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The Impact of an Early Structured Research Elective for Medical Students on Research Confidence, Scholarly Output, and Residency Outcomes at a Community-Based Medical School

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Abstract

Background

The Research Experience for Medical Students (REMS) elective was developed to reduce barriers to scholarship through a structured, longitudinal curriculum within a community-based medical school. This study evaluates its impact on research confidence, research skill, scholarly productivity, and residency-related outcomes between 2020 and 2025.

Methods

A cross-sectional program evaluation was administered in 2025 using electronic surveys distributed to current REMS participants, past participants, nonparticipants, recent graduates, and faculty mentors. Survey metrics were supplemented by institutional Independent Student Analysis data (2020–2022). Quantitative between-group comparisons were evaluated using non-parametric analyses.

Results

Sixty-six students and graduates participated (58 REMS participants, 8 nonparticipants). REMS participants demonstrated significantly higher scholarly productivity than nonparticipants (M = 4.22 vs. 0.57 products; p=.004). Participants reported increased confidence in conducting research, identifying mentorship as the primary program strength. Among responding graduates, 81.3% discussed their REMS experience during residency interviews. Institutionally, student satisfaction with research access increased from 47% to 74%, and satisfaction with research support rose from 52% to 74% following REMS implementation.

Conclusions

Longitudinal structured research electives foster scholarly productivity, enhance student confidence, and cultivate a positive institutional research culture. The REMS Logic Model offers a reproducible framework for distributed, community-based medical schools.

Background

Scholarly inquiry has become an integral part of undergraduate medical education. Beyond generating publications, engaging in research develops physicians who can critically appraise evidence, apply evolving scientific knowledge to patient care, and contribute to the advancement of medicine throughout their careers. Beyond technical research skills, participation in scholarly activity fosters communication, collaboration, and intellectual curiosity. Collectively, these competencies are fundamental to clinical decision making and professional development [1, 2].

Educational research con in structured research experiences provides benefits beyond quantitative productivity. Students engaged in research report increased confidence in conducting research and stronger perceptions of the importance of research competence [3]. Similarly, participation in formal research training programs has been associated with sustained improvements in research self-efficacy [4] and promotes development of research skills, including study design, protocol development, data analysis, scientific writing, and dissemination [1].

The transition of the United States Medical Licensing Examination (USMLE) Step 1 to pass/fail reporting has intensified student desire to engage in scholarship. With the removal of numeric Step 1 scores, residency programs have increasingly relied on alternative indicators to distinguish applicants, including meaningful research participation and scholarly productivity [5]. National surveys indicate that residency program directors value substantive research participation as tangible evidence of critical thinking and self-directed inquiry, although scholarly expectations vary across disciplines [2]. Only for the highly competitive specialties are numbers of abstracts, presentations, and publications strongly associated with successful residency matching [6–8]. It is important to note that the Association of American Medical Colleges (AAMC) posits scholarly output alone incompletely predicts match success, and that significant educational engagement should remain the primary goal of research experiences [9].

Despite these advantages, medical students frequently encounter substantial barriers to research, including limited protected time, difficulty identifying mentors, and inadequate research training, and insufficient institutional support [8, 10]. These challenges are particularly pronounced in community-based medical schools, where distributed regional campuses often lack the centralized research infrastructure and extensive faculty investigator networks of traditional academic medical centers. Although specialized pathways and mentor-matching initiatives have improved research engagement, confidence, and scholarly output in specific departments in research-intensive academic medical centers [3, 11, 12], few comprehensive models have evaluated research confidence, mentorship efficacy, scholarly productivity, and residency preparation across distributed campuses of community-based medical schools [1, 11].

To address these barriers, the University of North Dakota School of Medicine & Health Sciences (UND SMHS) established the Research Experience for Medical Students (REMS) elective series. The longitudinal, faculty-mentored elective guides students through project formulation, execution, and scholarly dissemination. Through structured mentorship and dedicated research time, the program seeks to reduce barriers to scholarly activity for students in a community-based program across geographically distributed campuses.

The REMS curriculum is grounded in Kolb's Experiential Learning Theory, conceptualizing learning as a four-stage cyclical process: concrete experience, reflective observation, abstract conceptualization, and active experimentation [13]. Students first engage in authentic research experiences through faculty-mentored projects, reflect on those experiences with guidance from mentors, integrate methodological concepts through formal instruction, and subsequently apply those concepts during continued

participation in their research projects. Through repeated engagement in this experiential learning cycle, students are expected to strengthen research self-efficacy, develop a professional identity that incorporates scholarly inquiry, and recognize research as an integral component of clinical practice rather than an isolated academic exercise [3, 4].

We conducted this study to evaluate the effectiveness of the REMS by examining both subjective and objective outcomes. Specifically, we sought to determine whether participation in REMS was associated with greater confidence in research and increased scholarly productivity compared with medical students who did not participate in the program. We aimed to assess its potential to enhance research training, expand scholarly opportunities, and improve residency competitiveness for medical students training at a community-based medical school.

Methods

Study Design and Setting

We conducted a cross-sectional program evaluation at UND SMHS to evaluate the REMS curriculum. We combined quantitative survey metrics with historical institutional benchmark data. The study received exempt determination (categories 1 and 2) from the University of North Dakota Institutional Review Board (Protocol Number: IRB0006817). All participant responses were anonymous to protect participant confidentiality.

Participants

The eligible participants included three distinct cohorts:

1. current medical students of the UND SMHS classes 2026–2028 (n = 220)
2. recent graduates from the classes of 2024 and 2025 (n = 75)
3. faculty members and clinical preceptors who served as mentors within the REMS program (n = 116).

Exclusion criteria included students currently on official leave of absence, members of the classes of 2024 and 2025 who did not complete the M.D. program, and faculty who mentored only part of a REMS cycle. Eligible participants were identified using class email lists, records of previous REMS mentors, and forwarding email addresses on file for graduates. Survey invitations were distributed electronically through university email accounts, with alternative email addresses used for graduates and mentors when necessary. One reminder email was sent after the initial invitation. Current medical students also received a reminder via the GroupMe messaging platform. Participation was voluntary, and no incentives were provided.

Measures

We administered online surveys via Qualtrics. Participants reviewed an information sheet describing the study prior to proceeding to the survey and clicking through implied consent. Unique survey pathways were developed for students, graduates, and faculty mentors, utilizing conditional branching logic to tailor items based on self-reported REMS participation status. Survey items utilized five-point Likert scales (1 = strongly disagree to 5 = strongly agree). Questions for students and recent graduates measured participant satisfaction, perceived curriculum value, self-reported confidence in performing research, and impact of research on residency applications. For mentors, the questions included preparedness of students to participate in the program, progression of research projects toward dissemination, and culture of the program. Student surveys also collected demographic information including class year, intended specialty, and scholarly productivity. Graduate surveys included residency specialty and match outcome. The complete set of survey items are available in Additional file 1.

We extracted institutional benchmark metrics from the UND SMHS Independent Student Analysis (ISA) reports from 2020 (pre-implementation baseline), 2021 (year 1 post-implementation), and 2022 (year 2 post-implementation) to track multi-year shifts in student satisfaction regarding research access and institutional support.

Data Analysis

We performed our statistical analyses using IBM SPSS Statistics, Version 31.0.0 (IBM Corp., Armonk, NY, USA [14]). We evaluated variables for normality using the Shapiro-Wilk test. Because primary continuous variables demonstrated non-normal distributions ($p < .05$), we used non-parametric Mann-Whitney U tests to assess differences in scholarly output and perceptions between REMS participants and nonparticipants. We summarized multi-year ISA survey responses descriptively using counts and percentages. We set statistical significance at two-tailed $p < .05$.

Results

Demographics

Surveys were completed by 66 student and graduate respondents, representing 58 REMS participants (87.9%) and 8 nonparticipants (12.1%). Current students comprised 75.8% of respondents (50/66), while graduates accounted for 24.2% (16/66; see Table 1).

Table 1
Demographic Characteristics and Cohort Breakdown of Survey Respondents (N = 66).

Characteristic	n	%
REMS Participation		
Participant	58	87.9
Non-Participant	8	12.1
Student Status		
Current student	50	75.8
Previous student/alumnus	16	24.2
Class Year/Graduation Year		
MS2	15	22.7
MS3	23	34.8
MS4	12	18.2
Graduated 2025	8	12.1
Graduated 2024	8	12.1
Total	66	100.0

Data represent survey responses from current medical students and recent MD graduates across the classes of 2024 through 2028. Values are presented as number of respondents (*n*) and percentage of total sample (%). Abbreviations: MS2 = second-year medical student; MS3 = third-year medical student; MS4 = fourth-year medical student.

Student Perceptions

Overall, student perceptions of REMS were favorable (Fig. 1). Mentorship was the highest-rated programmatic element among REMS participants, with a median score of 4.00 (IQR 3.00–4.00; *M* = 3.69, *SD* = 0.90). Overall, 63.8% (37/58) of participants agreed or strongly agreed that the mentorship provided by the program was valuable to their learning, with 46.6% (27/58) agreeing and 17.2% (10/58) strongly agreeing. In contrast, 24.1% (14/58) responded neutral, and 12.1% (7/58) disagreed. Students reported increased confidence in conducting research, with a median score of 4.00 (IQR 3.00–4.00; *M* = 3.67, *SD* = 0.87). Overall, 63.8% (37/58) of participants agreed or strongly agreed that REMS helped them build research confidence, comprising 50.0% (29/58) who agreed and 13.8% (8/58) who strongly agreed. In contrast, 27.6% (16/58) responded neutral, 6.9% (4/58) disagreed, and 1.7% (1/58) strongly disagreed.

For students who reached the stage of applying to residency (*n* = 14), participants reported that REMS helped strengthen their applications, with a median score of 4.00 (IQR 3.00–4.00; *M* = 3.50, *SD* = 1.09). Overall, 57.1% (8/14) agreed or strongly agreed with this statement, comprising 42.9% (6/14) who agreed and 14.3% (2/14) who strongly agreed, while 28.6% (4/14) were neutral, 7.1% (1/14) disagreed, and 7.1% (1/14) strongly disagreed. Furthermore, 81.3% of responding graduates (13/16) reported discussing their REMS research project during residency interviews.

Comparative Cohot Outcomes

Mann-Whitney U testing (Table 2) confirmed that REMS participants produced significantly more total research products (Mean Rank = 35.35, *n* = 58) than nonparticipants (Mean Rank = 13.50, *n* = 7; *U* = 66.5, *z* = -2.92, p = .004). REMS participants reported a mean of 4.22 scholarly products (*SD* = 4.41) compared with 0.57 (*SD* = 0.98) among nonparticipants. No statistically significant differences were observed between REMS participants and nonparticipants regarding self-reported confidence in data analysis (Mean Rank = 26.00, *n* = 44 vs. Mean Rank = 21.83, *n* = 6; *U* = 110.0, *z* = − .71, *p* = .48), perceived preparedness to discuss research during residency interviews (Mean Rank = 26.32, *n* = 44 vs. Mean Rank = 19.50, *n* = 6; *U* = 96.0, *z* = -1.20, *p* = .23), or first-choice specialty match rate (Mean Rank = 8.57, *n* = 14 vs. Mean Rank = 8.00, *n* = 2; *U* = 13.0, *z* = − .38, *p* = .71).

Table 2
Nonparametric Between-Group Comparisons of Scholarly Productivity, Perceived Research Confidence, and Match Outcomes

Outcome	**REMS**		**Non-Rems**		**U**	**z**	**p**
	n	**Mean Rank**	**n**	**Mean Rank**			
Research products completed	58	35.35	7	13.5	66.5	-2.92	.004*
Confidence analyzing research data	44	26.00	6	21.83	110.0	− .71	.48
Prepared to discuss research in interviews	44	26.32	6	19.50	96.0	-1.20	.23
Matched into first-choice specialty	14	8.57	2	8.00	13.0	− .38	.70

Comparisons between medical students who participated in the REMS program and nonparticipating peers using the Mann-Whitney U test. Values represent sample sizes (*n*) and mean ranks for each cohort, alongside the Mann-Whitney test statistic (*U*), standard normal z-score (*z*), and asymptotic two-tailed significance level (*p*).

*Statistically significant at p < .05.

Specialty Interests

REMS participants pursued a broad range of specialties. Internal medicine was the most frequent target specialty among REMS students (19.0%, 11/58) compared to nonparticipants (12.5%, 1/8). REMS trainees demonstrated participation in competitive specialties, including orthopedic surgery (12.1%, 7/58), anesthesiology (10.3%, 6/58), and diagnostic radiology (8.6%, 5/58), whereas nonparticipants were not represented in these fields. Other specialties chosen by REMS participants included emergency medicine (6.9%, 4/58), obstetrics and gynecology (5.2%, 3/58), psychiatry (3.4%, 2/58), pediatrics (1.7%, 1/58), general surgery (1.7%, 1/58), and neurology (1.7%, 1/58). Undecided students represented 17.2% (10/58) of REMS participants and 12.5% (1/8) of nonparticipants.

Institutional Culture Trends

Institutional benchmark data revealed progressive improvements in student satisfaction following REMS implementation (Fig. 2). Satisfaction with the ease of accessing research opportunities rose from 47.0% (138/294) in 2020 to 57.0% (159/277) in 2021 and 74.0% (196/266) in 2022. Similarly, satisfaction with institutional support for student research increased from 52.0% (152/294) in 2020 to 61.0% (169/277) in 2021 and 74.0% (196/266) in 2022.

Mentors

Mentor survey responses (n = 23) demonstrated positive perceptions across all evaluated domains (Fig. 3). Mentors strongly endorsed recommending REMS as a valuable mentorship opportunity (median 5.00, IQR 4.00–5.00; M = 4.30, SD = 0.97), with 87.0% (20/23) agreeing or strongly agreeing. High levels of agreement were also reported for REMS fostering a positive student research culture (median 4.00, IQR 4.00–5.00; M = 4.22, SD = 1.04; 87.0% (20/23) agreement) and supporting effective student progress toward dissemination (median 4.00, IQR 4.00–5.00; M = 4.13, SD = 0.92; 87.0% (20/23) agreement). Mentors also agreed that students were well prepared to initiate their research projects (median 4.00, IQR 3.00–4.00; M = 3.65, SD = 1.03), with 65.2% (15/23) indicating agreement or strong agreement.

Discussion

This program evaluation indicates that implementing a structured, longitudinal research elective series within a community-based medical school significantly improves scholarly productivity, strengthens student research confidence, and fosters an institutional culture supportive of scholarship. REMS participants generated significantly more scholarly deliverables than nonparticipants (p = .004), while institutional data demonstrated sustained gains in student-perceived access to and support for research over a three-year period.

Our results align with prior medical education literature showing that formal, mentored research programs support trainee self-efficacy, skill acquisition, and scholarly participation [15]. The primary structural foundation of the program is the REMS Logic Model (see Additional file 2), which provides

explicit scaffolding from mentor identification to scholarly dissemination rather than requiring students to navigate the research process independently. Through an educational framework grounded in experiential learning, the REMS model supports students as they develop, complete, and disseminate original research while providing the institutional structure needed to sustain scholarly engagement, addressing barriers commonly encountered at community-based medical schools. As a result, it offers a practical, reproducible framework that other community-based medical schools can adapt to strengthen student scholarship despite limited research infrastructure.

Mentorship emerged as the highest-rated programmatic element by students and faculty alike. Structured mentoring networks not only enhance research execution but also foster professional identity formation and sense of belonging in the research community [10, 11]. The willingness of 87.0% of mentors to recommend the program underscores that formal curricular structures protect mentor effort and clarify expectations, sustaining faculty engagement in distributed teaching environments with limited research activity. Another key finding was the increase in participants' confidence in conducting research. Research self-efficacy is an important predictor of future scholarly engagement, and this study’s results are consistent with previous work demonstrating improvements in research confidence following structured research experiences [3, 4]. These findings suggest that REMS contributes to attitude and skills that are transferable in residency and clinical practice.

Although increasing publication counts was not the primary objective of REMS, participants demonstrated significantly greater scholarly productivity than nonparticipants, supporting the effectiveness of the program's structured design. This finding is particularly relevant as substantiative research experiences continue to be valued during residency selection, especially in the post-Step 1 pass/fail landscape [2, 6]. Notably, over 80% of graduates reported discussing their REMS research experiences during residency interviews, suggesting that the program provides students with experiences that extend beyond publications by helping them articulate scholarly growth, collaboration, and problem-solving during the residency application process.

Limitations

This study has limitations that should be recognized. First, it was conducted at a single community-based medical school, which may limit generalizability to institutions with different student populations or research infrastructures. Second, participation in REMS is voluntary, introducing the possibility of selection bias because students with greater baseline interest in research may have been more likely to enroll. Third, several outcomes, including research confidence and mentorship quality, were self-reported and therefore subject to response and recall bias. Additionally, the relatively small sample size, particularly among nonparticipants, may have limited statistical power. Finally, the cross-sectional design precludes conclusions regarding causality or long-term effects on academic careers, residency outcomes, and sustained scholarly productivity.

Conclusions

The REMS elective series demonstrates that a structured, integrated research curriculum can expand opportunities for scholarly engagement among students within a community-based medical school. The REMS Logic Model provides a reproducible, scalable framework for medical educators seeking to integrate research training, strengthen faculty mentorship, and support evidence-based medicine competencies across decentralized campuses. Future studies should examine community-based medical schools' implementations and longitudinal tracking to determine the long-term impact of structured undergraduate research electives on scholarly productivity during residency and academic career selection.

Abbreviations

• REMS
Research Experience for Medical Students
• USMLE
United States Medical Licensing Examination
• AAMC
Association of American Medical Colleges
• UND SMHS
University of North Dakota School of Medicine & Health Sciences
• ISA
Independent Student Analysis
• IQR
Interquartile Range

Declarations

Ethical Approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and institutional guidelines and regulations. The protocol was reviewed and approved by the University of North Dakota Institutional Review Board (UND IRB protocol number IRB0006817). All participants were presented with study information detailing the purpose of the research, procedures, voluntary nature of participation, confidentiality safeguards, and investigator contact information. Written informed consent to participate was obtained from all participants.

Consent for Publication

Not applicable.

Conflicts of Interest

The authors declare that they have no competing interests.

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None declared.

Author Contribution

ED and PF contributed equally to this work. ED and PF were responsible for developing the study measures, preparing the institutional review board protocol, conducting data collection and data analysis, and drafting and revising the initial manuscript. SS conceived the study, provided mentorship throughout study design and implementation, assisted with data analysis, edited the manuscript, and prepared and submitted the final version. SS serves as the corresponding author. All authors read and approved the final manuscript.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

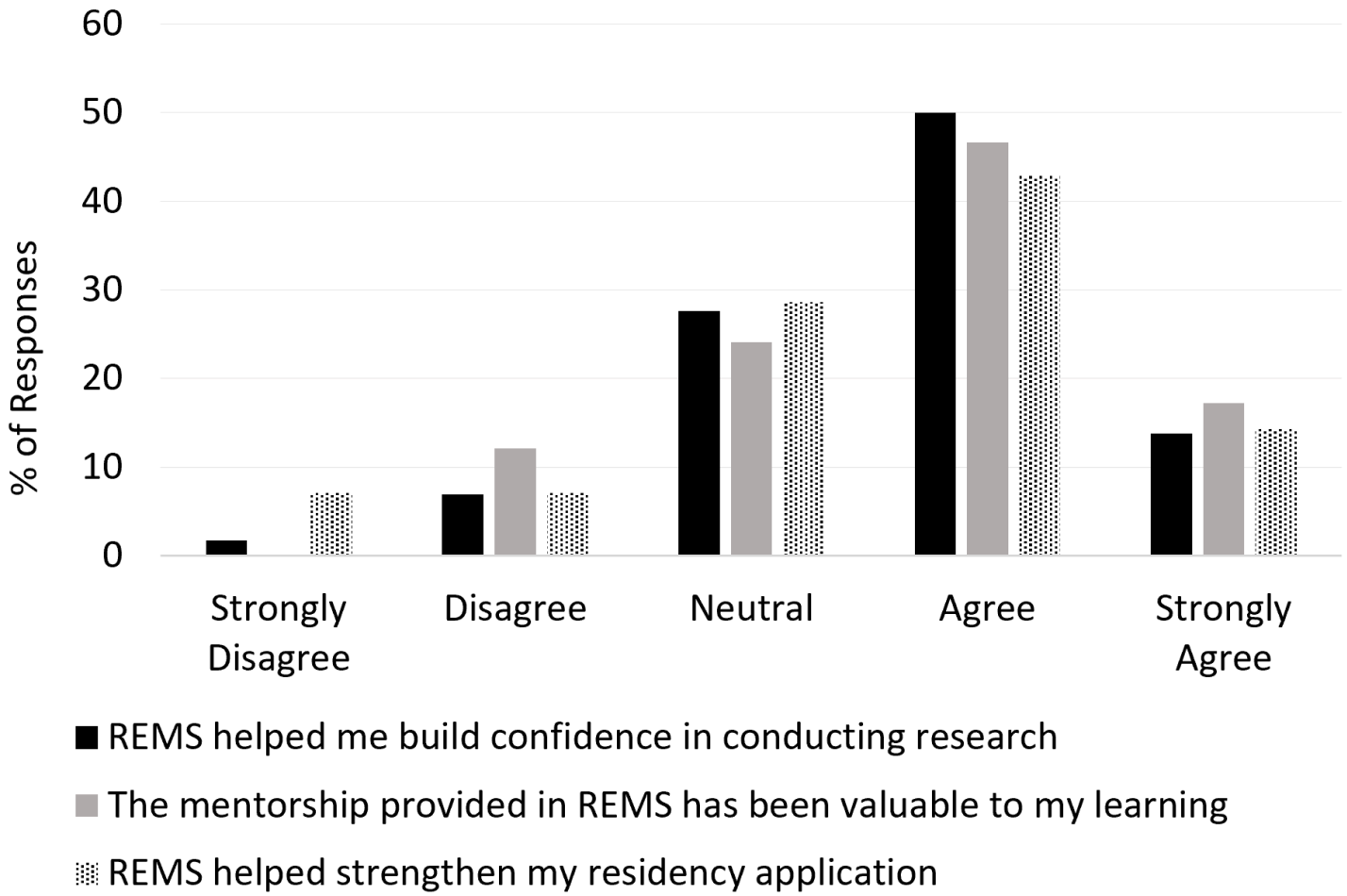


Figure 1

Student perceptions of the REMS elective series. Distribution of participant responses to Likert-scale items evaluating the impact of the REMS elective series on research confidence (*n* = 58), mentorship value (*n* = 58), and perceived strengthening of residency applications (*n* = 14). Bars represent the valid percentage of respondents endorsing each response category from 1 ("strongly disagree") to 5 ("strongly agree").

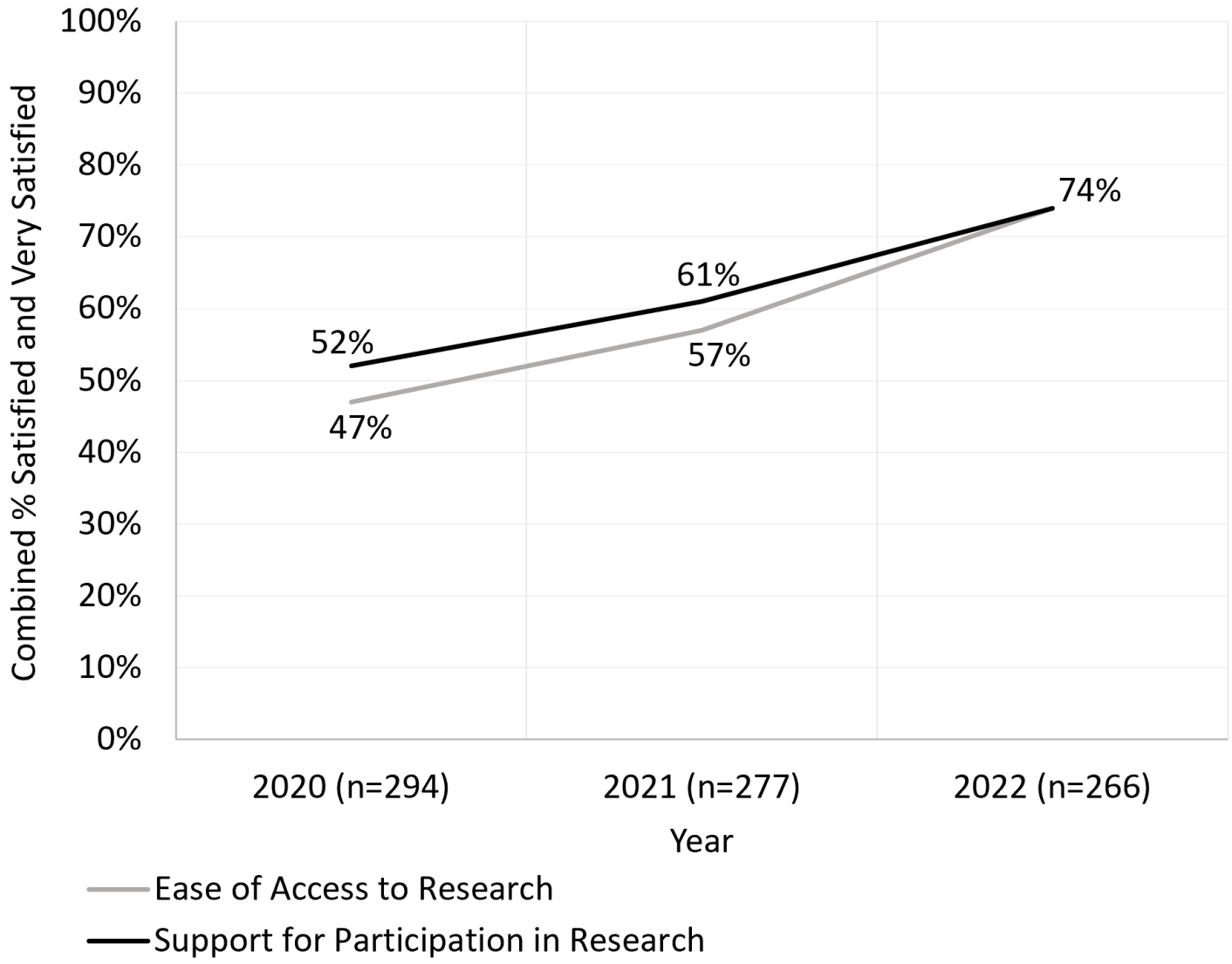


Figure 2

Institutional Benchmarking of Student Research Accessibility and Support from 2020 to 2022. Multi-year comparison of student satisfaction extracted from annual Independent Student Analysis reports at the UND SMHS. Data reflect combined percentages of students indicating they were satisfied or very satisfied with ease of access to research opportunities (gray line) and institutional support for research participation (black line) across the baseline year (2020; *n* = 294), Year 1 post-REMS (2021; *n* = 277), and Year 2 post-REMS (2022; *n* = 266).

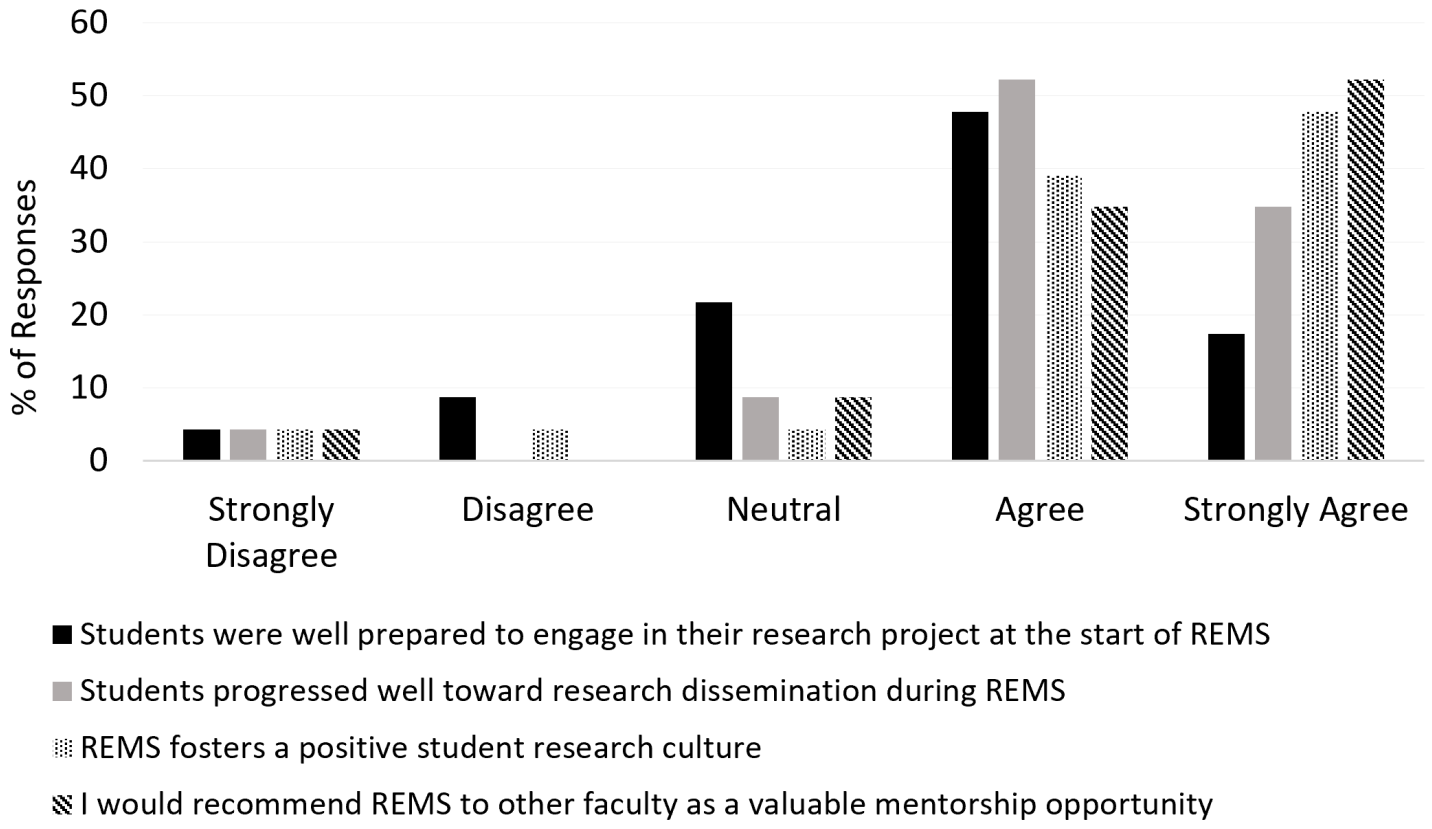


Figure 3

Mentor Perceptions of Student Preparedness, Scholarly Dissemination, Research Culture, and Mentorship Utility. Proportion of faculty mentor ratings (n = 23) evaluating the educational and institutional impact of the REMS elective series. Survey items assessed: (1) baseline student readiness to engage in mentored projects, (2) student progression toward formal scholarship dissemination, (3) program contribution to institutional student research culture, and (4) likelihood of recommending REMS to faculty colleagues as a rewarding mentorship opportunity. Data are presented as the valid percentage of total respondents across Likert-scale categories ranging from strongly disagree to strongly agree.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1.docx
- AdditionalFile2.docx