompted further investigation into how these resources are used throughout the course of undergraduate medical students’ education. Thus, a sequential explanatory mixed methods study was employed to answer the main research question (RQ): What factors explain undergraduate medical students’ perceptions and use of curriculum resources? An answer to the main RQ was gleaned through investigation of the following questions and corresponding hypotheses (a) Is there a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources? **Hypothesis:**
There will be a statistically significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources (b) What explains differences in students’ self-reported motivation? Relevant data was gathered from interviews, as well as questionnaires from the class of ’21 and ’22 cohorts of an undergraduate medical school. Data was analyzed using a MANOVA, a series of post-hoc statistical procedures, and thematic analysis. Results confirmed the hypothesis corresponding to the first RQ. Additionally, results revealed that positive perception and prevalent use of informal curriculum resources, over their formal counterparts, can be largely explained by greater confidence in conducting informal educational activities.
LACK OF EMPIRICAL PROGRESS IN REVEALING NOVEL BARRIERS TO URM MEDICAL SCHOOL ADMISSION: A SCOPING REVIEW WITH IMPLICATIONS

Abstract

Improving the health of an increasingly diverse US population requires a physician population that matches the diversity. To increase the diversity of the physician population, we need to understand the challenges facing underrepresented minorities (URMs) who seek admission to undergraduate medical schools. A scoping review revealed barriers faced by URMs in gaining admission to medical school following the publication of the revised MCAT in 2015. Specifically, the scoping review sought to answer two research questions: (a) What is the scope of scholarly literature regarding obstacles that URMs face in their attempts to gain admission into undergraduate allopathic medical school in the US? (b) What is the scope of scholarly literature regarding URM students’ access to and use of commercial study resources for the most recently revised MCAT? Results were interpreted using Bandura’s theory of self-efficacy. In response to the first question, a review of twenty-six relevant articles revealed that URMs encounter obstacles pertaining to insufficient academic qualifications, a lack of peer mentoring, and exclusive practices of medical school admissions committees. In response to the second research question, a review of four articles revealed that URMs lack access to MCAT commercial test preparation resources; URMs who are given access to such resources may not use them. Overall, the review demonstrated that existing literature regarding URMs medical school admission difficulties is deficit-focused, or fixated on the problems and needs of URMs. The review revealed a scarcity of theoretically and empirically based research to guide the
reform of programs used to facilitate URM admission into medical school. There is a lack of current literature regarding URM use of MCAT commercial test prep resources, and their pedagogical foundations. Research is needed to increase URM access to these materials. Furthermore, future attempts at enhancing diversity within medical school should follow a strength-based approach, such as describing the personal characteristics that have proven successful for past aspiring URM medical school students.

Keywords: URMs, underrepresented in medicine, medical school admission, MCAT, medical college admissions test, barriers
Introduction

Underrepresented physicians, which include Black/African American, American Indian (AI)/Alaska Native (AN), Hispanic, or Native Hawaiian/Other Pacific Islander (Association of American Medical Colleges, 2018), are vital to alleviating health disparities. Underrepresented physicians may improve patient health outcomes in several ways through; for example, patient-physician concordance and willingness to practice in underserved areas, which could lead to enhanced use of healthcare services, physician satisfaction and compliance among URM patients (Association of American Medical Colleges & Association of American Indian Physicians, 2018; Daar et al., 2017; Poole et al., 2020; Talamantes et al., 2019; Terregino et al., 2020; Toretsky et al., 2018; Uwaezuoke, 2018).

Despite the benefits offered by underrepresented physicians, the U.S. is struggling to develop a physician workforce that reflects the growing amount of racial and ethnic diversity in its population. Conservative estimates have predicted that by 2060, nearly half of the American population will be comprised of racial and ethnic groups that fit within the URM category (Emery et al., 2018). Yet, the number of URM matriculants to medical school remains low (Uwaezuoke, 2018; Emery et al., 2018).

Self-efficacy is an important concept to consider when examining challenges faced by aspiring URM medical students, as it appears to influence one’s chances of acceptance into medical school. Research indicates that self-efficacy predicts the number of attempts needed to pass standardized medical examinations (Wynn, 2020). Generally, medical school admission committees are reticent to accept applicants who have taken the MCAT more than twice. Furthermore, students with high self-efficacy beliefs appear to be more attractive to medical
school committees, due to their associated abilities to set goals and self-motivate, which are necessary in medical school (Roche et al., 2020).

Self-efficacy beliefs are characterized by a conviction in one’s abilities to produce effects that influence life events (Bandura, 1994). They are influenced by (a) success via continued effort, in the face of obstacles, (b) modeling or witnessing others, like oneself, succeed, (c) other’s assistance and support, or (d) the enhancement of positive moods (Bandura, 1994). When self-efficacy beliefs are enhanced through a perceived improvement in competency, an individuals’ motivation is also augmented (Schunk, 1995). Furthermore, self-efficacy beliefs are strong predictors of initial and ensuing performances (Schunk, 1995). People with high self-efficacy beliefs are driven to persist in the face of challenging feats (Bandura, 1994), such as the highly selective and competitive medical school admissions process. In contrast, those with low self-efficacy beliefs will not persist in the face of challenge (Bandura, 1994). Given the importance of self-efficacy to medical school admissions, Bandura’s self-efficacy theory will serve as the theoretical framework that guides the analysis of the scoping review’s results. Specifically, Bandura’s theory will explain how gleaned obstacles may affect URM’s self-efficacy.

The 2015 release of the longer, and arguably more difficult (Yale University, n.d.) Medical College Admission Test (MCAT) may cause additional obstacles to URM medical school matriculation. In addition to low self-efficacy, previous syntheses of research on barriers facing URMs’ matriculation into medical school have suggested that inadequate scores on academic measures have hindered the collective URM population from gaining admission into medical school (Agrawal et al., 2007; Henry, 2006). However, these investigations were
conducted prior to the release of the new MCAT, which necessitates a review of more current literature. The following scoping review intends to contribute to the formation of a more diverse physician workforce by answering the following research question: What is the scope of scholarly literature on URM admissions to medical school? An answer to the main research question will be gleaned through investigation of the following questions: (a) What is the scope of scholarly literature regarding barriers that URMs face in their attempts to gain admission into undergraduate, allopathic medical school in the U.S.? (b) What is the scope of scholarly literature regarding URM students’ access to and use of commercial study resources for the most recently revised MCAT?

For the purposes of this literature review, commercial resources were defined as platforms developed for standardized test preparation that include an integrated set of online features designed to prepare students for medical education. There are several commercially available MCAT resources, including those offered by the Association of American Medical Colleges (AAMC), UWorld, Anki, and Princeton Review (Wynn, 2020). Each commercial company provides several test preparation services. For example, AAMC offers a course that provides features for learning, studying, and practicing important concepts. Such features include multiple-choice practice tests and question item banks (Girotti et al., 2020).

Although commercial test preparation resources are considered an integral part of medical education (Griffin, 2018), their actual effectiveness in helping students succeed on the MCAT is debated. While some empirical research has shown that using these resources does not enhance multiple-choice question reasoning needed to excel on the MCAT (Wynn, 2020), others have yielded opposite conclusions (Chen & Corridon, 2020; Griffin, 2018). Regardless of their
true effects on MCAT score, commercial test preparation resources appear to provide aspiring medical students with a sense of psychological comfort in knowing that they are not missing out on a resource that their peers may be using to gain a leg up (Griffin, 2018).

The scoping review’s systematic search is guided by a modified approach suggested by Arksey and O’Malley. The search reveals 26 and 4 articles that respectively answer each research question. Results indicate that the extant literature continues to perpetuate naïve theories and focus on supposed deficits of potential minority applicants to undergraduate medical programs. The review ends with an interpretation of the results using Bandura’s theory of self-efficacy and a call for better quality, theoretically-based research.

Method

This review followed methods for conducting, as well as reporting the results of, a focused review suggested by Arksey and O’Malley (2005) that were modified by Khalil et al. (2016). Modifications included added details to the research questions, the development of a search decision flowchart and the examination of a variety of resources such as opinion pieces as well as quantitative and qualitative research (Khalil et al., 2016).

Stage 1: Identifying the Research Question

The objective of this scoping review was to examine research and literature for information regarding URM medical school admissions. Thus, research questions were developed to address this goal. The primary research question was: What is the scope of scholarly literature on URM admissions to medical school? Investigations of the following research questions yielded a response to the main inquiry: (a) What is the scope of scholarly literature regarding barriers that URMs face in their attempts to gain admission into
undergraduate, allopathic medical school in the U.S.? (b) What is the scope of scholarly literature regarding URM students’ access to and use of commercial study resources for the most recently revised MCAT?

Stage 2: Identifying the Relevant Studies

An initial search was conducted using the Google Scholar and University of Central Florida (UCF) library databases. The purpose of the initial search was to identify articles pertaining to the topic of URMs’ experiences in attempting to gain admission to medical school. The results of the pilot search yielded over 7,000 articles, many of which were irrelevant to the focus of the review. The assistance of two UCF main campus and College of Medicine librarians, as well as literature review experts was subsequently enlisted. The librarians and literature review experts identified databases, formulated, verified and implemented more sensitive search strategies (Arksey & O’Malley, 2005). Although some of the keywords (Appendix A) used for the search of each research question were identical, the fields were modified to the specifications of each database. In addition to the ProQuest, EBSCOhost, and PubMed databases, a hand search was conducted. Reference lists of articles gleaned through the database searches, or websites of organizations that provide MCAT commercial resources were also perused.

Stage 3: Study Selection

Inclusion and exclusion criteria (Appendix B) for both research questions related to the type of medical school discussed as well as the article’s location, participants, language, type, and publication date. Specifically, the articles needed to involve admission into allopathic
medical schools located within the U.S. Medical school admissions processes in different
countries were excluded due to an inability to generalize related findings to the target U.S. URM
population. The included articles must have been published in English, during or after 2016. The
language requirements were imposed to avoid potential time and financial requirements
associated with translation (Arksey & O’Malley, 2005). Additionally, the search was limited to
English publications due to the review’s focus on the U.S. medical system. All articles needed to
revolve around URMs either applying to allopathic medical schools after 2015 or studying for
the new MCAT. However, for empirical articles, there was an additional requirement that the
participants were URM students who were taking the newly revised MCAT, which was released
in 2015, and/or applying to medical school during or after 2016. The publication and participant
time requirements were imposed to enhance the relevance and generalizability of the findings
related to both research questions. The articles that met inclusion criteria consisted of empirical
investigations (including grey literature and dissertations), literature reviews, and editorials
pieces. Commentaries or opinion pieces were included as editorials. Literature published in
vanity presses and predatory journals were excluded due to the possibility of inadequate peer
review, editing and quality control (Ross-White et al., 2019).

After inputting search terms and filtering criteria, each result’s title and publication date
were read to ensure compliance with the inclusion criteria. If the article’s title and publication
date were appropriate, its corresponding abstract was read to ensure that it covered the subject
matter of the research questions, as specified by the inclusion criteria. If, after reading the
abstract, any uncertainty remained as to the relevance of the article to the study, the article was
read in its entirety. Citations of articles that were deemed appropriate for the research questions
were subsequently saved in a citation management application.

Stage 4: Charting the Data

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021) diagrams for research questions one and two are displayed in Figures 1 and 2. For the purposes of this scoping review, information about the type of article, as well as its author, year of publication, aims, and results were charted for all included literature. Additionally, if applicable, information was noted about empirical studies’ population, methodology, theoretical framework, outcome measures, and intervention. The full charts outlining these features for both research questions are displayed in Appendices C and D.
Figure 1: PRISMA diagram of research question 1 study selection process
Stage 5: Collating, Summarizing and Reporting the Results

Conclusions, as they relate to each research question, are reported below, and are based on the results of the studies included in the scoping review (Khalil et al., 2016). Conclusions are reported according to the most cited responses to each research question.
Results

Research Question One

A search of scholarly literature yielded twenty-six articles that answered the research question: What is the scope of scholarly literature regarding obstacles that URMs face in their attempts to gain admission into undergraduate allopathic medical school in the U.S.? Only seven of the relevant articles were empirical, while the rest were editorial pieces. The most discussed obstacles in both empirical and non-empirical articles were insufficient academic qualifications and lack of support. Academic qualifications, in the form of grade point average (GPA) and MCAT scores, have long posed significant challenges in URMs’ attempts to be competitive medical school applicants (Ballejos et al., 2018; Talamantes et al., 2019). With the advent of the new MCAT, academic qualifications remain a hindrance to URMs’ chances of gaining medical school admission. Differences in average scores between URMs and other groups on the new MCAT have not changed from the old MCAT, but URM test-takers continue to score lower than those from other groups (Girotti et al., 2020). Unfortunately, research and literature commonly conflate URMs with socio-economic challenges (AAMC & AAIP, 2018; Ballejos et al., 2018; Bright et al., 2018; Genao & Gelman, 2018; Lucey & Saguil, 2020; Thomas & Dockter, 2019) and cites these challenges as a rationale for their lack of academic preparation and subsequent underwhelming academic performance (Morgan et al., 2016; Toretsky et al., 2018). Yet, only one of the studies (Talamantes et al., 2019) reported data about the socioeconomic status (SES) of prospective medical school URM applicants and none presented data about the SES of URM applicants. URMs’ insufficient academic qualifications have also been empirically linked to another obstacle to URM medical school admission (AAMC & AAIP, 2018; Morgan et al.,
lack of racially or ethnically concordant role models (Uwaezuoke, 2018). Similarly, empirical and non-empirical literature have associated URMs’ insufficient academic qualifications with a lack of support from family members, and quality advisors (Bright et al., 2018; Toretsky et al., 2018).

Another common obstacle, identified by both empirical and non-empirical articles, was medical school admission committee processes. Medical schools have struggled with attempts to recruit and admit diverse matriculants (Cook, 2017; Daar et al., 2017; Emery et al., 2018). Yet, they are reluctant to consider diversity-enhancing initiatives (AAMC & AAIP, 2018; Roberts, 2020; Schwartzstein, 2020; Thomas & Dockter, 2019; Toretsky et al., 2018) and are fixated on accepting students with high MCAT scores, a practice that has been shown to lower the diversity of medical school student bodies (Cloutier et al., 2021; Nakae & Subica, 2021). Such reluctance is evident in medical school committees’ lack of focus on their social mission (Mullan, 2017) and failure to admit Deferred Action for Childhood Arrivals (DACA) applicants or community college graduates, many of whom are URMs (Daar et al., 2017; Halpern-Felsher & McLaughlin, 2016; Kost, 2018; Talamantes et al., 2019).

Medical school admission committee’s reluctance to consider the implementation of diversity-enhancing initiatives may be related to implicit bias among its members, and the stringent legal standards required of race-based admissions practices. The Supreme Court allows for the consideration of race in admissions decisions. However, in doing so, committees must adhere to strict and burdensome standards (Schwiekart, 2021). These complex standards may explain committees’ reluctance in implementing diversity-enhancing practices and policies, other than holistic review, which appears to be ineffective given the remaining racial inequities among
medical school student bodies (Robinett et al., 2021; Schwiekart, 2021; Williams, 2021). Another reason behind committee members’ reluctance may be implicit, unconscious bias, which has been shown to contribute to the paucity of medical school diversity (Bright et al., 2018; Robinett et al., 2021; Schwiekart, 2021). Bias can affect the medical school admission committee selection process when members’ expectations about the traits and experiences of an ideal medical student run contrary to those of URMs (Robinett et al., 2021). However, research has shown that bias-mitigating interventions, such as unconscious bias training, and blinding interviewers to interviewees’ academic metrics, can improve the number of URMs admitted to medical school (Robinett et al., 2021). These interventions appear to be an effective solution to enhancing URM medical school admission that avoids committee navigation through complex race-based admissions standards. Yet, the fact that diversity remains a prominent issue within medical schools suggests that bias-reducing initiatives are not being implemented. In neglecting to implement effective diversity-enhancing initiatives and choosing race-blind admissions policies instead, medical schools ignore the benefits that URMs could contribute to health quality and the medical school experience for all students.

Research Question Two

A search of scholarly databases yielded four articles, only one of which was empirical, that directly answered the second research question: What is the scope of scholarly literature regarding URM students’ access to and use of commercial study resources for the most recently revised MCAT? URM students appear to lack access to commercial test preparation resources (Stephens, 2018) due to either insufficient financial means (Griffin, 2018; Toretsky et al., 2018) or awareness (AAMC & AAIP, 2018). Research and literature indicate that applicants who seek
out commercial test preparation have a lower probability of being from a minority background. The number of medical school applicants from these groups who enroll in commercial test preparation is relatively low (Griffin, 2018). The common inference is that URMs may not access test preparation courses as often as their peers because they cannot afford the considerable and typically unsubsidized costs (Stephens, 2018; Toretsky et al., 2018). The arguably greater limitation to URM access to commercial test preparation resources, is unawareness of financial aid programs, which has been shown to adversely impact MCAT preparation (AAMC & AAIP, 2018).

Discussion

This scoping review synthesizes recent research on barriers faced by aspiring URM medical school students using articles published or based on data collected after the release of the new MCAT. Included studies and editorials repeat claims made in earlier studies, asserting that URMs are hindered by insufficient academic qualifications (Agrawal et al., 2005; Henry, 2006), lack of support (Barr et al., 2008), and the review process used by medical school admission committees (Garces & Mickey-Pabello, 2008). Recent studies also repeat that the academic qualifications of URMs are hurt by a lack of access to costly MCAT test preparation resources (Webb, 2008), presuming that minority status is associated with poverty (Patterson et al., 2009) and inadequate financial aid information. Taken together, recent research and scholarship does not provide new perspectives on the problem.

The challenges that URMs face in gaining admission to medical school may adversely impact their self-efficacy beliefs. Bandura’s theory helps us to understand the vicious or virtuous
cycles about our abilities, our beliefs about our abilities (i.e. self-efficacy beliefs), how our social environment influences those beliefs, the amount of effort we spend on challenging tasks, and the outcomes of those tasks (Bandura, 1994). With regard to the findings of the first research question, authors frequently link factors responsible for URMs’ low scholarly performance to economic bias (Kovach et al., 2019), with long-standing roots in societal stereotypes and racism (Genao & Gelman, 2018; Lucey & Saguil, 2020; Stephens, 2018; Thomas & Dockter, 2019; Uwaezuoke, 2018). Such discriminatory treatment leads to low academic self-efficacy (Stephens, 2018). Additionally, due to the race-blind, exclusionary practices of medical school admissions committees, the efficacy of aspiring URM medical school students may be lowered by the knowledge that their pursuit of medical education may be futile (Arias, 2017). This doubt, especially in the absence of the enhanced self-efficacy that role models can provide through mentorship and motivational encouragement (Stephens, 2018), may cause reticence in pursuing and following through with the difficult task of preparing for and applying to medical school. Interpreting the results of the second research question through the lens of Bandura's theory (1994), the limited access that URM's have to popular commercial test preparation resources may lead them to doubt their ability to gain admission to medical schools, further undermining their self-efficacy beliefs and motivation.

Unfortunately, the analysis of the challenges facing aspiring URM medical students often conflated URM status with low SES. While it is true that certain URM groups are more likely to come from lower SES backgrounds (Ghazzawi et al., 2021; Lucey & Saguil, 2020; Talamantes et al., 2019), it should not be assumed that all URMs are economically disadvantaged. Instead of assuming the relationship, future research needs to collect data on the SES of aspiring URM
applicants and disentangle claims about minority status and SES.

Implications and Future Research

In considering the aforementioned findings, it is important to be aware of the following limitations. The scoping review was limited by the decision to include non-empirical publications. Twenty-seven percent of the novel articles that resulted from the literature searches were empirical studies. The other articles were primarily composed of editorial articles, in the form of opinion pieces and commentaries. Although the editorial articles provided some novel insight into URM barriers to medical school admission, their accuracy and applicability is questionable, given the subjective nature of the articles. Additionally, many of the editorial articles cited literature published prior to the new MCAT. Given the lack of accuracy, timeliness and quality of findings regarding URM barriers to medical school admission, initiatives aimed at increasing the proportion of URMs in medicine have little, valuable evidence-based findings that can be used to re-formulate their approaches to better address the needs of aspiring URM medical students.

The scoping review was further limited by the number and type of databases that were used in the search of literature pertaining to the research questions. The databases that were used to identify relevant articles were general or specifically focused on medical education. However, given the review’s focus on race and ethnicity, it may have also been useful to search databases dedicated to studies in the humanities and social sciences. The exploration of such databases may have yielded more insight into URM medical school admissions by providing a more exhaustive search.

Additional insight into URM medical school admission experiences may have also been
yielded had the study not been limited to articles related to allopathic medical schools. Including both osteopathic and allopathic medical schools in the search criteria may have resulted in more empirical articles. Furthermore, novel insight into URMs’ medical school admission experiences may have been found. Given the additional information that could be found in including both types of medical schools, future scoping reviews on this topic may want to expand their inclusion criteria to allopathic and osteopathic medical schools.

The lack of empirical progress in gleaning novel barriers to URM admission suggests that, perhaps, there is a missing piece of the puzzle in terms of the type and frequency of the research being conducted on the topic. In seven years, there has been little empirical research, but a plethora of commentary on this topic. Thus, it appears that more actionable steps toward gleaning and remediying URM medical school admission issues need to be taken to address the healthcare needs of an increasingly diverse population that stands to benefit from enhanced patient-physician concordance. One promising potential area to focus novel empirical inquiry could be on the strengths-based approach to enhancing URM matriculation into medical school. Despite facing common barriers to URM matriculation, such as lack of mentorship and lack of funding, some URM students have been able to matriculate to medical school (Lorance, 2017; Stephens, 2018). Thus, rather than focusing on deficits, future attempts at enhancing diversity within medical school should follow a strengths-based approach and look to enhancing behaviors that have proven successful for past aspiring URM medical school students (Maton & Hrabowski, 2004).

Before URM access to commercial test preparation resources is increased, it is important to assess whether these commercial resources are designed to effectively impart the knowledge
and skills needed to succeed on the MCAT. Specifically, popular commercial test preparation resources should be examined for the implementation of quality, evidence-based pedagogical theories, strategies, and tools that facilitate learning. In the absence of these pedagogical components, subsequent research may need to be conducted to identify the best resources that can be supplied to URMs to improve their knowledge and skills.

Conclusion

A scoping review was conducted to examine the scope of scholarly literature on URM admissions to medical school. Most of the obstacles were gleaned from non-empirical articles that confirmed earlier research but offered no further insights. Additionally, the literature tended to conflate URMs with low SES, which may have led to an inaccurate depiction of the factors affecting their admission. Most articles relevant to the second question were also non-empirical and revealed that URMs lacked access to MCAT preparation commercial resources. The barriers that URMs face, coupled with their lack of access to commercial materials, may adversely impact their self-efficacy. To improve the plight of aspiring URM medical students, future research should focus on taking a strengths-based approach to enhancing their admissions chances and assess the pedagogical foundations of medical education commercial resources.

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PEDAGOGICAL ANALYSIS OF COMMERCIAL OFF-THE-SHELF-RESOURCES DESIGNED TO FACILITATE MEDICAL EDUCATION (MEDE-COTS)

Abstract

The analysis examined the pedagogical foundations of the most highly-rated commercial-off-the-shelf medical education learning platforms (MedEd-COTS) used by medical students to study for the USMLE Step 1. The analysis was guided by the following research questions: (a) What are the distinguishing functions of popular MedEd-COTS? (b) What are the distinguishing features of popular MedEd-COTS? (c) What theories and theoretical movements are used to guide the design of popular MedEd-COTS? (d) What instructional strategies do popular MedEd-COTS use to facilitate learning? The examined pedagogical foundations included the educational functions, features, theories, theoretical movements, and instructional strategies used to design each platform. Data regarding the pedagogical foundations of MedEd-COTS were collected from official websites, journal publications and personal communications with publisher representatives. The researchers screened for and discussed discrepant data. Findings were categorized by theory, theoretical movement, function, feature, and instructional strategy. The most cited function of all 17 COTS was reviewing previously learned material. All but one MedEd-COTS cited feedback, practice and learner progress checking features, as well as the instructional strategy of individualized instruction. Nearly half of the MedEd-COTS failed to mention guidance by a specific theory or theoretical movement. The analysis’ findings suggest that (a) COTS are becoming a major part of the core curriculum, so the MedEd community should be further assessing their usefulness; (b) COTS’ pedagogical foundations aren’t regularly
publicized, but they should be; and (c) more collaboration between instructional designers and MedEd stakeholders is needed. Subsequent research should focus on the extent to which users consider evidence-based pedagogical practices in selecting platforms. Empirical inquiries should be made into the rationale behind MedEd-COTS' pedagogical choices and their applications.

Keywords: medical education; commercial resources; pedagogy
Introduction

Medical school students use third-party commercial learning resources for various purposes due to their perceived usefulness, relative to instructional materials developed by their formal medical education (MedEd) institution. Undergraduate medical students commonly utilize third-party commercial learning resources as preparation materials for licensing exams and school courses because they are seen as helpful (Bauzon et al., 2021; Hirumi et al., 2022; Taylor et al., 2018). In concurrence with students’ perceptions, previous investigations have concluded that specific third-party commercial resources with question banks can positively affect standardized test scores (Hirumi et al., 2022; Parry et al., 2019).

Medical school students also use third-party commercial learning resources to study for clerkship (Taylor et al., 2018) and pre-clerkship (Bauzon et al., 2021; Wu et al., 2021) undergraduate medical education (UME) courses. They do so because of their perceived utility compared to resources provided by the formal MedEd curriculum. Medical students believe in the enhanced utility of third-party commercial learning resources for several reasons, including their (a) increased applicability to exams and learning goals, (b) ability to help students better manage time constraints and, (c) delivery of timely feedback (Hirumi et al., 2022).

In a 2022 poll taken by the International Association of Medical Science Educators, 69% of MedEd faculty worldwide revealed that third-party commercial resources were used at their schools. Additionally, 80% of faculty participants in this poll revealed that they used these resources in the development of their own instructional materials (International Association of Medical Educators, 2022). The augmented use of third-party commercial learning resources in MedEd institutions (Menon et al., 2017) and amongst faculty indicates that they also recognize
their multipurpose value. Third-party commercial learning resources are incorporated to support students who are studying for professional licensing examinations (Hirumi et al., 2022; Swan Sein et al., 2020) because their content, especially that found within question banks (International Association of Medical Science Educators, 2022), coincides with material found on the exams (Hirumi et al., 2022). Additionally, with the COVID-19 pandemic and the corresponding transition to online learning, third-party commercial learning resources are frequently looked to for distance learning materials (Southworth & Gleason, 2020).

The prevalent use by students and increasing integration by schools suggests the need to clarify the pedagogical foundations of third-party MedEd commercial off-the-shelf learning resources, hereby known as MedEd-COTS. Furthermore, such clarification may enhance medical schools’ and faculty members’ perceptions of MedEd-COTS’ effectiveness as well as their willingness to use them. Pedagogical foundations are operationally defined as the theories, theoretical movements, instructional strategies, functions, and features used to guide the design and development of MedEd-COTS. It is essential to examine and understand the features of e-learning platforms, such as MedEd-COTS, because they help manifest (Fernandez-Piqueras et al., 2011) and provide more information about the platform’s functionality. Awareness of e-learning platforms’ function enhances faculty and students’ ability to conceptualize (Fernandez-Piqueras et al., 2011) and integrate their use.

It is essential to ground the design of learning platforms on educational research and theory for many reasons. According to Hirumi (2014), grounded learning platforms provide established, defensible empirical and theoretical rationales based on human learning for decisions regarding the technology’s design. Grounded design also ensures that practice is
consistent with and supported by research and theory. Furthermore, grounded design helps explain and predict the results of an instructional intervention, enabling its systematic study, continuous improvement, and effective use across contexts (Hirumi, 2014). The continuous improvement of educational interventions is also facilitated by the critical appraisal of current, related literature required of the grounded design approach. While the alternative subject matter expert approach to instructional design may also be effective, the usefulness of resultant educational methods may be relatively limited (Harden et al., 1999).

Previous studies have evaluated MedEd-COTS by correlating their use with Step 1 performance (Hirumi et al., 2022). However, there is a lack of research focused on evaluating MedED-COTS by delineating their pedagogical foundations, from the publishers’ perspective. The current analysis aims to analyze the theories, theoretical movements and instructional strategies that publishers claim to utilize in the design of popular MedEd-COTS. Additionally, this analysis seeks to identify the functions and features that publishers include in their MedEd-COT. To achieve these aims, a systematic analysis was employed to answer the following research questions:

(a) What are the distinguishing functions of popular MedEd-COTS?

(b) What are the distinguishing features of popular MedEd-COTS?

(c) What theories and theoretical movements are used to guide the design of popular MedEd-COTS?

(d) What instructional strategies do popular MedEd-COTS use to facilitate learning?

Theories, theoretical movements and instructional strategies, were operationally defined based on the descriptions relayed by Reigeluth and Keller (2009).
were defined as instructional or learning theories that discuss instructional prescriptions, or how and why people learn. Instructional strategies were defined as approaches intended to direct instruction (Reigeluth & Keller, 2009). Functions were defined as intended purposes of each MedEd-COT, which could include review, test preparation, primary or supplementary instruction. Features were defined as instructional components, such as practice, mnemonics, and feedback.

Outcomes of this analysis will support MedED faculty by providing an initial set of neutral, evaluative criteria to use in making informed decisions about the use of COTS for themselves and their students. Faculty may also find this analysis useful in addressing the call for their enhanced role in curating COTS formally provided to students (International Association of Medical Science Educators, 2022). Furthermore, the analysis’ results will be helpful to MedEd institutions in satisfying the Liaison Committee on Medical Education accrediting body’s requirements regarding the evaluation of resources that students use for self-directed learning (Wu et al., 2021).

Method

Identifying MedEd-COTS

The current analysis sought to identify commercially authored or distributed MedEd-COTS. Fourteen of the seventeen analyzed MedEd-COTS were chosen using research conducted and published by the First Aid Team, a MedEd-COTS organization, based on their ability to provide an integrated set of online features designed to prepare students for board exams or MedEd. In its study, the First Aid Team distributed a survey to thousands of medical school students nationally. The surveys asked participants to evaluate several United States Medical
Licensing Exam (USMLE) Step 1 resources. Subsequently, students’ evaluations were combined into a rating that reflected how useful the resource was in providing quality Step 1 preparation (FAUSMLE, 2018). Fourteen resources from the First Aid Team’s survey were selected for inclusion in the current investigation, based on their high rating and compliance with the above criteria used for identifying MedEd-COTS. Additionally, Doctors in Training, Aquifer, and Lecturio were included in the analysis because of findings that supported their use and approval by several medical institutions. The three aforementioned MedEd-COTS also met the study’s inclusion criteria.

Data Collection

Data regarding the functions, features, instructional strategies, theories and theoretical movements of popular MedEd-COTS were gleaned from three sources. First, researchers examined the information that was posted on the websites of the MedEd-COTS identified for analysis. Subsequently, any relevant publications regarding specified MedEd-COTS, including three describing Picmonic (Yang et al., 2014) and Osmosis (Haynes et al., 2014; Menon et al., 2017) were searched for and reviewed. Finally, e-mail was used to solicit information directly from the publishers of MedEd-COTS regarding any educational theories, principles, or approaches that their company used, if any, to design their resource. Additionally, the publishers were asked to name any educational theories, principles, or approaches that their company advocated for integrating the use of the MedEd-COT to facilitate MedEd. The second round of e-mails served as a form of member checking, in which the publishers were given the opportunity to validate, refute or add to findings gleaned from websites and publications. The process of
member checking was included to ensure the credibility and trustworthiness of the data.

Data Analysis and Evaluation

Two researchers independently collected data regarding MedEd-COTS’ functions, features, theories, theoretical movements, and instructional strategies. The data were derived from relevant websites, publications, and personal correspondence. Subsequently, the researchers compared their findings and attempted to remediate any discrepancies by identifying where they had found the function, feature, theory, theoretical movement, or instructional strategy in question, and discussing whether the finding was appropriate for the aims of the analysis. If the two researchers (authors ZB and LH) were unable to resolve any inconsistencies amongst themselves, a third researcher (author AH) provided remediation.

After all researchers agreed on the findings, identified functions were categorized as one or more of the following: test preparation, curricular supplements, and UME or graduate medical education. Additionally, MedEd-COTS were classified based on their ability to function as instruction or review resources. MedEd-COTS’ capacity to function as reference tools, designed to facilitate performance, but not necessarily education, was not considered. Features were defined as instructional components. Examples of features include practice and feedback. Instructional strategies were defined as approaches that guide instruction. They are made up of a set of components that serve as the building blocks of instruction and provide a more detailed description of the strategy (Reigeluth & Keller, 2009). An example of a popular instructional strategy in medical education is case-based learning, which centers instruction around authentic scenarios through use of such components as authentic tasks, guided practice, collaborative and team work (McLean, 2016; Reigeluth & Keller, 2009).
Information that was gathered during the data collection phase was also classified according to the type of theory or theoretical movement with which MedEd-COTS identified. Conceptually, there is a distinction between instructional and learning theories. Learning theories are descriptive and seek to explain how and why people learn. In contrast, instructional theories are prescriptive in nature and include methods and means for facilitating learning (Reigeluth & Keller, 2009). However, in literature, learning theories often discuss instructional prescriptions and instructional theories often talk about how and why people learn. Thus, for the purposes of this analysis, instructional and learning theories were classified as theories or theoretical movements.

In reviewing the following results, it is important to keep in mind that most data were derived from marketing materials designed to boost sales by making promising assertions. Additionally, the qualifications of the publishers making assertions about the pedagogical foundations of their MedEd-COTS were not verified. Thus, the assertions may not be completely accurately. Data were also collected from articles regarding MedEd-COTS that were published in peer-reviewed, non-predatory journals. However, the articles’ results could be biased due to MedEd-COTS publishers’ role as researchers or authors.

The following sections include the data collection results and analysis of MedEd-COTS’ pedagogical foundations. A description of functions and features that MedEd-COTS publishers claimed to utilize is presented first, followed by an explanation of theories, theoretical movements and instructional strategies that publishers identified in describing their platforms’ design.
Results

This analysis was intended to provide an initial set of neutral, evaluative criteria for MedEd faculty and institutions to use in making informed decisions about COTS, based on their pedagogical foundations. Faculty may want to consider the results presented in the following subsections as initial criteria that can be utilized when deciding which COTS to adopt. Additionally, MedEd institutions can use these criteria for evaluating the resources that students use for independent learning.

What are the distinguishing functions of popular MedEd-COTS?

MedEd-COTS serve different functions. Table 1 includes the primary functions that were identified by each MedEd-COTS publisher. While several publishers directly named the primary categories of functions, others used synonymous terms. For example, some publishers used residency, rather than the synonymous term graduate medical education (American Medical Association, 2021). Similar terms were grouped to depict a parsimonious list of functions.

Table 1 Functions explicitly mentioned by MedEd-COTS

<table>
<thead>
<tr>
<th>a. Instruction</th>
<th>Amboss</th>
<th>Ankil</th>
<th>Aquifer</th>
<th>Boards &amp; Beyond</th>
<th>Doctors in Training</th>
<th>FineCracker</th>
<th>HLT</th>
<th>Kaplan</th>
<th>Lecturia</th>
<th>Memorang</th>
<th>OnlineMedEd</th>
<th>Osmosis</th>
<th>Physio</th>
<th>Plicmic</th>
<th>Sketchy</th>
<th>USMLE Rx</th>
<th>UWorld</th>
<th>Total COTS</th>
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<td>b. Review</td>
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<td>c. Board exam preparation</td>
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<td>d. Undergraduate medical education</td>
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<td>e. Graduate medical education</td>
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<td>Total number of functions</td>
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41
Review was cited by 100% of MedEd-COTS, making it the most common function. Review uses summarizing to connect key points of learning experiences. The purpose of review is to reinforce the understanding of important concepts (Reigeluth & Keller, 2009).

What are the distinguishing features of popular MedEd-COTS?

Table 2 depicts the features that were explicitly identified by MedEd-COTS publishers. Like features were grouped to provide a parsimonious list. While several publishers directly named the primary categories of features listed in Table 2, others identified synonymous terms (e.g., advising rather than coaching). Publishers who mentioned either spaced repetition or automated practice were included in the practice category, due to its requirement of repetitive learner interaction with educational content (Reigeluth & Keller, 2009). Similarly, publishers who referred to features involving metacognition, such as note-taking (Boyle et al., 2016) or reflection (Reigeluth & Keller, 2009), were classified under the metacognition feature. For the purposes of this analysis, reflection was defined as a metacognitive method in which students contemplate, analyze, and examine their thoughts, feelings, and actions (American Psychological Association, 2022). Finally, elaboration was defined as assigning meaning to novel material by conveying it in an individualized manner that links it to prior knowledge (Hirumi, 2020). Therefore, publishers that mentioned builds on prior knowledge, were included in the elaboration category.
Table 2 Features explicitly mentioned by MedEd-COTS

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<td>a. Practice</td>
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<td>b. Feedback</td>
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<td>c. Learner progress checking</td>
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<td>e. MCO, all lecture/notes</td>
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<td>f. Mnemonics</td>
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<td>k. Examples</td>
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<td>❏</td>
<td>❏</td>
<td>✔</td>
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<td>❏</td>
<td>✔</td>
<td>❏</td>
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<tr>
<td>p. Advance Organizer</td>
<td>❏</td>
<td>❏</td>
<td>❏</td>
<td>✔</td>
<td>❏</td>
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<td>❏</td>
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<tr>
<td>q. Drill and Practice</td>
<td>❏</td>
<td>❏</td>
<td>❏</td>
<td>✔</td>
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<td>8</td>
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</tr>
</tbody>
</table>

Note: P.C. = personal correspondence; Web = official website; Art = journal article

Use of learner progress checking, practice, and feedback was mentioned by 94% of MedEd-COTS, making them the most cited features. Learner progress checking is characterized by students’ ability to monitor their advancement through a unit of study by checking which modules were completed. Feedback is defined as information provided to students about the quality of their academic performance. Feedback includes specific guidance about the accurate and erroneous facets of learners’ performance (Reigeluth & Keller, 2009).

What theories and theoretical movements are used to guide the design of popular MedEd-COTS?

As explained above, conceptually, there is a significant difference between learning and instructional theories. Learning theories, such as behaviorism, are descriptive in nature and explain the process of learning (Honebein & Reigeluth 2021). Classes of instructional theories,
such as those that are learner or teacher centered, prescribe methods for facilitating learning in certain contexts (Honebein & Reigeluth, 2021). Although conceptually, the difference between learning and instructional theories is clear, practically, they are not as distinct. Thus, for the purposes of this paper, references to theories made by the publishers will be classified under major theories, such as behaviourism and neurobiological, as well as theoretical movements, which include the science of learning and cognitivism.

Table 3 lists the theories and theoretical movements that were explicitly identified by MedEd-COTS publishers. Publishers who mentioned cognitive-based learning theories (e.g., cognitive science, constructivism, and information processing) or principles (e.g., the theory of multimedia learning) were all included in the theoretical movement of cognitivism. References to other synonymous terms (e.g., learning science and science of learning) were also grouped together to provide a parsimonious list.

Table 3 Theories and theoretical movements explicitly mentioned by MedEd-COTS

<table>
<thead>
<tr>
<th>Theories and Theoretical Movements</th>
<th>P.C.</th>
<th>Web</th>
<th>P.C.</th>
<th>Web</th>
<th>P.C.</th>
<th>Web</th>
<th>P.C.</th>
<th>Web</th>
<th>P.C.</th>
<th>Web</th>
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<th>Web</th>
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<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>4</td>
</tr>
<tr>
<td>Science of Learning</td>
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<td>✓</td>
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<td>✓</td>
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<tr>
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<td>✓</td>
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<td>4</td>
</tr>
<tr>
<td>VARK Learning Model</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Self-Determination Theory (SDT)</td>
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</tr>
</tbody>
</table>

Note: P.C. = personal correspondence; Web = official website
The theoretical movements most cited by MedEd-COTS publishers were cognitivism and science of learning, which were each named by about 24% of the companies examined. The science of learning utilizes an interdisciplinary approach. This approach draws on such disciplines as artificial intelligence, cognitive psychology, instructional technology, and anthropology to explain how and why people learn. Learning scientists strive to comprehend the link between learning, its intended results, and environmental designs to facilitate efficacious learning. An important assumption in the science of learning is that learning, as well as its processes, can vary as a function of educational domain and a student’s previous cognitive state. Additionally, it is assumed that empirical studies of socio-technical systems, which include formal and informal learning environments, can yield comprehensive, scientific, and generalizable findings that explain learning environments (Sawyer & Dunlosky, 2019).

Theories that comprise the cognitivism theoretical movement include cognitive constructivism, cognitive information processing and the theory of multimedia learning. These theories share a similar aim to describe people’s cognitive processes and understand how they affect learning. Otherwise, cognitive learning theories have different perspectives on how information is collected and processed. Cognitive constructivism proposes that learners actively construct knowledge by connecting novel information with prior knowledge (Dong et al., 2021). In cognitive information processing, input is collected from the senses and processed in the brain, which subsequently yields a behavioral response output. The cognitive theory of multimedia learning posits that when learning specifically with presentations containing words and pictures, information is processed via auditory and visual channels, which each have limited capacity. Additionally, in the cognitive theory of multimedia learning, learning consists of an
active process of employing prior knowledge to filter, choose, organize, and assimilate information (Dong et al., 2021).

What instructional strategies do popular MedEd-COTS use to facilitate learning?

Instructional strategies are guided by theories that relate their comprising components (Strayer, 2016). The components of instructional strategies are typically comprehensive, provide a more detailed description of the strategy and serve as instructional building blocks (Reigeluth & Keller, 2009). Such components can include, for example, collaborative work, which is characteristic of the problem-based learning instructional strategy (Reigeluth & Keller, 2009; Yew & Goh, 2016). Table 4 depicts the instructional strategies specified by publishers for facilitating learning. Several publishers directly referred to the primary categories of instructional strategies listed in the table; others identified synonymous terms. For example, instructional simulations were commonly referred to as interactive patient encounter simulations.

Table 4 Instructional strategies explicitly mentioned by MedEd-COTS

<table>
<thead>
<tr>
<th>Source(s)</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
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<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>P.C., Web</td>
<td>2</td>
<td>P.C., Web</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: P.C. = personal correspondence; Web = official website; Art = journal article

46
Individualized learning was cited by 94% of publishers, making it the most common instructional strategy. The next most common instructional strategy mentioned was case-based learning, which was cited by 41% of the MedEd-COTS. Direct and anchored instruction were cited the least frequently, with only one MedEd-COT mentioning the use of each. Although anchored instruction and case-based learning may be considered synonymous, Reigeluth and Keller (2009) argue that the two are distinct yet share similar aspects. Both strategies provide instruction based on authentic conditions. However, anchored instruction is a kind of situated learning in which a learner is presented with an authentic problem. In contrast, the requirements of case-based learning are broader, and only require the learner to consider or interact with an authentic scenario (Reigeluth & Keller, 2009). Given that an overwhelming majority of publishers mentioned the use of individualized instruction, a detailed explanation of this instructional strategy follows.

Individualized instruction is an instructional approach that is responsive to each learner’s needs (Reigeluth & Keller, 2009). The approach is primarily comprised of self-paced learning and one-one-one teaching regarding progressive goals that represent curriculum or course objectives (American Psychological Association, 2020). Individualized learning also incorporates teacher assistance in helping students identify unacquired knowledge or underdeveloped skills (American Psychological Association, 2020).
Discussion

Implications

Due to the useful board-exam and academic content offered, MedEd-COTS are becoming a major part of the core curriculum to UME students (Bauzon et al., 2021; Hirumi et al., 2022; Parry et al., 2019; Taylor et al., 2018). The data displayed in Table 1 indicates that all the analyzed MedEd-COTS offer educational review subject matter pertaining to UME. Survey and interview data collected as part of a separate study indicate that 80% of UME students use MedEd-COTS over school-provided resources. The increasing reliance upon MedEd-COTS is primarily due to UME students’ perceived confidence in the resources’ ability to help them achieve their short-term goals of doing well on their licensing exams and preparing for clinical rotations (Bagot et al., 2022). Given the importance of these resources to UME students, it is troublesome that their usefulness has not been rigorously assessed by medical schools for content or quality. Instead, the quality of MedEd-COTS is being assumed by students who utilize and create much of the content that appears in them (Wu et al., 2021).

Approximately 60% of the examined COTS that posted information about their content authors revealed the use of medical students, many of whom are residents, for this role. Additionally, 94% of the COTS websites contained medical student testimonials correlating their academic success with use of the resource. Peer influence, in the form of confidence in resources that students have found success using, have been found to play large roles in medical students’ motivation to use commercial curriculum resources (Bagot et al., 2022). Thus, in advertising UME content created and promoted by high-achieving medical students who have matriculated to residency, COTS publishers may be gaining the confidence of UME students in their
resource’s ability to help them succeed on their licensing exams and prepare for clinical rotations.

Table 3 indicates that nearly 50% of MedEd-COTS publishers failed to mention adherence to any theory or theoretical movement. However, Tables 2 and 4 show that the majority of publishers disclosed strategies and features that they utilized. COTS publishers may have utilized a specific feature or instructional strategy because they saw its value in accomplishing their intended goals. However, publishers may not have identified with the theory or theoretical movement that the feature or strategy was traditionally associated with. Furthermore, they may have been challenged in coming up with a prescriptive theory based on descriptive theoretical foundations, as descriptive theory is typically not enough to inform design decisions, due to the interactional and situational nature of its comprising methods (Honebein & Reigeluth, 2021).

Despite the importance of theoretically and empirically grounded educational resources, nearly half of the MedEd-COTS failed to identify a particular theoretical movement. Failure to post or publish information about the application of theory or respond to the request for related information may be due to competing organizational priorities and suggests a lack of perceived market gain in publishing theoretical or empirical foundations. Learning platforms grounded in research and theory (a) provide established, defensible empirical and theoretical rationales based on human learning for decisions regarding the design of technology; (b) ensure that practice is consistent with and supported by research and theory and (c) explain and predict the results of an instructional intervention, enabling its systematic study, continuous improvement, and effective use across contexts (Hirumi, 2014). MedEd programs will likely need to call for empirically and
theoretically grounded MedEd-COTS because instructors, students, and publishers are not likely to do so. As discussed, the target populations for MedEd-COTS, educators, and students, may be more interested in the content, rather than how and why it was designed. For example, in a video explaining the educational theory of one MedEd-COTS, its founder cautioned that his impending monologue would likely be purposeless for its users (Williams, 2021). If similar views are held by other MedEd-COTS founders and publishers, they may not see the value in publishing pedagogical information.

Researchers and instructional designers could play a key role in helping MedEd practitioners apply descriptive theories to their specific needs. However, before such collaboration occurs, it will be important to achieve a common understanding of each discipline’s pedagogical terminology, as well as key practices, and adopt a common language regarding such terms and practices. The different background and experiences of those involved in medical education, compared to those in research and instructional design, may lead to parallel, yet distinct terminology and views on vital pedagogical practices to implement. For example, out of the forty-four key learning strategies identified by Reigeluth and Keller (2009) and Brown et al. (2014), only twenty-eight were utilized by MedEd-COTS. The distinction between medical education and instructional design and research is further highlighted by the different yet synonymous terminology employed to describe the same strategy or theory. For example, strategies commonly referred to as interactive patient encounters in medical education are known as instructional simulations in the fields of research and instructional design.
Limitations

Due to its publication in 2018, First Aid’s survey results fail to account for novel MedEd-COTS that have since incurred popularity at a level equivalent to those that were highly rated in the initial investigation, and correspondingly used in this analysis. Additionally, the results do not reflect the effect that newer versions of the COTS included in First Aid’s rankings had on their current popularity and standing amongst students.

It is important to keep in mind that the analysis’ findings are limited to a selected number of MedEd-COTS, and by the information provided by publishers at the time. Thus, the discussion and conclusions may not apply to all MedEd-COTS. Additionally, the findings do not account for any modifications to the design of the MedEd-COTS under analysis, following the conclusion of this investigation.

MedEd-COTS frequently evolve to respond to the demands of medical education, which have changed in many ways, with the COVID-19 pandemic and the transition of USMLE Step 1 to pass/fail. Given that these occurrences happened following the conclusion of this study, the identified functions, features, instructional strategies, theories, and theoretical movements may not accurately or comprehensively reflect how the analyzed MedEd-COTS modified their design to adjust to such events.

The current analysis was further limited by a lack of available information due to what may be publishers’ focus on providing concrete instructional deliverables and difficulty in receiving responses from them. Consequently, the complete list of instructional strategies, theories, theoretical movements, features, and functions employed by MedEd-COTS may not be depicted in this analysis. The focus of MedEd-COTS is on providing tools to facilitate the
delivery and learning of medical topics. Because most MedEd-COTS users are likely involved in the field of MedEd as either teachers or students, rather than instructional designers, the companies may cater to their users; thus, concentrating on what they can provide, rather than how and why they have chosen to provide it. In other words, MedEd-COTS may not publish information about pedagogical foundations on their websites to accommodate their users’ desire for MedEd content and learning tools. To account for the potential lack of pedagogical information provided on the websites of MedEd-COTS, the researchers attempted to directly contact publishers via email. However, over half of the publishers personally contacted for information did not respond to the requests.

**Conclusion**

The analysis examined the pedagogical foundations used to design popular MedEd-COTS, including each platform’s functions, features, and instructional strategies. In addition, the theories and theoretical movements that guided MedEd-COTS’ design were examined. Although they are not applicable to all COTS, the results of this study yielded two major takeaways. First, the inconsistent use of terms to describe closely related concepts and instructional design strategies is a problem for those who wish to understand the differences and similarities among the available COTS and suggests the necessity for enhanced collaboration between instructional designers and those involved in MedEd. This collaboration should aim to create a shared, streamlined understanding and employment of educational terms, concepts, principles, and theories. Second, given their importance to alignment, research, and efficacy (Hirumi, 2014), pedagogical foundations should be increasingly incorporated and publicized on MedEd-COTS platforms.
Given the lack of information regarding the theoretical bases of MedEd-COTS, it was difficult to discern whether utilized strategies were appropriate and aligned with the purposes underlying them. Thus, additional efforts or different methods are needed to determine if and how publishers apply research and theory. Future studies should also expand upon the present one by seeking to understand the rationale behind MedEd-COTS’ choice of strategies and theories or theoretical movements. Additionally, to provide a less publisher-biased and more relevant picture of the pedagogical foundations of MedEd-COTS, future, similar investigations should utilize a different source, with no publisher conflict of interest, to identify the most popular MedEd-COTS. Subsequently, the results of these studies should be compared to those which are presently described to ascertain whether there is a change in popularity because of COVID-19 or the new Step 1 grading system. Given the evolving nature of MedEd-COTS, it would also be interesting to systematically understand how their patrons adapt their use to these changes and whether other underlying factors dictate how MedEd-COTS are utilized. Finally, the MedEd community should be looking into MedEd-COTS to assess their usefulness; particularly, in comparison to resources that are developed by formal medical education institutions. The results of these comparative studies could be used to streamline the medical education curriculum and simplify the experience of UME stakeholders by (a) formally integrating the MedEd-COTS that students desire into the curriculum if they are found to be effective (Wu et al., 2021), and (b) saving students’, COTS’ publishers, and faculty members’ time by eliminating the need to find or curate curriculum materials. Instead, the results of resources that are scientifically shown to be effective could be shared amongst all stakeholders; thus, helping them to reach a common understanding and consensus of what qualifies as effective curriculum
materials, which could lead to enhanced efficiency and improved relationships among stakeholders.

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UNDERGRADUATE MEDICAL STUDENTS’ CURRICULUM RESOURCE USE, AND PERCEPTIONS

Abstract

A common challenge faced by undergraduate medical school students is resource overload, which describes the inundated feeling medical students experience due to the use of both formal, faculty-prescribed, and informal, student-selected curriculum resources. The study aimed to alleviate medical school students’ resource overload, as well as facilitate the development and continuous advancement of curriculum resources by gaining insight into the resources students use. Specifically, the study sought to investigate the following research questions (a) Is there a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources? (b) What explains differences in students’ self-reported motivation? To answer these questions, the study employed a mixed-methods approach, grounded in Keller’s ARCS Model, to gain a thorough understanding of fourth-year undergraduate medical education students’ use and perceptions of formal and informal curriculum resources. Qualitative data was collected through one-on-one interviews and open-ended questions. Quantitative data was gathered through close-ended questions. The closed and open-ended questions were administered via a questionnaire. Once all data was collected, thematic and a series of statistical analyses were conducted. Analyses revealed that relative to formal curriculum resources, undergraduate medical education students have more positive perceptions and frequent use of informal curriculum resources. Positive perception and prevalent use of informal curriculum resources, over their formal counterparts, can be largely explained by greater confidence in conducting informal educational activities. Social factors, attention bias,
and satisfaction of students’ extrinsic requirements, as well as intrinsic desires, appeared to play a role in the motivational constructs most highly attributed to informal curriculum resources. Comparative studies should be conducted at other MedEd institutions to see if resource use differs with specialty, the transition of Step 1 to pass-fail grading, and types of resources offered. Students’ use of and trust in, informal resources underscore the importance of publishers’ use and publication of evidence-based learning strategies.

Keywords: medical education resources, motivation
Introduction

Medical school students are inundated with institutionally and commercially developed curriculum resources. Commercially developed resources are created and offered by third-party companies, typically for monetary gain. Institutionally developed curriculum resources are those that are curated by medical school faculty members. As a result of the plethora of commercially and institutionally developed resources available, medical students experience significant stress due to resource overload.

Traditionally, medical educators have relied on an instructor-centered pedagogical approach, which utilizes synchronous, instructor-led interactions such as lectures (Ramnanan & Pound, 2017). Lectures have been lauded for their ability to facilitate the organization and acquisition of information (Rysavy et al., 2015). Instructor-led interactions are the primary method for delivering content during the pre-clerkship years of undergraduate medical education (UME). Additionally, instructor-led interactions play a pivotal role during the clerkship years of UME, when students have authentic opportunities to improve their physical examination skills through bedside teaching (Narayanan & Nair, 2020). Other resources traditionally employed by medical educators to facilitate student learning include post-lecture assignments, in which students independently apply the knowledge acquired through class lectures (Ramnanan & Pound, 2017).

While UME students have positive perceptions of formal curriculum resources developed by their medical education institutions, they are used less in the first three years of UME than those that are commercially produced (Bauzon et al., 2021; Burk-Rafel et al., 2017; Lau & Kolli,
When the topic of education is viewed as valuable and clinically relevant, first-year UME students are particularly more inclined to use certain instructional materials, such as lectures, over textbooks (Roberts et al., 2016). However, they more frequently utilize commercial resources, because they believe in their superior ability to prepare them for exams (Bauzon et al., 2021).

Similarly, second-year UME students utilize commercial resources, such as UWorld and First Aid (Burk-Rafel et al., 2017), to prepare for exams; particularly, the Step 1 board exam (Hirumi et al., 2022), which is taken at the end of the year. Lower percentages of second-year students use institutionally developed curriculum resources, such as synchronous lectures, lecture notes and videos (Burk-Rafel et al., 2017; Wu et al., 2021). Studies have shown that commercial platforms, such as UpToDate and UWorld, are generally used by third-year students on their clerkship rotations for reference, knowledge enhancement, and assessment because they are perceived as accessible. Only a small percentage of third-year UME students cross-reference information from these commercial resources with institutionally developed materials (Lau & Kolli, 2017). Research into fourth-year UME students’ curriculum resource usage has shown the use of and favorable regard towards formal curriculum resources (Bonfiglio et al., 2019; Courtier et al., 2016). However, a review of related literature yielded no insight into informal curriculum resource usage and perspectives among fourth-year students.

The problem is that there is a lack of theoretical or empirical understanding of students’ perceptions and use of formal, or faculty-prescribed, and informal, or student-selected, resources. Students experience resource overload because they seem to be bombarded with numerous resources that they don’t necessarily find useful, and they spend valuable time searching through
resources for the ones that work best for them. To increase the efficiency of medical students, and make their medical school experience easier, it would be better to provide them with effective resources that they will utilize; but, to do so, it is important to understand what they use, and when. Without an understanding of students’ perceptions and use, it is difficult to optimize the design of formal resources and integrate informal resources.

Several facets contribute to learning in medical education. However, motivation was chosen as a specific focus of this study due to the author’s experiences with students at a College of Medicine (COM). The most prominent actions and topics of conversation amongst medical students at this school were the use of informal resources, in the face of formal resources. Their heavy reliance on informal resources sparked curiosity behind the motivation to use such resources, especially when formal resources are readily available.

According to Pellacia & Viau (2017), motivation is an important component of learning, because it determines medical students’ approach to educational experiences and their resultant outcomes. Motivated medical students are more likely to implement effective learning strategies and persist when confronted with difficult academic tasks. As a result, these medical students have higher quality learning experiences and academic performance. Given their academic pursuits, medical students are typically associated with a high degree of motivation. However, motivation amongst medical students varies as a product of each learner’s perceived self-efficacy, value, and controllability of educational activities (Pelaccia & Viau, 2017).

Motivation was examined to gain knowledge about students’ use and perceptions of curriculum resources because it is (a) an essential component of learning that varies among different academic tasks, and (b) reflective of the learner’s unique beliefs about educational
activities (Sansone et al., 2019). According to Keller (2012) utilization of the ARCS multi-factorial model of motivation facilitates the (a) systematic analysis of student motivation, and (b) design of motivational strategies. The ARCS multi-factorial model of motivation is a comprehensive conglomeration of motivational theories and constructs. It includes, for example, the notion of learner goal motivation contained within Self-Determination Theory.

The ARCS model argues that attention, relevance, confidence, and satisfaction (ARCS) comprise humans’ initial and continued motivation to learn. Attention refers to learners’ engagement and curiosity in the educational experience. Relevance refers to the extent to which the learning experience is linked to learners’ personal goals, preferences and previous experiences. Confidence refers to the extent to which the learning experience helps learners believe in their ability to control their own success. Satisfaction refers to the rewards that the learner receives from accomplishing an educational activity (Keller, 2012).

The current study aims to examine undergraduate medical students’ perceptions and use of curriculum resources in years one through four. To achieve this aim, an explanatory sequential mixed-methods study was employed to answer the main research question (RQ): What factors explain undergraduate medical students’ perceptions and use of curriculum resources? An answer to the main RQ will be found by investing the following questions:

(a) Is there a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources?

(b) What explains differences in students’ self-reported motivation?

It is hypothesized that there will be a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources.
Method

Study Design

The study employed an explanatory sequential mixed-methods design. Mixed-methods research assumes that the use of qualitative and quantitative approaches provides an enhanced comprehension of complex phenomena and research problems compared to the use of either approach, by itself (Manzoor, 2020). In explanatory sequential mixed methods research, quantitative data is initially collected and analyzed. Subsequently, qualitative data is collected, analyzed, and interpreted to help explain the results of quantitative data collection (Mills & Gay, 2019).

Participants

Participants were fourth-year medical students from a COM located in a large public university. The students were part of the graduating cohorts of 2021 and 2022 (n = 241). One hundred twenty-one students from the class of 2021 and 120 from the class of 2022 were recruited. Seventy-two students agreed to participate in the questionnaire portion of the study, 11 gave their consent to be interviewed. Consent forms were electronically administered to participants with invitations to participate in each component of the study. The University of Central Florida Institutional Review Board approved the research (Appendix F).

Procedure

Data regarding students’ perceptions and use of formal versus informal curriculum resources were gleaned from two sources. Quantitative and qualitative data was collected using the Instructional and Motivational Design Questionnaire (IMDQ), which is a tool to utilize in
gathering information about student motivation in the use of curriculum resource use due to its basis in Keller’s Instructional Material Motivation Survey (IMMS). Understanding students’ motivation can provide insight into their beliefs, or perceptions, regarding an educational activity (Sansone et al., 2019). Thus, in asking students about their motivation to use curriculum resources in various medical school modules and rotations, comprehension of their perceptions was also achieved.

Although an IMDQ does not always contain multiple parts, the version used for the study contained two parts, so that students’ motivation to use formal and informal resources could be compared. Each portion of the IMDQ contained twenty closed-ended questions and two open-ended questions. The closed-ended questions were accompanied with responses on a 5-point Likert scale ranging from 1 (not true) to 5 (very true). Each part inquired after students’ motivations in using formal or informal curriculum resources.

Cronbach’s alpha for each part of the questionnaire ranged from .865-.943, similar to earlier studies utilizing an Instructional Materials Motivation Survey (IMMS). The questionnaire’s convergent and discriminant validity was previously confirmed by the same studies utilizing the IMMS (Hauze & Marshall, 2020).

With the promise of a $10 gift card, participants were invited to complete the online, fifteen-minute IMDQ via electronic communications from the COM administration and some of their peers serving as co-researchers of the study. Individually identifying information was removed prior to analysis to maintain participant confidentiality,

Additional qualitative data were collected through open-ended interviews. Fourth-year COM students were selected towards the end of the 2021 academic year and asked to participate
in a one-on-one, 30 to 60-minute, video teleconference interview with co-researchers, who were also fourth-year students at the COM. Prior to the interviews, each co-researcher received training from a qualitative research expert on how to conduct open-ended, conversational interviews, using a guide that was provided to them (Appendix E). During the interviews, inquiries were made about participants’ perceptions of curriculum resources and factors that influenced their use. Additionally, participants were asked about their evolving utilization of curriculum resources, or how their use of curriculum resources changed as they progressed through UME.

Coding and Scoring

Open-ended survey and interview data was independently coded by two researchers to determine which curriculum resources were used by each participant. Type of resource used was coded as a binary/dichotomous variable, in which 1 was used to symbolize use of primarily formal resources, and 2 was used to symbolize use of primarily informal resources. If the two researchers disagreed on the scoring of a participant, the participant’s responses were given to the study’s research consultant, who made the final coding decision. In total, 60 participants provided open-ended data for coding and scoring.

Data Analysis

In accordance with the sequential explanatory mixed-methods design, quantitative data analysis was completed first, followed by a qualitative analysis that sought to explain the results of the quantitative analysis. A Two-way Repeated Measures Multivariate Analysis of Variance (two-way MANOVA) was conducted to investigate the first RQ: Is there a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources? The independent variable, type of curriculum resource, had two levels, formal curriculum resource
and informal curriculum resource. There were five dependent variables, which were participants’ scores on each of the four motivational constructs (attention, relevance, confidence, and satisfaction) as well as their total score on all constructs. All data met the MANOVA statistical assumptions of normality and the absence of multivariate outliers, as well as multicollinearity.

Additionally, a series of post hoc tests were conducted to compare students’ scores for each type of curriculum resource and obtain additional insight into factors affecting students’ curriculum resource use. To further investigate the first RQ, post-hoc paired sample t-tests were conducted using the Bonferroni corrected critical value of $p=.01$. The purpose of the paired sample t-tests were to determine which paired subscales and total scores had a statistically significant mean difference and the magnitude of difference between statistically significant means.

Post-hoc logistic regression was conducted to yield additional insight from questionnaire data that neither the MANOVA nor paired sample t-test could provide. The MANOVA could determine a significant difference between students’ self-reported motivation to use formal vs. informal resources. The paired sample t-test could determine which specific ARCS motivational constructs were significantly different in students’ related scores for formal verses informal resources. However, neither of the statistical procedures could determine which motivational constructs, if any, played a more central role in which curriculum resources students used. Thus, post hoc logistic regression was conducted to determine which motivational constructs most strongly predict, or influence, students’ curriculum resource use.

Using the dichotomous, dependent variable initially coded from open-ended survey and interview data, a stepwise, binary logistic regression was run, in which absolute values of
participants’ scores on the ARCS subscales were calculated and served as the 8 predictor variables. The total score was removed as a predictor variable to avoid multicollinearity. The MANOVA and post hoc statistical procedures were conducted in SPSS Version 28.0.

Results

Is There a Significant Difference Between Students’ Self-Reported Motivation to Use Formal vs. Informal Curriculum Resources?

The results will be discussed in terms of how they answer the original RQs, starting with: Is there a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources? A two-way MANOVA was conducted to test the hypothesis that there would be a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources. Results revealed that there were large and statistically significant interaction effects between ARCS sub-scale score and type of curriculum resource (Pillai’s Trace = .142, F = 3.816, df =3, p =.014). This indicates that there is a significant difference between students’ self-reported motivation to use formal vs. informal curriculum resources. A moderate effect size ($\eta^2_p$) of .142 suggests that type of curriculum resource accounts for 14.2% of the variance in ARCS + Total questionnaire score. A post hoc power analysis was conducted in SPSS. The post hoc power of the test, given the sample size of 72, alpha level of .05, and observed effect size of .142, was .80.

As shown in Table 5, most of the mean scores for the formal curricula sub-scales and total score was approximately 3. This means that almost half of the respondents thought they were moderately motivating. In contrast, most of the mean scores for the informal curricula
motivational subscales hovered around 4, signifying that nearly half of the respondents believed that informal curriculum resources were motivating for the most part.

*Table 5 MANOVA descriptive statistics*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Formal Mean</th>
<th>Formal SD</th>
<th>Informal Mean</th>
<th>Informal SD</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>72</td>
<td>2.9</td>
<td>.83</td>
<td>4.1</td>
<td>.75</td>
<td>1.5</td>
</tr>
<tr>
<td>Relevance</td>
<td>72</td>
<td>3.2</td>
<td>.77</td>
<td>4.4</td>
<td>.64</td>
<td>1.7</td>
</tr>
<tr>
<td>Confidence</td>
<td>72</td>
<td>3.1</td>
<td>.90</td>
<td>4.4</td>
<td>.58</td>
<td>1.7</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>72</td>
<td>2.3</td>
<td>.88</td>
<td>3.8</td>
<td>.88</td>
<td>1.7</td>
</tr>
<tr>
<td>Total Score</td>
<td>72</td>
<td>2.9</td>
<td>.75</td>
<td>4.2</td>
<td>.62</td>
<td>1.9</td>
</tr>
</tbody>
</table>

The difference between mean scores for the formal vs. informal curriculum subscales and the total score is further supported by a post hoc paired sample t-test. The paired sample t-test was conducted to determine which paired subscales and total scores had a statistically significant mean difference. It was also conducted to determine the magnitude of difference between statistically significant means. The results (Table 6) indicate that the mean difference between paired informal and formal subscales and total score are significantly different from each other (t= -11.129, -9.853, -10.851, -9.954, -10.144, df = 69, p<.001). The effect size $d$ (calculated as the mean difference divided by the standard deviation of the difference) was around 1.7, indicating that the paired means differed by about 1.7 standard deviations. Using Cohen’s (1988) guidelines, this is interpreted as a large effect. The results provide evidence to support the conclusion that the mean scores for the formal curriculum subscales and total score are different than the mean scores for the informal curriculum subscales and total score.
Table 6 Results of the paired sample t-test

<table>
<thead>
<tr>
<th></th>
<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig (2 Tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Error Mean</td>
<td>Lower</td>
<td>Upper</td>
<td></td>
</tr>
<tr>
<td>Pair 1</td>
<td>-1.34000</td>
<td>.12041</td>
<td>-1.65896</td>
<td>-1.02104</td>
<td>-11.129</td>
</tr>
<tr>
<td>Total mean score for all formal items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total mean score for all informal items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2</td>
<td>-1.25286</td>
<td>.13020</td>
<td>-1.62776</td>
<td>-.93796</td>
<td>-9.533</td>
</tr>
<tr>
<td>Mean score for formal attention items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean score for informal attention items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3</td>
<td>-1.23714</td>
<td>.11692</td>
<td>-1.54685</td>
<td>-.92743</td>
<td>-10.581</td>
</tr>
<tr>
<td>Mean score for formal relevance items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean score for informal relevance items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 4</td>
<td>-1.32286</td>
<td>.13290</td>
<td>-1.67489</td>
<td>-.97082</td>
<td>-9.954</td>
</tr>
<tr>
<td>Mean score for formal confidence items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean score for informal confidence items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>-1.51614</td>
<td>.14956</td>
<td>-1.91333</td>
<td>-1.12096</td>
<td>-10.144</td>
</tr>
<tr>
<td>Mean score for formal satisfaction items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean score for informal satisfaction items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post hoc logistic regression was conducted to determine which motivational factors predicted students’ use of curriculum resources. Good model fit was evidenced by nonsignificant results on the Hosmer-Lemeshow test, $\chi^2 (n = 59) = 14.530$, df = 8, $p = .069$, and large effect size indices when interpreted using Cohen (1988) (Cox and Snell $R^2 = .294$; Nagelkerke $R^2 = .491$). These results suggest that the predictors, as a set, reliably distinguished between students who used formal curriculum resources versus students who used informal curriculum resources. Of the eight predictors in the model, perceived confidence in informal resources ($\text{Wald} = 7.334$, df = 1, $p = .007$) and relevance of formal resources ($\text{Wald} = 6.65$, df= 1, $p = .010$) were statistically significant predictors of students’ curriculum resource use. The odds ratio for perceived confidence in informal resources suggest that for every one-point increase in confidence in informal resources, the odds are about six times greater that student will use them. The odds ratio for perceived relevance of formal resources suggests that for every one-point increase in relevance of formal resources, there is a .2 increase in the odds of students using them. Mean
scores for formal attention, informal attention, formal relevance, informal relevance, formal confidence, formal satisfaction, and informal satisfaction were not statistically significant, which suggests that the odds of using formal curriculum resources (relative to informal curriculum resources) are similar regardless of scores on each of these motivational constructs. The following table, Table 7, presents the results for the model including the Wald statistics, regression coefficients, odds ratios and 95% CI for the odds ratios.

*Table 7 Logistic regression results*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>p</th>
<th>Exp (B)</th>
<th>95% CI for Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Intercept (constant)</td>
<td>-1.329</td>
<td>3.503</td>
<td>.144</td>
<td>.704</td>
<td>.265</td>
<td></td>
</tr>
<tr>
<td>Confidence in informal</td>
<td>1.811</td>
<td>.669</td>
<td>7.334</td>
<td>.007</td>
<td>6.118</td>
<td>1.649</td>
</tr>
<tr>
<td>Relevance of formal</td>
<td>-1.574</td>
<td>.610</td>
<td>6.65</td>
<td>.010</td>
<td>.207</td>
<td>.063</td>
</tr>
</tbody>
</table>

With confidence in informal and relevance of formal resources, it was possible to correctly classify which curriculum resources 90% of fourth-year students used throughout UME (83% of students mainly used informal curriculum resources and 17% mainly used formal curriculum resources). Given the importance of confidence and relevance in explaining students’ motivation to use curriculum resources, their related answers to RQ2 will be discussed first.

**What Explains Differences in Students’ Self-Reported Motivation?**

Analysis of the qualitative data revealed that, compared to formal resources, participants were more confident in informal resources’ ability to help them achieve their short-term academic goals because they were found to be successful among their peers, and they allowed students to focus on achieving understanding. Informal resources helped to provide enhanced
comprehension of the skills and concepts that students needed to be successful in accomplishing their goals, by facilitating the isolation and re-formulation of ideas that students had found to be particularly difficult. As demonstrated by the first and second quotations displayed in the Confidence section of Table 8, informal resources allowed students to rephrase ideas in a manner that they found comprehensible or; alternatively, they provided different explanations or formats that students believed led to better retention. Students were also more confident in informal resources’ ability to help them achieve their short-term goals because as one participant said, they were tried and true (third quotation in the Confidence section of Table 8). In other words, students were more confident in informal resources that their peers had previously used and found success.

Informal resources were regarded as more relevant to students’ primary goals of efficiency, passing board licensing exams, and obtaining the clinical knowledge needed to do well in their final two years of UME. Given the many responsibilities that medical students have, resources that offer efficient study methods appear to be a priority. Unfortunately, as described in the first quote of Table 8’s Relevance section, achieving efficiency with the primary and supplemental materials prescribed by medical students’ institution does not seem feasible due to the volume of recommended or required resources.

Even if the desire for efficiency was met through school provision of just lecture material, students may still view formal curriculum resources as irrelevant to their goals of passing licensing exams and obtaining clinical knowledge. This is exemplified by the second quote displayed in Table 8’s Relevance section, in which one student describes how a particular
informal resource helped her study for the Step licensing exam and learn material related to medical practice.

A common theme among interviewees was a heavy reliance on formal curriculum resources during the beginning of their UME experience. However, as they progressed, students transitioned to using more informal curriculum resources, due to changes in satisfaction. Students’ changes in satisfaction were influenced by novel, adverse perceptions of formal resources, and comparisons of their lagging progress to the success of peers utilizing informal resources (first quotation of Table 8’s Satisfaction section). In addition, students’ satisfaction with informal resources was enhanced by positive, subjective assessments of their experiences using them, relative to formal resources (second quotation of Table 8’s Satisfaction section).

Informal curriculum resources were found to hold participants’ attention more than formal curriculum resources because they presented fundamental information in a more engaging, consistent manner, which provided multiple modalities and features. Both quotes in Table 8’s Attention section feature students discussing paying limited attention to formal resources, in the form of lectures, in favor of informal resources, because the latter deliver content that appealed to each learner. Overall, given the diversity in learning methods offered by informal resources, students appeared to be more inclined to find their preferred learning method in these resources and rely on them to absorb and solidify their understanding of fundamental concepts.
Table 8 Student explanations of why higher ARCS are attributed to informal resources

<table>
<thead>
<tr>
<th>Motivational construct</th>
<th>Examples quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>“I like that [Boards &amp; Beyond] was like kind of condensed um it was really easy to understand…I felt like sometimes in class they were talking about a lot of like really interesting nuances um but it didn’t stick as well”</td>
</tr>
<tr>
<td></td>
<td>“I would make the Anki cards for any of the [UWorld] questions I’d missed…I found it more useful to have a deck that I created because I understood what I was getting at with the words and questions”</td>
</tr>
<tr>
<td></td>
<td>“[I reached for Boards &amp; Beyond and Pathoma because] they were like tried and true you know like people had used them”</td>
</tr>
<tr>
<td>Relevance</td>
<td>“Assigning optional and/or required readings to aid in the lecture material is unrealistic considering the amount we already have to study. [Informal curriculum resources] are time efficient”</td>
</tr>
<tr>
<td></td>
<td>“I could not forget Boards &amp; Beyond because that was…the best medical resource every like I think that students…could just watch those videos and learn more than attending lectures [because the Boards &amp; Beyond lecturer]…always links it to something um and maybe because I was studying for um for um Step 2 so it was just helpful to like have those pathways linked…it was a lot more medically related versus sometimes we have classes that are…not always medically related”</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>“I think I was still stuck on that whole like old school lecture’s the way to go like I didn’t trust that the cartoons would teach me what I needed to know for an exam a lecturer taught me and I think I was scared of putting all my cards in that basket like my peers did and they did better than me so looking back I need to trust what they peers said about just trusting Sketchy and getting through it”</td>
</tr>
<tr>
<td></td>
<td>“Right now it feels like lectures are on separate topics from SLMs…I’d have a hard time integrating the information, [whereas informal resources] focus on high-yield topics and ideas, helping to consolidate what I’ve learned in lectures in SLMs and connect them to ideas from previous modules”</td>
</tr>
<tr>
<td>Attention</td>
<td>“I could listen to [Pathoma] over and over again…I could do it in the car I could do it anywhere and it wouldn’t get derailed by liked questions other people in the class have asked like it’s a set thing you know…because of Pathoma’s like a set thing there were already Anki cards that had it so it was like really easy to like reinforce”</td>
</tr>
<tr>
<td></td>
<td>“I found out that the Sketchy videos game me basically all the relevant information they were so much more fun and interesting to watch anyway so I think at that point I realized like I should just stop watching the pharmacology lectures and just watch Sketchy instead”</td>
</tr>
</tbody>
</table>
Discussion

Differences in each of the subscales, as well as overall scores, indicate that students were more motivated to use informal curriculum resources over formal resources. Post hoc regression analysis of students’ perceived levels of ARCS and thematic analysis of the open-ended survey questions and interviews explained the differences found in overall motivation. To ensure trustworthiness, qualitative themes and related explanations were checked for accuracy by a member of the participant population. Post-hoc analyses revealed that students have more confidence in informal curriculum resources’ ability to help them achieve their short-term goals, which largely predicts their use of these resources over their formal counterparts. Qualitative data analysis revealed that students have more confidence in informal resources because they allow them to achieve a focus on understanding, and other students had found success in using them.

In accordance with previous literature (Burk-Rafel et al., 2017; Hirumi et al., 2022; Lau & Kolli, 2017) the majority (80%) of the medical students interviewed in this study demonstrated a particular preference for, and use of, formal and informal practice questions. Seventy percent of interviewees commented that even though practice questions were given formally, there were not enough, which may explain why Sketchy and Boards & Beyond were among the most popular informal resources used among students in this study, as well as others (Wu et al., 2021). These commercial medical education platforms offer several practice self-assessment options that are similar to those provided formally. They also provide instructional material to make up for what students perceive as lacking in the formal lecture content. The excess supplemental information
offered by informal resources may explain students’ reliance upon them to achieve understanding.

The way informal resources present information may also aid in understanding, which leads to students’ enhanced confidence in them. Several interviewees stated that informal resources helped to provide enhanced comprehension of the skills and concepts that they needed to be successful in accomplishing their goals, by facilitating the isolation and re-formulation of complex ideas. This rationale for use of informal resources has also been made by some experts in medical education, who argue that the alternative organization and presentation of concepts given by informal resources are helpful; especially, for providing remediation to students who have had difficulty with the structure of formal curriculum resources (International of Medical Science Educators, 2022).

Previous research on cognitive biases has shown that disparate conclusions are drawn from information, depending on who presents it, in what is known as the framing effect (Bellé et al., 2018). Previous research has also indicated that peer influence impacts students’ use of curriculum resources (Lau & Kolli, 2017). Student confidence in using resources recommended by their peers, over those suggested by faculty, may be due to the framing effect. Although curriculum resource advice is also conveyed by faculty members, students may put less faith in their advice.

Social factors also appear to play a role in students’ perceived satisfaction with the outcomes of learning experiences provided by curriculum resources. According to Cognitive Evaluation Theory, a component in which ARCS is based upon (Keller, 2012), satisfaction is rooted in an individuals’ subjective assessment of an outcome. Personal expectations, as well as
social comparisons, dictate the extent to which one is satisfied with an outcome, and demonstrates continued motivation to engage in the task that yielded it (Keller, 2012). Within ARCS, outcomes are characterized as learning experiences; thus, the extent to which an individual is satisfied with a learning experience and motivated to continue with it is dictated by his or her own personal expectations, as well as social comparisons. As a result of adverse expectations and social comparisons that resulted from the use of formal resources, students were less motivated to use them and increasingly utilized informal resources, which were regarded positively.

Students’ enhanced attention towards informal resources may be due to attention bias, in which people tend to place more importance on processing specific forms of stimuli, over others (Azriel & Bar-Haim, 2020). Student interviewees demonstrated a clear preference for how they received information and their preferences appeared to take priority in deciding what resource they chose. Students believed that informal resources were better able to capture their attention due to heuristic reasoning regarding learning styles, a controversial approach that has been rendered scientifically invalid and unrelated to effective, efficient knowledge acquisition (Kirschner, 2017). Despite the popularity of learning styles, several studies have shown that aligning instruction with students’ preferred learning styles does not improve learning or academic achievement (An & Carr, 2017; Kirschner, 2017). As a result, in using informal curriculum resources, students may be acquiring knowledge in the manner they prefer, but it may not be the most optimal manner for facilitating learning.

Previous research has indicated that medical students do not perceive formal curriculum resources as relevant to some of their short-term goals, such as passing their licensing exams
(Hirumi et al., 2022). Students’ goals of passing licensing exams, as well as doing well in the last two years of UME, are extrinsic requirements that are imposed on them for matriculation into residency. The goal of efficiency is driven by an intrinsic desire among medical students to manage multiple priorities and responsibilities. The extrinsic requirements of residency schools and the intrinsic desire to take on many tasks, motivate medical students’ goals (Keller, 2012) of efficiency, passing board licensing exams and obtaining sufficient clinical knowledge. Because informal resources help students satisfy both the extrinsic requirements and intrinsic desires behind their goals, they are viewed as more relevant than formal curriculum resources and students are more motivated to learn from them.

Limitations and Future Research

As the findings and implications of the study are considered, it is important to keep in mind that generalizability may be adversely affected by certain limitations. First, the study took place at one medical school. Different institutions may have different formal and informal curriculum resources. Second, the study had a relatively small sample size, with a 30% questionnaire response rate and 5% of the total population of fourth-year students interviewed. Thus, it is uncertain whether study participants represent the target population or original sample (Mills & Gay, 2019). If the participants are not representative of the original sample or target population, then non-response bias may have occurred. Third, the study relied on self-report data, collected from questionnaires containing single-statement items and Likert scale response options. Self-report data collected in this fashion may lead to response bias and have adverse effects on study validity (Kreitchman et al., 2019). Finally, data collection occurred during the pandemic, in which many formal curriculum resources traditionally available to students were reduced,
replaced, or eliminated. Pandemic-related modifications to the traditional formal curriculum may have altered participants’ perceptions.

There are multiple areas in which future research can expand upon the results of the current study. Other facets of motivation mentioned by other theories, not covered by ARCS, should be explored in relation to students’ use and perceptions of curriculum resources. Furthermore, comparative studies should be conducted at other medical schools, both nationally and internationally, to see if use of curriculum resources differs between specialties, the transition of Step 1 to pass-fail grading, and types of formal vs. informal curriculum resources offered. Medical students’ use and perceptions of informal curriculum resources should also be examined with respect to the resources’ intended purpose. Specifically, to help students understand the most effective use of informal curriculum resources, comparisons should be made between publishers’ intended purpose for informal curriculum resources and how students are using them or perceive their intended use.

Conclusion

The study aimed to examine undergraduate medical students’ perceptions and use of curriculum resources in years one through four. Although they are not applicable to all medical education institutions, the study yielded two major takeaways: (a) relative to formal curriculum resources, UME students have more positive perceptions and frequent use of informal curriculum resources; and (b) positive perception and use of informal curriculum resources, over their formal counterparts, can be largely explained by greater confidence in conducting informal educational activities and interpersonal relations; namely the amount of faith that students put in
their peers. Students’ use of and trust in informal resources underscores the importance of publishers’ sharing evidence-based learning strategies.

References


APPENDIX A:
SEARCH STRATEGIES FOR EACH DATABASE
MeSH: medical school admissions, obstacles, minority groups/education

Key Terms: minority barriers to medical school, minority access to MCAT resources, URM access to MCAT study resources, minority access to MCAT commercial resources, medical school admissions, minority groups, African Americans, Latinos, Latinas, Native Americans, medical college admission test, minority group students, African American students, Hispanic American students, American Indian students, diversity, online courses, distance education, electronic learning, internet, online systems, virtual classrooms, web based instruction, educational technology, MCAT, obstacles, minorities

Preliminary Search:

1. Google Scholar

Key Terms:

- minority access to MCAT resources
- URM access to MCAT study resources
- minority access to MCAT commercial resources

2. University of Central Florida Library

Key Terms:

- minority barriers to medical school

Database Key Terms:

1. PubMed

MeSH

- ((medical school admissions) AND (obstacles) AND ("minority groups/education" [MeSHTerms]))
- ((medical school admissions) AND ("minority groups/education" [MeSH Terms]))
- "admission*" [All Fields] AND ("schools, medical" [MeSH Terms] OR ("schools" [All Fields] AND "medical" [All Fields]) OR "medical schools" [All Fields] OR ("medical" [All Fields] AND "school" [All Fields]) OR "medical school" [All Fields]) AND ("minority groups" [All Fields] OR "underrepresented" [All Fields] OR "minority groups" [MeSH Terms])
- ("minority groups" OR underrepresented OR "minority groups" [MeSH Terms]) AND ("medical college admission test" OR MCAT)
Key terms:

- "medical school admissions" AND ("minority groups" OR "African Americans" OR Latinos OR Latinas OR "native Americans")

2. ProQuest

Key terms

- (“medical college admission test” OR MCAT) AND (minority group students OR African American students OR Hispanic American students OR American Indian students OR minority groups OR diversity) AND ("online courses" OR "distance education" OR "electronic learning" OR "internet" OR "online systems" OR "virtual classrooms" OR "web based instruction" OR "educational technology")
- (“medical college admission test” OR MCAT) AND (minority group students OR African American students OR Hispanic American students OR American Indian students OR minority groups) AND ("online courses" OR "distance education" OR "electronic learning" OR "internet" OR "online systems" OR "virtual classrooms" OR "web based instruction" OR "education technology") AND stype.exact("Scholarly Journals") AND la.exact("English") AND PEER(yes)
- (medical college admission test) OR MCAT AND (minority group students) OR (African American students) OR (Hispanic American students) OR (American Indian students) AND (online courses) OR (distance education) OR (electronic learning)
- ("medical school admissions" AND "obstacles" AND (minorities OR "African Americans" OR Latinos OR Latinas OR "Native Americans")) AND stype.exact("Scholarly Journals") AND la.exact("English") AND PEER(yes)
- ("medical school admissions" AND (minorities OR "African Americans" OR Latinos OR Latinas OR "Native Americans")) AND stype.exact("Scholarly Journals") AND la.exact("English") AND PEER(yes)
- ("medical school admissions" AND (minorities OR "African Americans" OR Latinos OR Latinas OR "Native Americans")) AND stype.exact("Scholarly Journals") AND la.exact("English") AND PEER(yes) AND pd(2014-2020)

3. EBSCOhost

Key Terms

- ("medical college admission test" OR MCAT ) AND DE ( minority group students OR African American students OR Hispanic American students OR native American students OR minority group students ) AND SU ( educational technology OR online course OR distance education OR electronic learning OR internet OR online systems OR virtual classrooms OR web based instruction )
( "medical college admission test" OR MCAT ) NOT DE ( minority group students OR African American students OR Hispanic American students OR American Indian students OR minority group students ) AND SU ( educational technology OR online course OR distance education OR electronic learning OR internet OR online systems OR virtual classrooms OR web based instruction )
APPENDIX B:
INCLUSION AND EXCLUSION CRITERIA
### Table 9 Inclusion and exclusion criteria

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<tr>
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<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
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<td>Medical School</td>
<td>- US allopathic institutions</td>
<td>- Osteopathic/non-US based institutions</td>
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<td>Article location</td>
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<td>- International</td>
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<td>Participants</td>
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<td>- URM who are currently seeking or have sought admission to undergraduate medical school during or after 2016.</td>
<td>- Non-URMs who are currently seeking or have sought admission to undergraduate medical school.</td>
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<td>RQ2:</td>
<td>RQ2:</td>
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<td>- URM who are studying or have studied for the MCAT, released on 2015.</td>
<td>- Non-URMs who are studying or have studied for the MCAT.</td>
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<td></td>
<td></td>
<td>- URM who are not studying or have not studied for the MCAT.</td>
</tr>
<tr>
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<td></td>
<td>- URM who studied/took the MCAT prior to the release of the 2015 version.</td>
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<td>- English</td>
<td>- Non-English languages</td>
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<td>- Articles published in vanity presses</td>
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<td>- Literature Reviews</td>
<td>- Articles published in predatory journals</td>
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<td>- Commentaries/Opinion pieces</td>
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<td>- 2016 or after</td>
<td>- Before 2016</td>
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APPENDIX C:
ARTICLE CHARACTERISTICS (RESEARCH QUESTION 1)
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Intervention type, duration, and comparator</th>
<th>Study populations</th>
<th>Aims</th>
<th>Methodology</th>
<th>Outcome measures</th>
<th>Theoretical Framework</th>
<th>Barriers</th>
</tr>
</thead>
</table>
| AAMC & AAIP             | 2018 | Outline the present state of AI/AN in medicine and argue for enhancement |                    |                                                                      |             |                  |                      | • Lack of financial support  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Limited information  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Cultural conflict  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Lack of role models  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Limited support  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Family obligations  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Structural racism  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Faculty biases  
| *Ballejos et al.* 2018 |      | • Pre-admissions workshop (PAW), 2 days    | AI/AN students interested in health professions | To evaluate the 2016 PAW’s primary activities and sessions | Qualitative |                  |                      | • Greatest application difficulties  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Weiss’ Theory of Change  
| *Bright et al.* 2018   |      |                                             | URM               | Glean causes for the lack of URMs in MedEd                           | Focused literature review |                  |                      | Application challenges:  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • MCAT (29%)  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • GPA (19%)  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Interview (19%)  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Personal Statement (14%)  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Finances (9.5%)  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Lack of rigor  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Finances  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Lack of academic support  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Lack of hands-on experiences  
|                         |      |                                             |                   |                                                                      |             |                  |                      | • Medical school admissions process  
| Cloutier et al. 2021   |      |                                             |                   | To argue for decreased MCAT consideration in medical school selection processes |             |                  |                      | • Medical school admission committee focus on MCAT  

Table 10 Article characteristics (research question 1)
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Intervention type, duration, and comparator</th>
<th>Study populations</th>
<th>Aims</th>
<th>Methodology</th>
<th>Outcome measures</th>
<th>Theoretical Framework</th>
<th>Barriers</th>
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<tr>
<td>Cook</td>
<td>2017</td>
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<td></td>
<td>To discuss the sunk cost fallacy in the context of education and briefly compared to medical education</td>
<td></td>
<td></td>
<td></td>
<td>• Medical schools are challenged to recruit URM applicants.</td>
</tr>
<tr>
<td>Daar et al.</td>
<td>2017</td>
<td></td>
<td></td>
<td>Explain important efforts made to augment the amount and value of Latino, Spanish-speaking physicians</td>
<td></td>
<td></td>
<td></td>
<td>• Medical programs neglecting to consider admission and support of DACA students, who are majorly comprised of URMs</td>
</tr>
<tr>
<td>Emery et al.</td>
<td>2018</td>
<td></td>
<td></td>
<td>To discuss URM recruitment barriers and propose a solution</td>
<td></td>
<td>Identity theories</td>
<td>Development theories</td>
<td>• Difficulty recruiting URM students due to:</td>
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<td></td>
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<td></td>
<td>Low MCAT scores</td>
<td>Dearth of diverse role models</td>
<td>• Admissions review process that relies on standardized test scores</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Institutions</td>
<td>Low MCAT score</td>
<td>• Institutions</td>
</tr>
</tbody>
</table>

Genao & Gelman 2018 | To argue against the use of the MCAT because of disparate impact |             |
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Intervention type, duration, and comparator</th>
<th>Study populations</th>
<th>Aims</th>
<th>Methodology</th>
<th>Outcome measures</th>
<th>Theoretical Framework</th>
<th>Barriers</th>
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<tbody>
<tr>
<td>Halpern-Felsher &amp; McLaughlin</td>
<td>2016</td>
<td>To promote and justify the implementation of STEP-UP</td>
<td>To promote and justify the implementation of STEP-UP</td>
<td>• URM youth are less likely to graduate from high school and attend college. Those who do are more likely to matriculate to two-year higher education institutions, less likely to pursue science-related degrees and graduate.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kost</td>
<td>2018</td>
<td>To argue for enhanced consideration of medical school applicants from community college</td>
<td>To argue for enhanced consideration of medical school applicants from community college</td>
<td>• Medical school admissions committees assign more value to 4 year, degree-granting schools over community colleges, which is perceived as a barrier to matriculation</td>
<td></td>
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<tr>
<td>Kovach et al.</td>
<td>2019</td>
<td>Public health/medical health equity experts</td>
<td>To facilitate the decision-making of organizations aspiring to advance health equity</td>
<td>Mixed methods</td>
<td>Vital practice and policies that can be utilized to enhance diversity in medicine</td>
<td>Factors affecting diversity in medical school admissions: • Implicit bias among medical school admissions committees • Insufficient academic preparation • Applicant extracurricular portfolios</td>
<td></td>
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<tr>
<td>Lucey &amp; Saguil</td>
<td>2020</td>
<td>To discuss MCAT scores and their use</td>
<td>To discuss MCAT scores and their use</td>
<td></td>
<td></td>
<td></td>
<td>• Lower MCAT scores</td>
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<tr>
<td>Author</td>
<td>Year</td>
<td>Intervention type, duration, and comparator</td>
<td>Study populations</td>
<td>Aims</td>
<td>Methodology</td>
<td>Outcome measures</td>
<td>Theoretical Framework</td>
<td>Barriers</td>
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<tr>
<td>Morgan et al.</td>
<td>2016</td>
<td>To discuss data about URM premedical experiences and propose increased diversity</td>
<td>To discuss data about URM premedical experiences and propose increased diversity</td>
<td>• Mismatched theory</td>
<td></td>
<td></td>
<td>• SES related issues</td>
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<tr>
<td>Mullan</td>
<td>2017</td>
<td>To argue for more commitment to social mission among health professions stakeholders</td>
<td>To argue for more commitment to social mission among health professions stakeholders</td>
<td>• Flexner Report→ decrease focus of medical schools on social mission, which includes the promotion of diversity</td>
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<tr>
<td>*Nakae &amp; Subica</td>
<td>2021</td>
<td>2018-2018 MCAT test-takers</td>
<td>To argue that the MCAT excludes URMs from medical school</td>
<td>Quantitative</td>
<td>• MCAT scores of those different ethnic group applying and admitted to medical school, by percentile</td>
<td>Academic redlining</td>
<td>• Admission committee use of MCAT cutoff scores</td>
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<tr>
<td>Roberts</td>
<td>2020</td>
<td>To reflect on the appropriate role the MCAT should play in medical education</td>
<td>To reflect on the appropriate role the MCAT should play in medical education</td>
<td></td>
<td></td>
<td></td>
<td>• Admissions committees fixated upon the highest MCAT score aren’t contributing to the physician diversity effort.</td>
<td></td>
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<tr>
<td>Author</td>
<td>Year</td>
<td>Intervention type, duration, and comparator</td>
<td>Study populations</td>
<td>Aims</td>
<td>Methodology</td>
<td>Outcome measures</td>
<td>Theoretical Framework</td>
<td>Barriers</td>
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<td>-----------------------------------------------</td>
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</tbody>
</table>
| *Robinett et al.* | 2021 | • Unconscious bias training  
• Blinding interviewers to MCAT and GPA score  
• Enhancing diversity of medical school admission committee | Medical school admission committee | To impart strategies and outcomes of mitigating bias in the medical school admissions process | Quantitative | % of URMs interviewed, accepted and matriculated |                       | • Admission committee bias                  |
| Schwartzstein | 2020 |                                            |                   | To argue for medical educators’ consideration of calls to reduce the MCAT’s role in admissions decisions |             |                                                 |                       | • Medical school’s fixation with high MCAT scores |
| Schweikart    | 2021 | Explain why limitations to legal affirmative action hinders medical schools’ ability to contribute to social justice |                   |                                                                 |             |                                                 |                       | • Medical school admission committee bias |
| *Stephens*    | 2018 | Underrepresented students in a health professions graduate program |                   | To explore and comprehend experiences of the study population | Qualitative | How participants recounted/made sense of their experiences | • Self-Determination Theory | • English as a second language  
• Finances  
• Undergraduate under preparedness |
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Intervention type, duration, and comparator</th>
<th>Study populations</th>
<th>Aims</th>
<th>Methodology</th>
<th>Outcome measures</th>
<th>Theoretical Framework</th>
<th>Barriers</th>
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</thead>
<tbody>
<tr>
<td>Talamantes et al.</td>
<td>2019</td>
<td></td>
<td></td>
<td>Discuss how to enhance URM recruitment among medical schools</td>
<td></td>
<td></td>
<td></td>
<td>• Less competitive GPAs and MCAT • Community colleges held in low regard by admissions committees</td>
</tr>
<tr>
<td>Thomas &amp; Dockter</td>
<td>2019</td>
<td></td>
<td></td>
<td>Argue for holistic review</td>
<td></td>
<td></td>
<td></td>
<td>• Government intervention • Less social capital • Low-resourced schools • Lack of preparation• Admissions requirements • Lack of concordant mentors • Subpar advising</td>
</tr>
<tr>
<td>Toretsky et al.</td>
<td>2018</td>
<td></td>
<td></td>
<td>Summarize literature in URM obstacles to health profession and explore strategies to enhance their presence</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>*Uwaezuoke</td>
<td>2018</td>
<td>Former URM UC pre-medical students</td>
<td></td>
<td>Enhance comprehension of the URM pre-medical experience and post-bac programs; put forth related recommendations</td>
<td>Qualitative (Pre-medical) undergraduate experience • Modified Grounded Theory</td>
<td></td>
<td></td>
<td>Subpar academic performance due to: • Insufficient study skills • Lack of self-efficacy • Lack of fruitful guidance • Perceived unbelonging • Negative campus climate • Chemistry classes • Under prepared for pre-medical curriculum</td>
</tr>
<tr>
<td>Vick et al.</td>
<td>2018</td>
<td></td>
<td></td>
<td>Discuss attempts to enhance American medical school diversity</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Author</td>
<td>Year</td>
<td>Intervention type, duration, and comparator</td>
<td>Study populations</td>
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<td>Methodology</td>
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<td>Williams et al.</td>
<td>2021</td>
<td></td>
<td></td>
<td>To argue for a re-examination of the medical school admission process</td>
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<td>Medical school admissions committees</td>
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*Note:* Blank spaces denote that the category wasn't applicable. The asterisks in front of the authors’ names denote empirical studies.
APPENDIX D:
ARTICLE CHARACTERISTIC (RESEARCH QUESTION 2)
<table>
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<tr>
<th>Author</th>
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<th>Intervention type, duration, and comparator</th>
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<th>Methodology</th>
<th>Outcome measures</th>
<th>Theoretical Framework</th>
<th>Use/access</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAMC &amp; AAIP</td>
<td>2018</td>
<td>Outline the present state of AI/AN in medicine and argue for enhancement</td>
<td></td>
<td>• URMs have limited access to commercial resources due to a lack of knowledge of aid programs</td>
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<tr>
<td>B. Griffin (in Patterson &amp; Zibarras)</td>
<td>2018</td>
<td>To describe why and the mechanisms through which coaching has become a significant enterprise</td>
<td></td>
<td>• Applicants who seek out commercial test preparation have a higher probability of not being from a minority</td>
<td></td>
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</tr>
<tr>
<td>*Stephens</td>
<td>2018</td>
<td>Underrepresented students training in a health professions graduate program</td>
<td></td>
<td>• URMs have reduced access to test preparation resources, which are typically expensive and not subsidized by application services</td>
<td>Qualitative</td>
<td>How participants recounted/made sense of their experiences</td>
<td>Self-Determination Theory</td>
<td></td>
</tr>
<tr>
<td>Author</td>
<td>Year</td>
<td>Intervention type, duration, and comparator</td>
<td>Study populations</td>
<td>Aims</td>
<td>Methodology</td>
<td>Outcome measures</td>
<td>Theoretical Framework</td>
<td>Use/access</td>
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</tr>
<tr>
<td>Toretsky et al.</td>
<td>2018</td>
<td></td>
<td></td>
<td>Summarize literature in URM obstacles to health profession and explore strategies to enhance their presence</td>
<td></td>
<td></td>
<td></td>
<td>• Many URMs can’t afford the test prep courses that their peers utilize to maximize their MCAT scores</td>
</tr>
</tbody>
</table>

*Note: Blank spaces denote that the category wasn't applicable. The asterisks in front of the authors’ names denote empirical studies.*
APPENDIX E:
INTERVIEW PROTOCOL
<table>
<thead>
<tr>
<th>Interview goals</th>
<th>Possible questions and probes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Overview/Explanations</td>
<td>• Join meeting with video and audio.</td>
<td>Purpose, consent, recording, interview format. Nature of interview.</td>
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<td></td>
<td>• When ready to start the interview, ask permission to record, start recording by clicking</td>
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<td></td>
<td>&quot;Record&quot; → &quot;Record to the Cloud&quot; on Zoom and enable recording on your back-up device.</td>
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<td></td>
<td>• Record time/date and interviewee and class.</td>
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<td></td>
<td>• Restate purpose of study.</td>
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<td></td>
<td>• Did you get a chance to review the consent form?</td>
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<td></td>
<td>• Also note nature of interview: Conversational, very open-ended. Focus is on uncovering</td>
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<td></td>
<td>your perspectives and experience, not answering our questions.</td>
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<td></td>
<td>• Any questions or concerns?</td>
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<td></td>
<td>• Do we have your consent to participate in the study and record this session?</td>
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</tr>
<tr>
<td>1. Establish Rapport</td>
<td><strong>How is everything going so far this semester?</strong></td>
<td>Focus on building relationship, establish conversational tone, put</td>
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<td></td>
<td>• Tell me about something interesting you’ve done outside class? That sounds exciting, tell</td>
<td>interviewee at ease.</td>
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<td></td>
<td>me more…</td>
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<td></td>
<td>• M1/M2: How’s your current Module going?</td>
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<td>• M3/M4: What Rotation/Electives are you in?</td>
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<td></td>
<td>How is it going? What are you learning?</td>
<td></td>
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<td></td>
<td>• Faculty: How is teaching going this year?</td>
<td></td>
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<tr>
<td>2a. Grand Tour,</td>
<td><strong>What are you focusing on right now at school?</strong></td>
<td>Overview of the program and where they are to contextualize</td>
</tr>
<tr>
<td>Participant priorities</td>
<td>• What do you hope to accomplish this term?</td>
<td>subsequent answers. Be sure to note goals (X, Y, Z)</td>
</tr>
<tr>
<td>(overview of the &quot;house&quot;)</td>
<td>• What are your immediate goals?</td>
<td></td>
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</tbody>
</table>
| 2b. Follow one of the priorities mentioned in the grand tour (enter 1 room at a time) | **Tell me more about what you are doing this term?**
- What are you doing to accomplish your goal to X, Y, Z?
- Tell me more about your experience (e.g., what learning looks)? | Use priorities mentioned in response to the previous question, explore one (X, Y or Z) at a time; this and next questions may be repeated. |
|---|---|---|
| 3. Within “room 1”, focusing on resources, looking for general patterns | **What resources or information do you use to help you [your students] toward these goals?**
- Tell me about what you are doing to accomplish X (Y or Z)
- What resources do your professor(s) [do you prescribe]?
- What other resources do you use?
- What do you find helpful? Not helpful?
- What kind of information do you look for? Where? | Focusing in on resources from what was said in response to the previous questions. Replace X with what they said, using as much of their language. Make sure you clarify the terminology (don’t assume that what you think it is matches their thinking) |
| 4. Focusing on one kind of resource at a time | **You mentioned formal resources (prescribed by faculty) for both mandatory and non-mandatory sessions. Tell me about them.**
- Describe what is in the resource you use.
- How do you choose them? How do you know they will help you?
- Why do you choose to use them?
- What do you find helpful?
- What is not helpful?
- What would you change and how? | Use this question multiple times to explore different kinds of resources (participant mentioned in the grand tour question) This cycles back to 2-3, picks up on what was said before |
| 4b. Example | Either identify a specific formal resource or ask learners to identify one. *Please walk me through the process of how you used it.*  
Repeat question for other formal resources | Similar idea as in 4 (cycling between general to a specific example, getting context for the resource used); continued in the next questions |
|---|---|---|
| 5. Expanding to other resources, reiterating a similar question, | You mentioned using some informal resources (not prescribed by your professors, recommended by other). *Please tell me about them.*  
- What informal resources do you use and why? 
- How do you choose them? How do you know they will help you? 
- Why do you choose to use them? 
- What do you find helpful?  
- What is not helpful? | FACULTY researchers probe faculty members’ knowledge and perception of informal resources (e.g., tell me what you know about students’ use of commercial software programs and other informal resources? What do you think of X/Y/Z? How much time do you think students spend using X/Y/Z)? |
| 5a. Add new kind of deeper layered information | If *Legacy Files* (documents and files given to them by their Bigs) are not mentioned above.  
- Describe the resources you get from your Bigs  
- Describe what resources you give to your Littles  
- What did you find most useful, least useful and why  
- How you use them, how much | FACULTY researchers probe faculty members’ knowledge and perception of legacy files (e.g., tell me what you know about students’ use of files handed down to them by their peers? What do you think are included in such files? What do you think of students use of such files? How much time do you think students spend using X/Y/Z)? |
| 5b. Specific example | Either identify a specific informal resource or ask learners to identify one. *Please walk me through* | }
| 6. Change over time | **How has your use of the different resources changed over time?**  
- This year  
- Over the years in the program  
What resources? Used for what purposes? What influenced the choices of what you use? At what times do you use particular kinds of resources? | This question is particularly important. Be sure to allocate time to discuss changes, and reasons for changes, particularly for M2, M3, and M4 students, and faculty. |
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<tbody>
<tr>
<td>7. Recommendations</td>
<td><strong>If you were to redesign your program, what would you change and how?</strong></td>
<td>May be easier to start with a focus on a particular class/experience to start</td>
</tr>
</tbody>
</table>
| 7a. Program recommendations | **What advice would you give faculty or administration?**  
- About the program  
- Resources used and experiences offered |  |
| 7b. Student recommendations | **What would you tell the next group of students about ways of succeeding in the program?** | **Follow up:** How would you recommend they manage all the varieties of resources |
| 7c. Commercial resource provider recommendation | **What advice would you give to developers of the informal resources you use?**  
- Be specific, share an example of how you think it would change X resource  
- Why is the change needed? | If more than one resource was mentioned above, probe for responses about those resources the student mentioned most |
<p>| 7d. Faculty prescribed resources | <strong>What advice would you give to [other] faculty about the design and use of formal resources?</strong> | If more than one resource was mentioned above, probe for responses about those |</p>
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<tbody>
<tr>
<td></td>
<td>Be specific, share an example of how you think it would change X resource</td>
<td>resources the student mentioned most</td>
</tr>
<tr>
<td></td>
<td>Why is the change needed?</td>
<td></td>
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<tr>
<td>8. Research focus</td>
<td>We have talked about your experiences in the program and the many resources you use for your learning. <strong>What would you say is the most important for us to consider as we research the use of varied resources in medical education?</strong></td>
<td>Refocusing on the importance of their perspective, beginning of the ending sequence</td>
</tr>
<tr>
<td>9. Concluding invitation</td>
<td><strong>What would you like to add that we did not discuss or I did not know to ask?</strong></td>
<td>Wait for a few seconds after asking.</td>
</tr>
<tr>
<td>10. Parting</td>
<td><strong>Thank you for your time. I learned a lot from you and I hope your contributions and our research can make a difference. If you think of anything you would like to add after this conversation, please email me at any time. (give card/email)</strong></td>
<td>Show importance of their contribution</td>
</tr>
</tbody>
</table>
March 24, 2022

Dear Atsusi Hirumi,

On 12/18/2020, the IRB reviewed the following submission:

<table>
<thead>
<tr>
<th>Type of Review:</th>
<th>Initial Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Stakeholders’ Perceptions and Use of Formal and Informal MedEd Curriculum Resources</td>
</tr>
<tr>
<td>Principal Investigator:</td>
<td>Atsusi Hirumi</td>
</tr>
<tr>
<td>Co-Investigator:</td>
<td>Ziana Bagot</td>
</tr>
<tr>
<td>IRB ID:</td>
<td>STUDY00002339</td>
</tr>
<tr>
<td>Funding:</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID:</td>
<td>None</td>
</tr>
<tr>
<td>IND, IDE, or HDE:</td>
<td>None</td>
</tr>
<tr>
<td>Documents Reviewed:</td>
<td>Consent Form, Category: Consent Form; Curriculum Resources IMDO .docx, Category: Survey / Questionnaire; Curriculum Resources Study IRB, Category: IRB Protocol; Interview Questions.docx, Category: Interview / Focus Questions; Learning Log, Category: Other; Recruitment Invitations_201216_2c.docx, Category: Recruitment Materials</td>
</tr>
</tbody>
</table>

The IRB approved the protocol from 12/18/2020.

In conducting this protocol, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. Guidance on submitting Modifications and a Continuing Review or Administrative Check-in are detailed in the manual. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Katie Kilgore
Designated Reviewer