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From Screen to Skills: Preparing Medical Students for Telemedicine Practice

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Abstract

Background

To assess the impact of a multimodal telemedicine curriculum on pre-clerkship medical students' confidence in core competencies.

Method

A cohort of 238 second-year medical students completed mandatory asynchronous modules, with 15 students (6%) opting for an additional interactive workshop. Confidence in nine telemedicine competencies was measured using pre- and post-intervention surveys, with a one-year follow-up. One-way ANOVA and post hoc Tukey tests were employed to analyze group differences.

Results

Significant differences in confidence were observed across six groups ($F(5, 6258) = 340$, $p < .001$). Post-module confidence increased from baseline (Pre-Modules Group: $M = 2.14 \pm 0.87$) to post-module (Post-Modules Group: $M = 3.02 \pm 0.71$) and further after the workshop (Post-Workshop Group: $M = 3.59 \pm 0.59$). The Pre-Workshop Group had a mean of 2.63 ± 0.64, lower than the Post-Modules Group, with no additional intervention between surveys. The No Intervention Group maintained baseline confidence ($M = 2.14 \pm 0.95$). Competency-specific gains were largest in performing focused examinations, troubleshooting technology, and documentation. One-year follow-up showed confidence remained above baseline (1-Year Follow-Up Group: $M = 2.36 \pm 0.97$) but declined from post-intervention levels.

Conclusions

A brief, structured telemedicine curriculum improved pre-clerkship students' confidence across multiple competencies. The pattern of workshop participation suggests self-selection among students seeking extra practice. Integrating multimodal telemedicine training longitudinally may enhance preparedness for virtual care and bridge gaps between pre-clerkship education and clinical demands.

BACKGROUND

The landscape of modern medicine has been transformed by technological advancements. Among these advances, telemedicine has emerged as a rapidly growing and impactful modality that has reshaped healthcare delivery.[1] Telemedicine enables physicians to provide care remotely, overcoming geographic and logistical barriers, and improving access for underserved populations. The COVID-19 pandemic accelerated telemedicine adoption across nearly all specialties, highlighting the necessity for clinicians to become proficient in telemedicine.[2–5]

Despite this rapid expansion, formal training in telemedicine remains limited in medical school curricula, leaving many students unprepared for virtual care during clinical clerkships.[6–12] Even prior to the COVID-19 pandemic, the American Medical Association recognized this need in 2016, recommending telemedicine as a core competency in medical education and emphasizing skills such as remote communication, digital professionalism, and technology integration.[13] However, few institutions offer structured curricula prior to this call to develop these competencies.[14–19]

To address these gaps, medical schools have implemented institution-specific telemedicine curricula, including multimodal programs, longitudinal telehealth threads (e.g., Stanford), and national asynchronous modules from the Society of Teachers of Family Medicine.[20–22] Before the COVID-19 pandemic, only about 56% of U.S. schools reported any formal telehealth

curriculum, with rapid expansion during and after the pandemic.[23] Despite this growth, significant gaps persist: challenges to incorporate standardized competency-based content, robust assessment of telemedicine skills, and early hands-on training in in curricula, and only a small proportion incorporate student-led or learner-initiated innovations.

Transition to Clerkship (TTC) curricula are increasingly used to prepare medical students for clinical responsibilities through concentrated, practice-oriented experiences that bridge preclinical and clinical training. Within this context, we developed a multimodal telemedicine curriculum as part of our institution's TTC series to address these gaps by embedding telemedicine competencies, incorporating structured skill assessments, and fostering student-driven learning and innovation.

This study aimed to: 1) assess the attitudes and exposure to telemedicine amongst medical students in their preclinical years; 2) evaluate the types of telemedicine educational experiences during third-year clerkships; 3) develop a multimodal curriculum tailored to student needs; and 4) assess the impact of this curriculum on students' confidence in delivering care via telemedicine. By identifying educational gaps and evaluating curricular effectiveness, this study seeks to prepare future physicians for the evolving landscape of virtual healthcare.

METHODS

Study Design, Curriculum Development, and Learning Objectives

We used the Plan-Do-Study-Act (PDSA) framework to design, implement, and refine a multimodal telemedicine curriculum.[24] Curriculum development followed Kern's Six-Step Approach, beginning with a needs assessment, defining goals and objectives, selecting educational strategies, implementing the curriculum, and evaluating the outcomes.[25]

Findings from our needs assessment survey informed development of a focused curriculum targeting core telemedicine competencies, with emphasis on areas of lower self-reported confidence. The learning objectives for this curriculum were:

1. Demonstrate use of telemedicine platforms and technology.
2. Complete a focused virtual physical examinations.
3. Complete accurate documentation for telemedicine encounters.
4. Identify and resolve common connectivity and technological issues.
5. Use telemedicine platforms to communicate clinical information clearly and accurately to patients and caregivers.

The curriculum was delivered during the transitional phase between preclinical (pre-clerkship) and clinical years (end of second year of medical school) and consisted of the following:

1. Mandated completion of asynchronous modules on a web-based learning platform (all second-year students)
2. Optional interactive workshop with standardized patient encounters to practice skills and receive real-time feedback (for students who elected to pursue this workshop)

Student confidence across nine telemedicine competencies was measured using surveys (Table 1), and overall confidence was calculated as the mean of the nine competency scores. This structured approach ensured that the curriculum systematically targeted both general telemedicine competencies and the specific skill gaps identified in our needs assessment, preparing students for the transition to clerkship.

Table 1
Telemedicine Competencies Assessed in Medical Students

A	**Navigating telemedicine platforms & technology**
B	Establishing rapport with patients & families
C	Obtaining a focused history
D	Performing a focused clinical exam
E	Formulating a differential diagnosis
F	Formulating a plan of care
G	Documenting a telemedicine encounter
H	Troubleshooting technological issues
I	Troubleshooting non-technological issues

Study Population

Participants were medical students at McGovern Medical School. We grouped the students based on the basis of the curricular intervention. The No Intervention Group were students who had completed their clinical years without any formal telemedicine curriculum and served as the control group. The intervention groups consisted of students who completed the telemedicine curriculum during their transition to clerkship block near the end of their second year of medical school and were assessed at different timepoints and with different interventions. Pre-Modules Group, Post-Modules Group, Pre-Workshop Group, and Post-Workshop Group represented sequential stages of curricular exposure before the MS3 year and the 1-Year Follow-Up Group represented one-year follow-up after clerkships (Table 2, Figs. 1–2).

Table 2
Study Groups and Subgroups and Timing of Telemedicine Curriculum Exposure

Group	N	Cohort	Timing	Intervention
No intervention	118	Class of 2023	Beginning of MS4 year	No intervention (control)
Pre-modules	238	Class of 2025	End of MS2 year	Pre-TTC modules (baseline)
Post-modules	238	Class of 2025	End of MS2 year	Post-TTC modules
Pre-workshop	15	Class of 2025	End of MS2 year	Post-TTC modules, pre-TTC workshop
Post-workshop	15	Class of 2025	End of MS2 year	Post-TTC modules, post-TTC workshop
1-year follow-up	72	Class of 2025	Beginning of MS4 year (1-year follow-up)	Post-TTC modules ± workshop

Data Collection

Surveys were administered to medical students at multiple time points corresponding to the six study groups (Table 2, Figs. 1–3). All surveys used the same 4-point Likert scale (1 = not at all confident, 2 = slightly confident, 3 = moderately confident, 4 = extremely confident) question to assess self-reported confidence across nine telemedicine competencies (Table 1, Fig. 4).

Outcomes

The primary outcome was change in self-reported confidence in telemedicine competencies.

Statistical Analysis

Data were analyzed using Microsoft Excel (2010). Descriptive statistics (means, standard deviations, and percentages) were used to summarize the survey responses. Differences across groups and modalities were assessed using one-way ANOVA, followed by Tukey's Honest Significant Difference (HSD) test for pairwise comparisons. Effect sizes were calculated using partial eta-squared (ηp^2).

Ethical Considerations

The project was reviewed and determined to be exempt by the McGovern Medical School Institutional Review Board under its Quality Improvement charter, as it aimed to evaluate and improve the curriculum rather than conduct human subjects research.

RESULTS

Needs Assessment

Of the 240 fourth-year students contacted, 128 completed the baseline survey (54% response rate). Students reported exposure to telemedicine in all 8 third-year clerkships. Family medicine (95%), neurology (62%), and pediatrics (52%) had the highest proportion of students reporting exposure to telemedicine, whereas surgery (7%) and obstetrics/gynecology (12%) had the lowest.

The majority of students felt not confident at all or slightly confident in navigating telemedicine platforms (75%), performing focused telemedicine exams (80%), documenting encounters (65%), troubleshooting technology (77%), and troubleshooting non-technological issues (75%). These baseline results corresponded to the No Intervention Group, which served as a secondary control.

Primary Outcome of Curricular Intervention

All 238 students in the Class of 2025 completed the mandatory asynchronous modules (100% participation). Of these, 15 students (6%) elected to participate in the optional interactive workshop. One-way ANOVA revealed significant differences in overall confidence across the six study groups ($F(5, 6258) = 340$, $p < .001$, $\eta p^2 = 0.2$).

Comparison of Control Groups

Students in the no-intervention control group (No Intervention Group: 2.14 ± 0.95) maintained baseline confidence, and there was no statistically significant difference between the No Intervention Group and Pre-Modules Group ($p = 0.90$), indicating that both groups effectively served as controls.

Subgroup Analysis

Mean overall confidence, calculated as the average across all nine competencies, increased from baseline (Pre-Modules Group: 2.14 ± 0.87) to post-module (Post-Modules Group: 3.02 ± 0.71) and further after the interactive workshop (Post-Workshop Group: 3.59 ± 0.59) (Table 3, Fig. 5).

Table 3
Mean ± SD Confidence Scores Across Telemedicine Competencies by Study Group

Competency	Pre-Modules	Post-Modules	Pre-Workshop	Post-Workshop	1-Year Follow-Up	No Intervention
A	1.847 ± 0.930	1.857 ± 0.865	2.966 ± 0.680	2.667 ± 0.488	3.733 ± 0.458	2.069 ± 0.998
B	2.517 ± 0.845	2.571 ± 0.833	3.282 ± 0.596	2.867 ± 0.640	3.600 ± 0.507	2.694 ± 0.850
C	2.695 ± 0.822	2.597 ± 0.721	3.210 ± 0.601	2.800 ± 0.561	3.667 ± 0.617	2.833 ± 0.822
D	1.703 ± 0.870	1.895 ± 0.872	2.987 ± 0.640	2.533 ± 0.640	3.600 ± 0.633	2.111 ± 0.972
E	2.373 ± 0.855	2.214 ± 0.741	2.933 ± 0.720	2.533 ± 0.516	3.533 ± 0.640	2.500 ± 0.822
F	2.297 ± 0.899	2.071 ± 0.790	2.916 ± 0.747	2.533 ± 0.743	3.533 ± 0.640	2.431 ± 0.863
G	2.051 ± 0.959	2.063 ± 0.891	2.958 ± 0.773	2.467 ± 0.743	3.467 ± 0.640	2.125 ± 1.047
H	1.822 ± 0.902	1.929 ± 0.904	2.950 ± 0.745	2.600 ± 0.737	3.600 ± 0.633	2.222 ± 1.091
I	1.907 ± 0.915	2.021 ± 0.819	2.966 ± 0.728	2.667 ± 0.724	3.533 ± 0.640	2.222 ± 0.982
Overall	2.135 ± 0.945	2.135 ± 0.867	3.019 ± 0.705	2.630 ± 0.644	3.585 ± 0.591	2.356 ± 0.970

Across individual competencies, the largest gains were observed in performing focused telemedicine examinations, troubleshooting technological issues, and documenting encounters, each improving by approximately 50–60% from baseline to post-intervention. Smaller but meaningful gains were observed in obtaining a focused history and establishing rapport with patients who had higher baseline confidence (Table 3). Overall, variability across competencies was modest, with SDs ranging from 0.50 to 0.72, suggesting consistent improvements across students.

Longitudinal Follow-Up

Seventy-two students completed the one-year follow-up survey (1-Year Follow-Up Group). Overall mean confidence remained above baseline (2.45 ± 0.73 vs 2.05 ± 0.85; mean difference = 0.40, 95% CI: 0.38–0.42, $p < .001$), although it declined relative to immediate post-intervention levels, indicating partial regression over time. Competency-specific trends mirrored these overall patterns, with retention most substantial in troubleshooting technology and documentation skills, and slightly lower in rapport-building and history-taking.

Summary

These results demonstrate that the multimodal telemedicine curriculum effectively increased student confidence across all core competencies, with the interactive workshop providing additional gains beyond asynchronous modules alone. The improvements were consistent across students and partially sustained at one-year follow-up, supporting the curriculum's value in pre-clerkship telemedicine training (Table 3, Fig. 5).

DISCUSSION

The rapid expansion of telemedicine during the COVID-19 pandemic has underscored the need for medical students to develop competencies in this field. Our multimodal curriculum directly addresses the AAMC telemedicine competencies for medical students by building skills in using technology for clinical care, performing virtual examinations, documenting

encounters, and communicating effectively in a patient-centered manner. By targeting these competencies, the curriculum prepares students to integrate telemedicine into clinical decision-making and to practice safely and professionally in virtual care settings.

This curriculum differs from prior telemedicine initiatives in several key aspects. Compared with pre-pandemic programs, which were often optional, limited in scope, or focused on a single specialty, our intervention was implemented after COVID-19 and provides early, standardized exposure for pre-clerkship medical students. This foundational exposure ensures that all students acquire core telemedicine skills before clinical clerkships, creating a baseline upon which specialty-specific telemedicine training can be built as they progress through their respective fields. While previous curricula have often emphasized short-term outcomes such as immediate confidence or satisfaction, this study demonstrates gains across multiple competencies, with longitudinal follow-up indicating retention above baseline one year later. However, some regression highlights the potential need for reinforcement.

Students completing both the asynchronous modules and the interactive workshop reported the highest overall confidence, demonstrating that even brief, structured interventions can meaningfully enhance perceived readiness for telemedicine encounters. Confidence gains were largest in performing focused telemedicine examinations, troubleshooting technological issues, and documenting encounters. In contrast, smaller gains were observed in obtaining a focused history and establishing rapport with patients, likely reflecting higher baseline confidence in these areas. These findings are consistent with prior literature showing that experiential telemedicine training, including standardized patient interactions and technology practice, enhances learner confidence.[6,7,14–19,26] Importantly, our results demonstrate that pre-clerkship exposure can bridge the gap between curricular preparation and the demands of clinical clerkships, providing foundational skills before students encounter telemedicine in practice.

An interesting pattern emerged among the subset of students who elected to participate in the optional workshop (Pre-Workshop Group). Their confidence scores before the workshop were lower than the those of the post-module group, despite having completed the same asynchronous modules. This may reflect self-selection bias, with students opting for additional training being those who felt less confident and sought more intensive instruction. This highlights the importance of offering both mandatory foundational modules and optional experiential opportunities to accommodate varying learner needs and readiness.

Telemedicine has become an integral component of clinical training in the current healthcare environment. Early, structured exposure ensures that students gain the knowledge and skills necessary to engage effectively in telemedicine and supports the broader goal of sustained integration across undergraduate and graduate medical education. By systematically targeting AAMC telemedicine competencies, this curriculum provides foundational training that can be reinforced as students advance into clinical practice and specialty-specific telemedicine experiences.

Several limitations should be noted. In this study, we assessed Kirkpatrick Level 1 (learner reaction) by measuring student self-reported confidence across telemedicine competencies. While this provides insight into learners' perceived preparedness and satisfaction, evaluating higher Kirkpatrick levels—such as behavioral change in clinical practice or patient outcomes—remains challenging given the broad range of medical specialties that students subsequently enter and the variable opportunities to apply telemedicine in each setting. Furthermore, learners were not formally assessed on performance in each objective via formal competency exams. Nonetheless, demonstrating increased confidence and familiarity represents an essential first step toward preparing students for safe and effective virtual care. Confidence measures were self-reported rather than objectively assessed; workshop participation was elective with a small number of students; and data were collected at a single institution. Nevertheless, the session's design is adaptable and scalable, offering a framework for broader implementation across medical schools. Future work should incorporate objective skill assessments, longitudinal evaluation, and multi-institutional studies to examine both retention and impact on patient care.

In conclusion, this study demonstrates that even brief, targeted interventions can enhance student confidence in core telemedicine competencies. Early, structured exposure establishes a foundation for lifelong learning in virtual care, facilitates

standardized telemedicine education, and supports the integration of telemedicine training across UME and GME. As telemedicine becomes increasingly essential to clinical practice, sustained curricular incorporation is critical to prepare future physicians for evolving healthcare delivery.[27]

Abbreviations

ANOVA
analysis of variance
COVID-19
Coronavirus disease 2019
TTC
Transition to Clerkship
PDSA
Plan-Do-Study-Act
MS3
third-year medical student
M
mean
SD
standard deviation
HSD
honest significant difference
ηp^2
Partial eta-squared
F
F statistic
P
p value
CI
confidence interval
AAMC
Association of American Medical Colleges
UME
undergraduate medical education
GME
graduate medical education

Declarations

Ethics approval and consent to participate

This study was reviewed and approved by the Institutional Review Board (IRB) at McGovern Medical School, University of Texas Health Science Center at Houston (UTHealth Houston) (protocol number HSC-MS-22-0602), and determined to be exempt from full review under its Quality Improvement charter, as the study aimed to evaluate and improve the curriculum rather than conduct human subjects research. The need for informed consent was waived by the McGovern Medical School IRB, consistent with 45 CFR 46, given the anonymous and voluntary nature of survey participation. All procedures were performed in accordance with the Declaration of Helsinki and relevant institutional guidelines and regulations.

Consent for publication

Not applicable.

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Author Contribution

E.B. contributed to study design, curriculum development, data collection, and statistical analysis, and was the primary author of the manuscript. S.C. and A.J. contributed to study design and curriculum development. M.H. and A.O. contributed to review of the study design. All authors reviewed and approved the final manuscript.

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Not applicable.

Authors' information

Not applicable.

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to institutional data governance policies but are available from the corresponding author on reasonable request.

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Figures

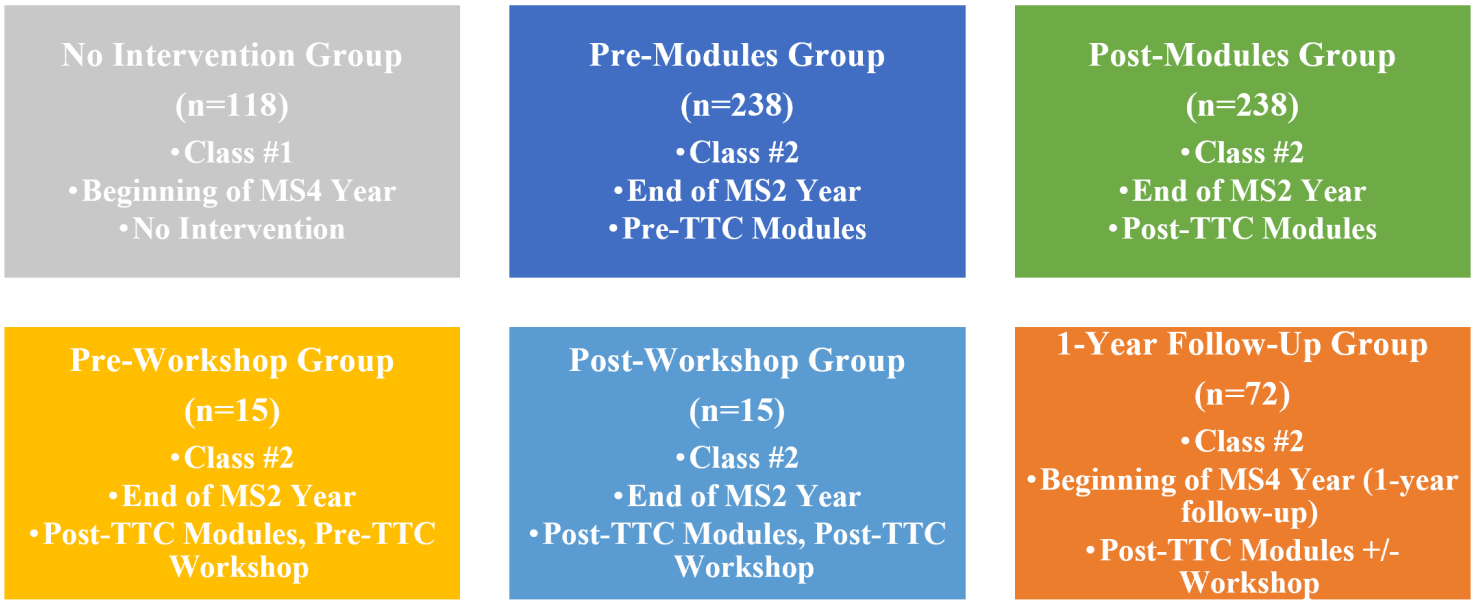


Figure 1

Study Groups and Subgroups and Timing of Telemedicine Curriculum Exposure

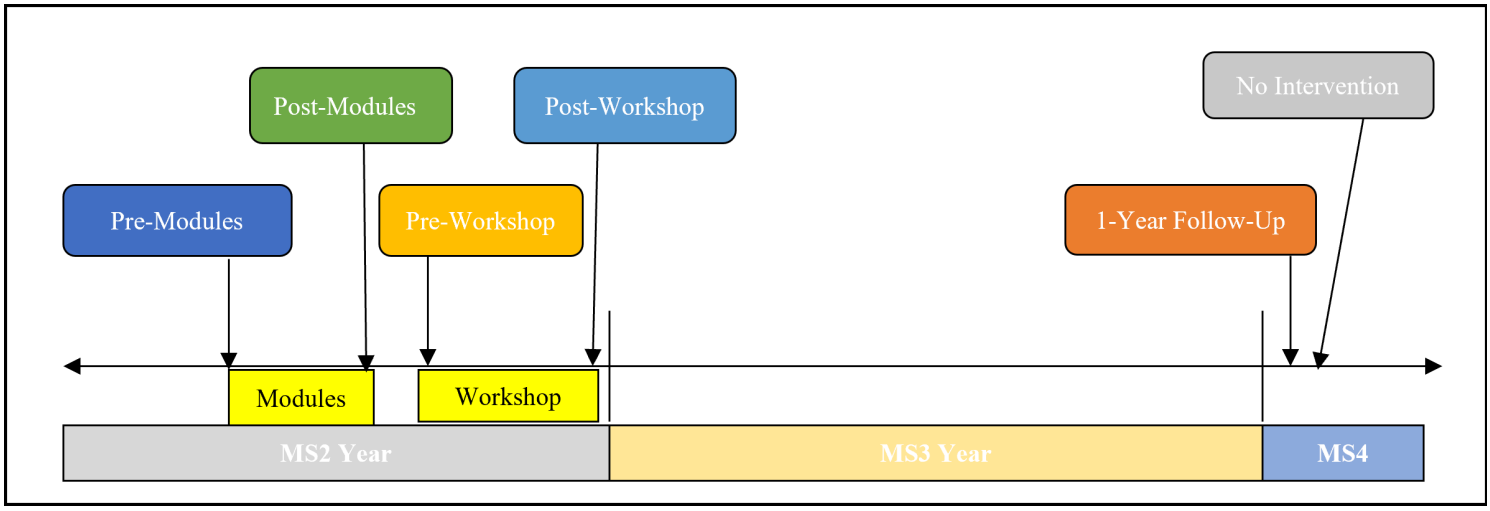


Figure 2

Study Groups on Intervention Timeline

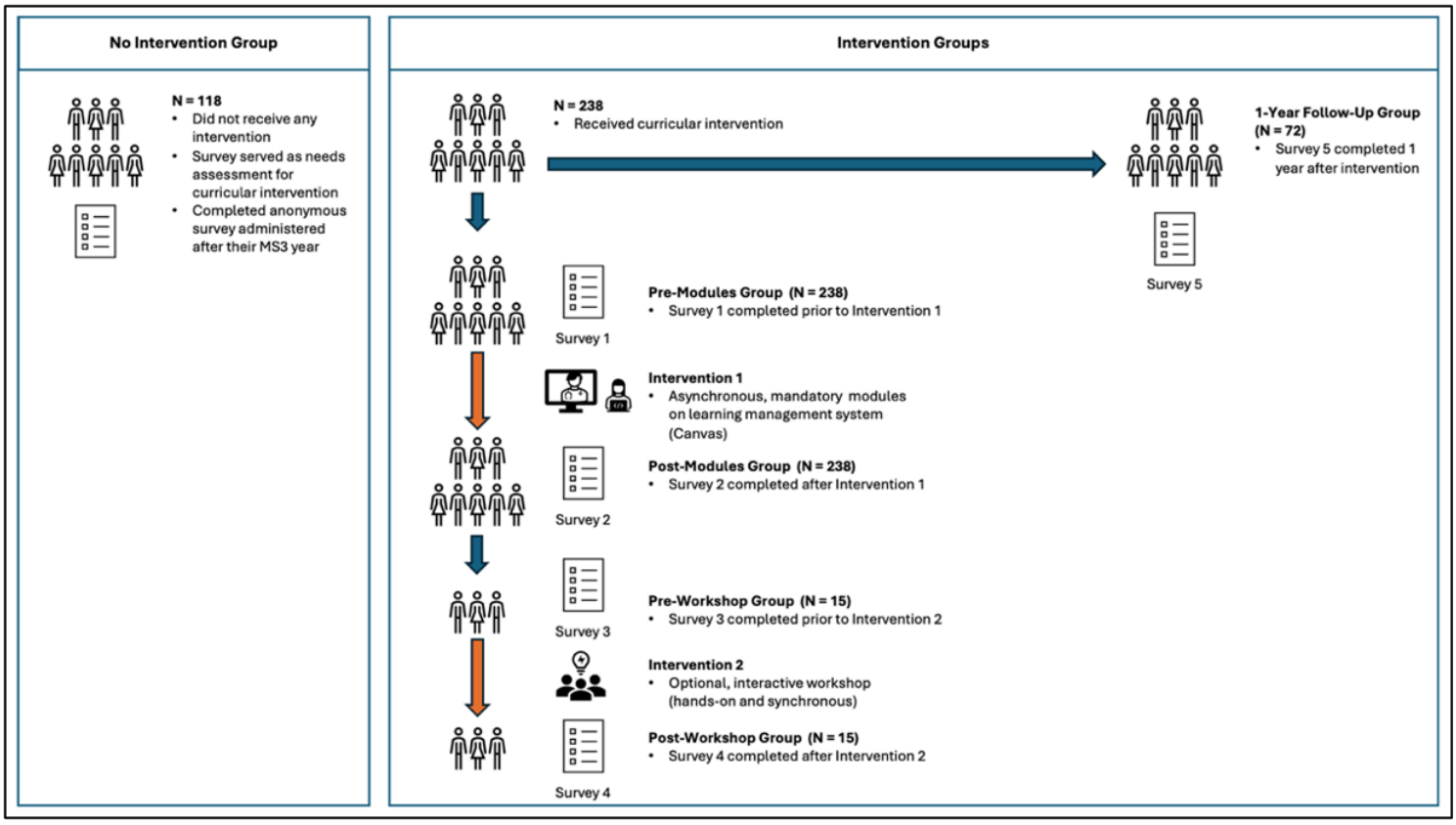


Figure 3

Schematic of Study Groups and Interventions

How confident do you feel with the following **telemedicine** competencies?

	Not confident at all	Slightly confident	Moderately confident	Extremely confident
Navigating telemedicine platforms & technology	○	○	○	○
Establishing rapport with patients & family	○	○	○	○
Obtaining a focused history	○	○	○	○
Performing a focused clinical exam	○	○	○	○
Formulating a differential diagnosis	○	○	○	○
Formulating a plan of care	○	○	○	○
Documenting a telemedicine encounter	○	○	○	○
Troubleshooting technological issues	○	○	○	○
Troubleshooting non-technological issues	○	○	○	○

Figure 4

Likert scale survey question assessing student confidence across nine telemedicine competencies

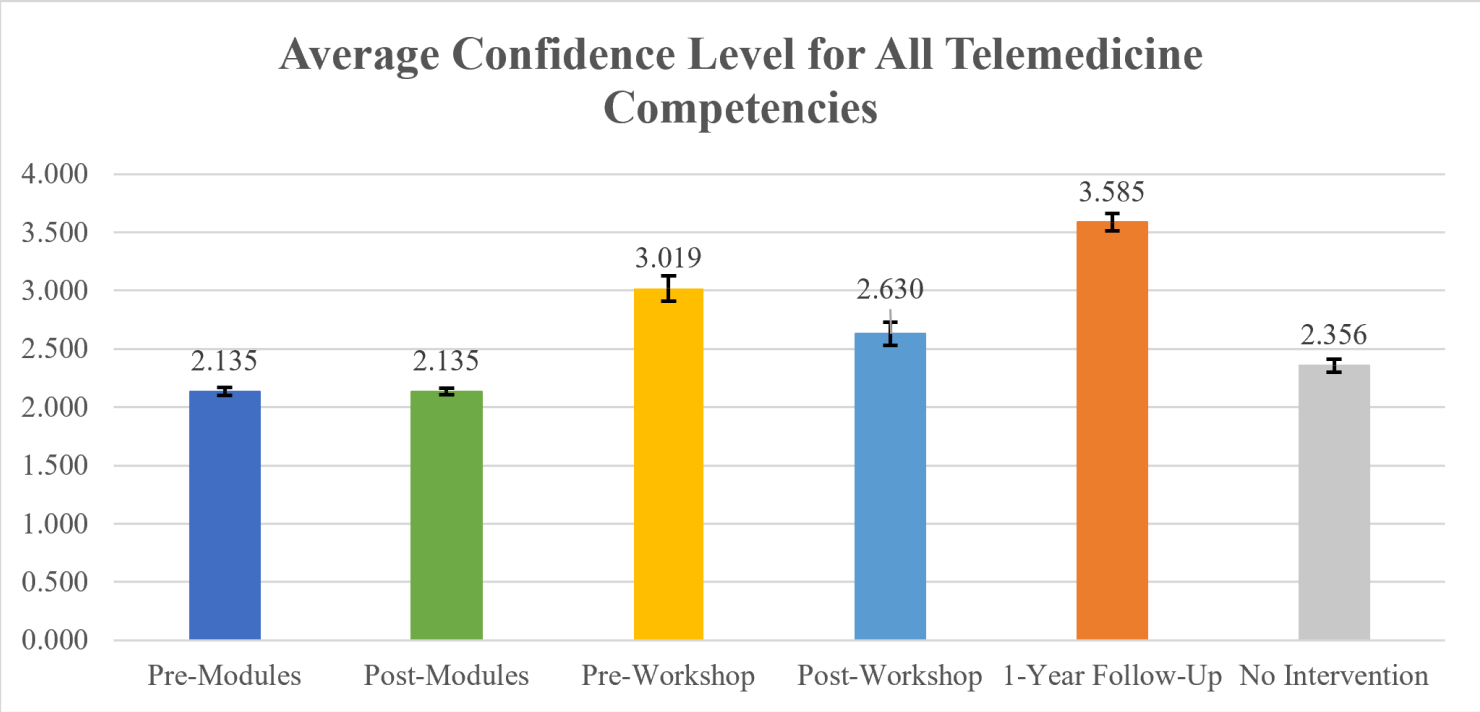


Figure 5

Overall Mean Confidence in Telemedicine Competencies Across Study Groups

Supplementary Files

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

- Appendix1.docx