# RESEARCH

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Impact of online expert interview-based research training on medical trainees' knowledge and confidence: a mixed-methods design

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# Abstract

**Background** Research training is important for medical trainees, because it improves their critical thinking, problemsolving, and the application of scientific principles to clinical practice. The COVID-19 Pandemic, which limited trainees' access to hospitals, had also disrupted traditional research training. The International Emergency Medicine Education Project introduced the *online Fundamentals of Research in Medicine* course to support trainees. The course was designed as an expert interview. This format intended to foster a relaxed learning environment and promote experience sharing rather than transferring only factual information about research. This study assesses the course's effect on participants' perceived knowledge and confidence in research concepts.

**Methods** A prospective observational mixed-methods research was conducted through the International Emergency Medicine Education Project's online platform. Pre- and post-course surveys measured participants' perceived knowledge and confidence levels across 16 research-related topics. Quantitative survey data were analysed using the Wilcoxon Signed-Rank test, and qualitative feedback was evaluated to explore participants' experiences.

**Results** A total of 272 participants enrolled in the course. 168 participants started, and 52 (19.2%) completed the pre- and post-surveys and the course completion exam. Medical students and interns, as well as participants from Africa and Asia, comprised the majority. Most participants were from India. 78.8% of the participants were from low-income or lower-middle-income countries. Participants' perceived knowledge and confidence significantly improved after completing the course, p < 0.001, with large effect sizes (-0.902 and -0.819, respectively). Qualitative feedback highlighted the course's clarity, simplicity, and effectiveness of the informal interview format. Some participants suggested adding more visual aids and detailed explanations for complex topics.

**Conclusions** The online course, designed as an interview format, effectively enhanced participants' perceived research knowledge and confidence. Future studies should incorporate objective measures of research skill acquisition from online courses and evaluate the long-term impact on participants' academic and professional development.

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Keywords Research, Online education, Knowledge, Confidence, Medical trainees, COVID-19

# Background

Research training is important for medical trainees because it enhances critical thinking, and problem-solving skills, and the ability to apply scientific principles to clinical practice; fosters a deeper understanding of evidence-based medicine; and promotes trainee-faculty interaction [1, 2].

The Coronavirus disease 2019 (COVID-19) pandemic significantly disrupted medical trainees' research training worldwide [3]. Trainees experienced isolation and interruptions to their curricula, which decreased their ability to engage in research activities [4]. The Pandemic caused the suspension of hospital clerkships and a transition to virtual learning, which limited trainees' direct patient care experiences and, subsequently, reduced their research opportunities in clinical settings [5, 6].

The disruption of traditional training during the Pandemic created a demand for alternative ways of teaching to assist medical trainees [7, 8]. With decreased face-toface opportunities, e-learning platforms fill the gap [9]. These platforms not only maintained academic engagement but also allowed trainees to continue their research education remotely [10].

E-learning provides flexibility and control over content, pace of learning and its sequence, allowing customisation to individual learning objectives, hence serving as a helpful adjunct to traditional approaches [11]. In May 2020, the International Emergency Medicine Education Project launched its course platform to support medical students and interns whose training had been affected by the Pandemic [12]. The platform initially offered a 4-week emergency medicine clerkship course, followed by two ultrasonography courses: Extended Focused Assessment with Sonography in Trauma and Rapid Ultrasound in Shock and Hypotension, as well as a COVID-19 preparedness course. The project introduced its 5th course *Fundamentals of Research in Medicine* in November 2021.

Online courses have been shown to improve knowledge. A study comparing online and on-site training in Biostatistics and Research Ethics reported that both formats led to significant knowledge gains [13]. In contrast to the widely accepted didactic lecture-based online courses, the *Fundamentals of Research in Medicine* course by the International Emergency Medicine Education Project was designed as an expert interview [14]. This format intended to foster a relaxed learning environment and promote experience sharing rather than transferring only factual information about research.

This study aims to assess the effect of the online *Fundamentals of Research in Medicine* course on

trainees' perceived knowledge and confidence in research concepts.

# Methods

## Study design and setting

This is a prospective observational mixed methods study, assessing participants' pre- and post-course perceived knowledge and confidence levels on research concepts. It was conducted through the online course platform of the International Emergency Medicine Education Project (iem-course.org).

#### Course platform, content and implementation

The International Emergency Medicine Education Project is a non-profit initiative aiming at providing free educational resources for medical students and interns globally [15]. The project is supported by the United Arab Emirates University College of Medicine and Health Sciences and is endorsed by the International Federation for Emergency Medicine. In May 2020, the project launched its course platform (iem-course.org) to assist medical students and interns whose training were negatively affected by the COVID-19 Pandemic [12]. During the Pandemic, the platform offered five courses, including the online *Fundamentals of Research in Medicine* course.

The content of the online *Fundamentals of Research in Medicine* course was outlined by FAZ, a world-renowned researcher and reviewer for several top scientific journals. The course was structured by using conversational video recordings, as opposed to traditional lecturebased didactic delivery. Besides one introductory, one on research errors, and a course conclusion video, 16 videos for defined contents were recorded using a Canon EOS 50 M Mark ii<sup>®</sup> camera and Zoom 6 H<sup>®</sup> audio recorder. AAC edited the videos using the TechSmith Camtasia video editing application. Videos were ranged from 6 min 36 s to 24 min 18 s. In total, the course contains 288 min and 26 s of conversational videos [14]. The average (standard deviation) of the videos was 15 min and 10 s (4 min and 33 s).

In addition to the videos, pre- and post-course surveys were prepared to gather demographic information, participants' perceptions of their perceived knowledge and their confidence in conducting research. Participants were required to take a course completion exam to complete the course.

The surveys, videos, and final course completion exam were all uploaded into a learning management system (LMS). The course platform uses the LearnDash LMS [16], which is developed for WordPress-based online platforms [17], where the project's course platform is located. The course was published on November 22, 2021, and concluded on November 21, 2023. The intended learning outcomes of the course include gaining a comprehensive understanding of the entire research process, from the initial stages to publication. Participants were offered to learn the ethical considerations of conducting research and appreciate the critical importance of formulating a research question, along with effective planning, design, and methodology. Additionally, they were offered to learn basics of data collection and analysis, manuscript writing and refinement, as well as the presentation of research findings. The course also covered the journal submission process and strategies for addressing reviewers' comments. Its structure and implementation flow are illustrated in Fig. 1. The course was free of charge to all participants similar to other courses in iem-course.org platform. The course content remains accessible at iem-student.org [14].

# **Ethical considerations**

According to the United Arab Emirates University Research and Graduate Studies Ethics Guidelines, this education evaluation study was considered exempt from ethical review because it did not include sensitive personal data or identifiable information (ERS\_2020\_6130). All participants were informed that completing the preand post-surveys was optional, before starting the course content and before each survey.

#### Participants

The course was open to participants from all geographical regions. As the International Emergency Medicine Education Project primarily targets medical students and interns, the platform was predominantly visited by this group. because of the course's relevance to a wide range of trainee groups (from medical students to PhD candidates) enrolment was not restricted to a specific group.

#### Quantitative data collection and analysis

Course enrolment, completion data, course completion exam data, as well as pre- and post-course surveys were

collected. These data were stored in the WordPress database and were accessible only by AAC, who is the Project Director, course Website Administrator, and Primary Investigator of this study.

The enrolment and completion data were automatically collected by WordPress, with no involvement from the research team in the data collection process. The course completion exam consisted of 35 multiple-choice questions (e.g., true/false, single best answer). Successful completion of the course required a score of 75% or higher on the course completion exam.

Participants were given 30 days to complete the course. To be eligible for the course completion exam, participants were required to complete each step showed in Fig. 1, except for the optional pre- and post-course surveys. The pre- and post-course surveys were placed at the entry and exit stages of the course (see Fig. 1).

The survey questions collected demographic information, including gender, current training level, geographic region, and country. Participants were also asked about their perceptions of their overall and specific knowledge on course topics and their current confidence in conducting research. Given potential differences in participants' training backgrounds, cultural contexts, and learning styles, we aimed to capture a broader range of perspectives by including open-ended questions and how likely they recommend the course to their peers/ colleagues/trainees in to the post-course survey. This addition allowed us to gather deeper insights into participants' experiences and perceptions, enhancing our study's mixed-methods design. Demographic questions were structured as best-option selections, while the perceived knowledge and confidence questions utilized a Likert scale sliding bar ranging from 0 to 10.

Course enrolment, completion, course completion exam and pre- and post-course survey data were exported from the WordPress website database as comma-separated values (CSV) files. The only identifier in the exported file was nine-digit user identification numbers for the course platform, which was used solely for matching pre- and post-course survey responses from



Fig. 1 Course plan and implementation. Participants visit the course website and enrol in the course. After enrolling, they have the option to take a pre-course survey. They begin with the first video and progress through the course step by step. After watching the final video, they have the option to take a post-course survey before advancing to the course completion exam. Participants who pass the exam with a score of 75% or higher are awarded a course completion certificate

the same individual. After matching individuals' pre- and post-survey responses, the nine-digit user identification numbers were removed from the final CSV file. This further ensured participant anonymity while retaining the data necessary for descriptive and comparative analysis.

The quantitative data were analyzed using SPSS version 29.0. Nominal data were presented as numbers and percentages. Continuous data were reported as medians with 25th–75th percentiles. Pre- and post-course survey results comparison was done with Wilcoxon Signed-Rank test. A p-value of <0.05 was accepted as statistical significance. Cohen's d effect sizes were calculated and  $\geq$ 0.8 was considered as a large effect size.

#### Qualitative data collection and analysis

Qualitative data collected through the post-course survey were organized using Large Language Model (LLM) Artificial Intelligence tools [18, 19], including ChatGPT-40 from OpenAI, NotebookLM from Google. The post-survey qualitative data, initially in CSV format, was uploaded to ChatGPT-40 to organize the data into text format. The text was then downloaded as a portable document format (PDF) and reviewed for correctness. This PDF file of the qualitative data was subsequently uploaded to Chat-GPT-40, NotebookLM to explore and identify emerging themes within the text. We used the six-step thematic analysis method to identify themes within the qualitative data [20], with the assistance of LLM tools.

#### Results

#### **Quantitative results**

During the active course period, 272 participants enrolled in the course. Of these, 168 (61.8%) completed the course entry survey and started the course stages. Males comprised 60.8% of the participants. Of the total, 46.5% were medical students or interns. 41.6% reported that there was no mandatory research training at their institution. Additionally, 83.8% of participants were from Africa and Asia. 54 countries were recorded in course entry survey. India was the most commonly represented country in the course entry survey, with 18.5% of participants (Table 1). 72.6% of the participants were from low-income or lower-middle-income countries according to World Bank country classification by income in 2023 [21]. Participants had high expectations from the course, with a median score of 9 (25th-75th percentile: 7-10). 71(42,3%) out 168 participants completed all stages of the course and reached the course completion exam stage. 56 (33.3%) filled out the course exit survey (Table 1), and 52 (30.9%) passed the course completion exam. The median passing score (25th–75th percentiles) was 80 (77.1–87.1). Participants' demographics, perceptions on their knowledge and confidence regarding the course topics are presented in Table 1.

Participants from Africa and Asia accounted for 85.7% of all respondents in the course exit survey. A total of 25 countries were represented in the exit survey. India had the highest number of participants at 26.8%, followed by Egypt at 10.7%. Participants indicated that their expectations from the course were met, with a median score of 8 (25th–75th percentile: 0–10). Regional participant distribution in both surveys is shown in Fig. 2.

Prior to the course, participants rated 15 out of the 16 topics listed in Table 1 (under "Current Perception of Knowledge") with a median score below 5. After completing the course, participants evaluated 15 out of the 16 topics, achieving a median score of 8 or higher. Participants' perceived confidence in conducting research, as well as their overall knowledge perception, increased from a median score of 5 to 8. Among the 56 participants who completed the post-course survey, the median response to the question "How likely are you to recommend this course?" was 9 (25th–75th percentile: 7–10).

# Participants who successfully completed the course and with pre- and post-course surveys

A total of 52 participants who successfully completed the course were analysed further. The majority were male (61.5%). Medical students and interns were 51.9% of the participants, 18 (34.6%) and 9 (17.3%), respectively. There were 10 residents (19.2%), 8 master's students (15.4%), and 7 participants (13.5%) from other professions. 31 (59.6%) participants reported that their institution had mandatory research training, while 29 (56.9%) stated that their institution offered elective research training opportunities. The top two geographic regions represented were Africa and Asia, with a total of 45 participants (86.5%): 23 (44.2%) from Africa and 22 (42.3%) from Asia. Other regions were North America (3 participants, 5.8%), Central and South America (3 participants, 5.8%), and Europe (1 participant, 1.9%). 23 different countries were recorded. Participants from India were the most represented country with 14 (26.9%) participants. Out of 52 participants, 78.8% of the participants were from low-income (19.2%) or lower-middle-income countries (59.6%). Participants from upper-middle-income and high-income countries comprised 9.6% and 11.5%, respectively.

The 52 participants' median (25th–75th percentiles) pre-course expectation was 9 (7.75–10). After completing the course, their median (25th–75th percentiles) for the question "how well the course fulfilled their expectations" was 8.5 (8–10), *Wilcoxon Signed-Rank Test*, p value: 0.433, *Cohen's d*: 0.157. The pre- and post-course scores for the 52 participants who successfully completed the course are shown in Table 2.

Participants' perceived knowledge and confidence showed significant improvements before and after the

 Table 1
 Participants' demographics, perceptions on their knowledge and confidence related to course content

	Pre-Course	Post-Course
Candar	N=168 (%)	N=50 (%)
Gender		20 (26 4)
Female	65 (39.2)	20 (36.4)
Male	101 (60.8)	35 (63.6)
Current level of training	20 (47 0)	0 (4 6 4)
Intern	30 (17.9)	9 (16.1)
Master student	17 (10.1)	9 (16.1)
Medical student	48 (28.6)	19 (33/9)
PhD student	4 (2.4)	0 (0.0)
Resident	40 (23.8)	11 (19.6)
Other	29 (17.3)	8 (14.3)
Mandatory research training in their institution/college		
No	69 (41.6)	21 (38.2)
Yes	97 (58.4)	34 (61.8)
Elective research training in their institution/college		
No	84 (50.9)	21 (38.2)
Yes	81 (49.1)	34 (61.8)
Region		
Africa	64 (38.3)	23 (41.1)
Asia	76 (45.5)	25 (44.6)
Australasia/Oceania	1 (0.6)	0 (0.0)
Central & South America	6 (3.6)	3 (5.4)
Europe	9 (5.4)	2 (3.6)
North America	11 (6.6)	3 (5.4)
Income Levels		
LIC	37 (22)	13 (23.2)
LMIC	85 (50.6)	31 (55.4)
UMIC	23 (13.7)	6 (10.7)
HIC	23 (13.7)	6 (10.7)
Current perceived confidence level to conduct research	5 (3–7)	8 (7-9.25)
Current overall perceived knowledge of research concepts	5 (2.75-7)	8 (8–10)
Current perception of knowledge on		
Research ethics	5 (2-7)	8 (7–10)
Authorship criteria	3.5 (1–5)	8.5 (7–10)
Generating research question	4 (1-6)	8 (7–9)
Designing research project/study	4 (1-6)	8 (7–9)
Animal vs. human research differences/similarities	3 (1-5)	8 (6–10)
Establishing registries	2 (0-5)	8 (6–9)
Ethical approval processes	3 (1-6)	8 (6 75–9 25)
Data collection	5 (2-7)	8 (7–10)
Analysing data	4 (1 6)	7 5 (5 75-0)
Prospecting resparch	4 (1 6)	8 (7 0)
Critical appraical	2 (0, 5)	8 (7 - <del>3</del> )
Writing a manuscript	3 (0 5)	0 (0-10)
Final tuning of the manuscript	3 (U-3) 25 (0 E)	0 (U-9.20)
	2.3 (U=3) 2 (0 E)	0 (0-9)
	2 (0-5)	0 (0-9)
This sets de after the acceptor of	2 (0-5)	8 (0-9) 0 (0(10)
mings to do after the acceptance	2 (U-5)	8 (0610)

 ${\sf LIC: low-income-countries, {\sf LMIC: lower-middle-income-countries, {\sf UMIC: upper-middle-income-countries, {\sf HIC: high-income-countries, {\sf LMIC: lower-middle-income-countries, {\sf LMIC: lower-middle-i$ 



**Fig. 2** The bar chart of the distribution of participants by geographic region. Orange color: pre-course (entry) and green color: post-course (exit) surveys

course (p<0.001), with large effect sizes (-0.902 and -0.819, respectively). Box-and-whiskers plot of participants' perceived knowledge and confidence before and after the course are presented in Fig. 3.

# **Qualitative results**

Out of the 56 participants who completed the postcourse survey, 33 (58.9%) provided written feedback on what they liked about the course (32 participants) and suggestions for improvement (28 participants). Out of a total of 33 participants, medical students provided most of the feedback, with 11 responses (33.3%). This was followed by master's students and residents, each contributing seven responses (21.2%). The regions that contributed most feedback were Africa and Asia, with 18 (54.5%) and 10 (30.3%) responses, respectively. In total, feedback was recorded from participants in 16 different countries. The top three countries providing feedback were India, Sudan, and Ethiopia, with 6 (18.2%), 4 (12.1%), and 4 (12.1%) responses, respectively.

From the qualitative data, 25 codes were extracted, and four themes emerged based on these codes: Clarity and Simplicity in Teaching, Appreciation for Expert Knowledge, Course Organization and Structure, and the Need for Additional Visual and Interactive Materials.

# Clarity and simplicity in teaching

Participants emphasized and appreciated how the expert's explanations, particularly using practical examples, made complex concepts more understandable. This theme highlights the importance of simplifying research

Table 2	Comparative	analysis of p	re- and	post-course	perceived
knowled	ge and confid	lence among	partici	pants	

5	51			
	Pre- Course N=52 (%)	Post- Course N=52 (%)	P value	Ef- fect Size
Current perceived confidence	5	8 (7–10)	< 0.001	-0.902
evel to conduct research	(3-7.25)			
Current overall perceived knowl-	5.5 (4–8)	8 (7–10)	< 0.001	-0.819
edge of research concepts				
Current perception of knowl- edge on				
Research ethics	6 (3–8)	8 (7–10)	< 0.001	-0.833
Authorship criteria	5 (2–7)	9 (7–10)	< 0.001	-0.874
Generating research question	5 (3–7)	8 (7-9.25)	< 0.001	-0.839
Designing research project/ study	5 (2.75-7)	8 (7–9)	< 0.001	-0.895
Animal vs. human research differences/similarities	4.5 (1.75-8)	8 (7–10)	< 0.001	-0.890
Establishing registries	4 (1–7)	8 (6–9)	< 0.001	-0.831
Ethical approval processes	5 (2–7)	8 (7–10)	< 0.001	-0.864
Data collection	6.5 (3–8)	8 (7–10)	< 0.001	-0.825
Analysing data	5 (3–7)	8 (6–9)	< 0.001	-0.870
Presenting research	6 (3-7.25)	8 (7–9)	< 0.001	-0.866
Critical appraisal	4 (2–7)	8 (6–10)	< 0.001	-0.961
Writing a manuscript	4 (2-6.25)	8 (6–10)	< 0.001	-0.931
Fine-tuning of the manuscript	3 (2–6)	8 (7–9)	< 0.001	-1.0
Submitting to journal	2.5 (1–6)	8 (6–9)	< 0.001	-0.985
Answering reviewers'	4 (2–7)	8	< 0.001	-0.981
comments		(6.75-9)		
Things to do after the acceptance	3 (1–6)	8 (6–10)	< 0.001	-0.987

training for diverse learners. One participant noted that the course was "very practical and simple to understand," giving them real insights from an experienced scholar.

"It is very practical and simple to understand. It gave me fresh insights from a well experienced scholar. I have always thought research was so difficult and can only be done by experts, but now I leant that I can grow while doing it."

(A participant from Ethiopia)

"Simple easy to understand, and good for beginners." (A participant from India).

"Easy and straightforward presentation. Very entertaining".

(A participant from Sudan).

This clarity helped them to believe they could grow while engaging in research. Another participant highlighted the "directness of the professor" as a key factor in understanding the material. The feedback reflects that the course's delivery style made research



Fig. 3 Box-and-whiskers plot of participants' perceived knowledge and confidence before and after the course. The box resembles the Interquartile Range (IQR) where the box begins with the 25th percentile and ends with 75th percentile. The horizontal line within the box resembles the median. Dots represent outliers. The whiskers lines represent the range of values that are not outliers. Orange color: Pre-Course (entry) Survey results, green color: Post-Course (exit) Survey results. \*\*\* represents p value < 0.001

concepts easier to comprehend and motivated participants to engage more deeply with the subject. "Plenty of knowledge shared off real life experience with examples which made concepts easier to understand."

(A participant from England)

"It's different! Unlike other courses I've taken in research, this is course was more attracting in terms of delivering it. Keep it up as a real chat with expert not a bunch of lectures."

(A participant from Egypt)

The combination of straightforward explanations, real-life examples, and expert guidance was helpful in enhancing participants' confidence in research.

# Appreciation for content and expert knowledge

Many participants valued the knowledge and experience shared by the instructors, recognizing the importance of learning from experts in the field. They frequently commented on the wealth of knowledge provided in the course. Many noted that the course offered invaluable information about crucial research concepts. This theme captures the gratitude participants expressed for receiving expert guidance. One participant expressed that the course was "full of experience and knowledge shared," appreciating the depth of expertise in videos. "It was very informative, and I would like to take this opportunity to thank you for sharing such a wealth of knowledge and experience with us". (A participant from United Arab Emirates)

"Full of experience and knowledge shared." (A participant from Tanzania).

Another participant mentioned on how the course refreshed their memory and exceeded their expectations. Detailed advice reignited their passion for research.

"Going into it, I thought this was basic research knowledge to refresh my memory after graduation. Turns out it was so much more! The advice given was so detailed and to the point. It made me want to contact a colleague and start new research after 4 years of limbo. Thank you so much!"

# (A participant from Egypt)

The course's focus on key principles like accountability, competence, and ethical considerations in research was also frequently highlighted, with participants recognizing the importance of these foundational elements.

"Very educative and has improved my research knowledge as a medical student. Very informative, articulate. It's so educating, and I learned more about research, ethics, and authorship."

(A participant from Uganda)

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"I like the fact that I was able to learn from the experience of a respected expert in the field. It gave me overall insight on fundamentals of research. I am now well aware of the issues of accountability and how important research is for the community." (A participant from Ethiopia)

## Course organization and structure

Participants provided several suggestions on how to improve the course. Some participants pointed out areas for improvement regarding the organization and flow of the course, suggesting that better structuring could make it easier to follow and retain information. This theme identifies the importance of course format. Several participants suggested improvements to the course by enhancing the depth of the content. They expressed a need for more detailed explanations for complex topics such as study designs and ethical considerations. Some felt that certain sections, like the discussion on study designs, were too complicated and could benefit from further elaboration.

"To be more organized in episodes script". (A participant from Egypt). "I would have liked more details on the specific structures of the study designs." (A participant from Ethiopia) "Some videos need a little bit more detailed and ordered explanation. For example, the discussion on study design was a little complicated." (A participant from Ethiopia)

# Need for additional visual and interactive materials

Several participants suggested that including more interactive elements, such as visual aids, slides, or subtitles, could enhance their understanding of research concepts. This theme emphasizes the demand for varied instructional tools.

"If videos were shown with a lecture slide format to help guide understanding of the concepts being explained."

(A participant from England)

"More explanation on scientific terms used, and if possible, additional notes on those points which could not be covered in the video."

(A participant from India)

"It would be great if you add links to further readings or links to the articles the professor mentioned so we can easily access them."

(A participant from Egypt)

"Manuscript, Slide presentation, in case for further reading." (A participant from Uganda).

# Integration of quantitative and qualitative results

The quantitative data shows a significant increase in participants' perceived knowledge and confidence across all measured areas. The high effect sizes indicate a significant shift in participants' perceived confidence and knowledge levels after the course. This quantitative result is reflected in the qualitative feedback. Participants frequently expressed clarity and a deeper understanding of research concepts. Many participants mentioned how the course's practical examples and expert insights made complex research topics more accessible. Comments such as "very practical and simple to understand" and "plenty of knowledge shared from real-life experience" show how the course's instructional approach contributed to participants' improved understanding.

The "Clarity and Simplicity in Teaching" theme aligns closely with the increase in perceived knowledge across various research skills. Participants' comments emphasize that the clear explanations and examples were instrumental in understanding research processes, which many initially thought it to be difficult. For example, one participant noted, "I have always thought research was so difficult and can only be done by experts, but now I learned that I can grow while doing it." This statement shows a mindset change that likely contributed to the increased confidence. In addition, participants mentioned that the course's direct and practical style helped them feel more equipped to take on research independently. This feedback supports the quantitative results showing significant growth in confidence. It suggests that the clarity of instruction contributed to participants' belief in their ability to perform research tasks. This is also important, which can foster long-term engagement in research.

The "Appreciation for Content and Expert Knowledge" theme supports the quantitative gains. Participants valued the depth of knowledge that experts shared. They recognized the course as a unique opportunity to learn from experienced researchers. Comments such as "full of experience and knowledge shared" and "the advice given was so detailed and to the point" reflect participants' appreciation for the content depth. These comments likely contributed to the increased perceived scores in knowledge. Additionally, several participants mentioned that the course reignited their enthusiasm for research. This enthusiasm indicates the confidence boost observed in the quantitative data.

Participants provided constructive feedback on the "Course Organization and Structure" and "Need for Additional Visual and Interactive Materials" themes. The comments indicate areas where future courses could improve the learning experience for participants. Although the quantitative results indicate increased perceived knowledge and confidence, participants expressed that more structured and detailed explanations, especially for complex topics like study design, could improve comprehension further. Some participants requested more visual aids and interactive elements, such as slides and additional reading materials, to reinforce the concepts covered. These suggestions align with study's aim and the quantitative increase in knowledge, as these tools could provide a reference for ongoing learning and retention.

# Discussion

In our study, most participants were from Africa and Asia, with India being the most represented country. The majority of the participants were from low- and lowermiddle-income countries. Initial expectations for the course were high, and participants felt that the course met their expectations. Perceived confidence in conducting research and knowledge improved significantly by the end of the course. The clarity, simplicity, and direct expert knowledge provided are the key strengths of the course according to the participants' feedback.

Research training is a crucial element of medical education, particularly in developing countries where unique healthcare challenges demand innovative, locally-driven solutions. This training tried to equip future healthcare providers with essential skills in scientific inquiry, data analysis, and evidence-based decision-making, fostering problem-solving abilities and critical appraisal of medical literature [22–24].

Developing countries face numerous obstacles in implementing effective research training, including lack of research education, funding, and resources. There is often limited appreciation for the value of healthcare research, compounded by bioethical concerns and limited access to health informatics [22]. Medical schools in developing countries struggle with providing adequate research opportunities due to time constraints and insufficient mentoring [23]. Strengthening health research capacity is a priority for low- and middle-income countries [25]. In our study, the majority of participants were from low- and lower-middle-income countries, highlighting their eagerness to use free resources, and the potential difficulty of accessing research training in their settings.

Kajjimu et al. highlighted that the transition from face-to-face to online was challenging during the Pandemic, especially in resource-limited regions, where technological and infrastructure limitations hindered equitable access to quality online education [26]. They also reported that these differences underline the urgent need for freely available, high-quality online resources to support medical and health education in underserved areas. The International Emergency Medicine Education Project's Fundamentals of Research in Medicine course, launched during the pandemic, represents a proactive response to this need. By offering free, comprehensive, and accessible online materials, the course aligns with global needs to bridge educational gaps and ensure continuity of learning during public health crises. This initiative models how open-access resources can address educational inequalities and promote resilient learning environments, preparing trainees for future disruptions and encouraging a more inclusive approach to global medical education.

The online learning has revolutionized access to medical education by offering a flexible and cost-effective alternative, allowing trainees to engage with high-quality educational resources from anywhere in the world. The strategic utilization of e-learning is crucial for healthcare providers in developing countries, as it accelerates learning, thereby enhancing the quality of care and health outcomes [27]. The asynchronous nature of many online courses ensures that trainees can learn at their own pace. This flexibility enables trainees to access course materials and lectures at their convenience, allowing them to manage their time effectively and balance their studies with other commitments [28].

Online research training has been found to be efficient [13, 29]. Although massive open online courses (MOOC) completion rates are generally low, with an average of 12.6% [30], 42.3% of participants in our study completed all stages of the training and reached the course completion exam. Several factors contribute to low MOOC completion rates, including spontaneous enrolment, the diverse backgrounds of participants, varying levels of self-regulation and motivation, course length, assessment methods, grading type, and start dates [30, 31]. Low completion rates may not necessarily indicate poor course quality [32]. On the other hand, we think that the higher completion rates seen in our online research course were due to the participants' high appreciation of the course's simplicity, the expert's sharing of his experience, and the wealth of knowledge offered.

Role models in medical education significantly shape the professional identity and career choices of medical trainees [33]. The influence of experienced physicians on medical trainees through role modelling and experience sharing cannot be overstated. When experts share their journeys, particularly the challenges and solutions they encountered, trainees gain valuable insights into how to navigate similar obstacles. Effective medical education must account for the diverse learning styles of trainees. Listening experiences of an expert may provide valuable mode of learning. It allows trainees to bridge theoretical

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knowledge and practical application, enhancing their comprehension of complex concepts. However, not every trainee can learn effectively through listening to a conversation or lecture alone; many require visual aids such as slides, diagrams, and simple explanatory figures to fully grasp the concepts [34]. This need for visual support was clearly stated by some participants in our study as a suggestion to improve the course.

The integration of quantitative and qualitative data demonstrates the course's impact. The quantitative improvements in participants' perceived knowledge and confidence are reflected in the qualitative feedback, where participants valued the clarity of instruction, expertise, and practical examples provided. However, the qualitative comments also point to opportunities for further improvement, particularly in course organization and the inclusion of additional resources. These findings suggest that the course enhanced participants' perceived research knowledge and confidence while providing insights for future course refinements to support diverse learning needs.

The recruitment of study participants via the iemcourse.org website helped create a sample that aligned well with our research course objectives. As the course was primarily designed for medical trainees, our participant group contained individuals from this group with a baseline interest in or need for research education. It is also important to recognize that the level of research training in medical education varies significantly across countries, which may affect initial knowledge and confidence levels among participants. However, our course was intentionally designed to address core research competencies in a straightforward, accessible manner. We think that this helped achieve the objectives of enhancing knowledge and confidence for medical trainees from diverse regions.

The International Emergency Medicine Education Project highlights the significant impact of collaborative efforts in enhancing emergency medicine training in developing countries [15]. Online training during the COVID-19 Pandemic has emerged as a social responsibility initiative by The International Emergency Medicine Education Project, addressing various educational needs while mitigating the Pandemic's adverse effects [12]. Our results showed that a simple conversation with an expert, without the use of additional presentation aids, can effectively improve trainees' perceived research knowledge and confidence.

# Limitations

This study has several limitations. *First*, it is conducted in an open course platform where participants' enrolment was not controlled. A large proportion of enrolment was from Africa and Asia, and from low- and lower-middle-income countries. This may hinder the generalizability of the study findings to a more diverse global population. However, reaching low- and lowermiddle-income countries was the primary goal of the project's existence. Therefore, we were satisfied with the results. Second, the study assessed participants' perceived knowledge and confidence, which may not objectively reflect actual improvements in research skills. Third, the study does not assess whether the increase in perceived knowledge and confidence will be translated into longterm application of research skills or participation in research activities. Fourth, the absence of a control group makes it difficult to determine whether the observed improvements in perceived knowledge and confidence were directly attributable to the course. Fifth, although 272 participants enrolled, 168 started and only 52 completed the pre- and post-course surveys and the final exam. This relatively small number might represent selection bias of the results. Sixth, we do not know the reason why some participants enrolled in the course but did not continue it. Therefore, the attrition rate could show response bias, as the participants who completed the course and surveys may not represent the entire enrolled cohort. Those who dropped out might have had different experiences or challenges. Seventh, the course content was primarily delivered via an expert interview format, which some participants found engaging. However, others suggested they could benefit from more structured formats like lecture slides or visual aids. Learners vary in their nature. Some learners are better at listening while other can be visual learners. The effectiveness of this format compared to traditional didactic methods was not rigorously evaluated. Eighth, the reliance on online platforms and the requirement for consistent internet access could have posed barriers for participants from lowresource settings, potentially affecting their engagement and completion rates.

# Conclusions

The online *Fundamentals of Research in Medicine* course improved participants' perceived knowledge and confidence in research. The course was attractive to trainees from developing countries, and it was well-received for its clarity, simplicity, and practical insights. Improvements in course structure, such as adding more visual aids and providing more detailed explanations of complex topics could further enhance its educational value.

We think that the course has successfully addressed a crucial gap in research education during the COVID-19 pandemic and has offered a promising model for integrating flexible, accessible online training into medical curricula globally. Future studies should consider objective measures of research skill acquisition and explore the

long-term effects of such training on participants' academic and professional development.

#### Abbreviations

AAC	Arif Alper Cevik
COVID-19	Coronavirus disease 2019
CSV	Comma-separated values
EOS	Electro-Optical System
FAZ	Fikri M. Abu-Zidan
LLM	Large Language Model
LMS	Learning Management System
MOOC	Massive Open Online Courses
PDF	Portable Document Format

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#### Author contributions

AAC launched the project's course platform. AAC and FAZ developed the course content. AAC was responsible for the instructional design, uploading the content to the learning management system, and conducting platform testing. AAC collected the data. AAC and FAZ jointly analysed the data. AAC and FAZ wrote the manuscript. AAC prepared the Figures. All authors have reviewed and approved the final version of the manuscript. AAC accepts full responsibility for the content of the manuscript.

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#### Data availability

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

# Declarations

#### Ethics approval and consent to participate

According to the United Arab Emirates University Research and Graduate Studies Ethics Guidelines, this education evaluation study was considered exempt from ethical review because it did not include sensitive personal data or identifiable information (ERS\_2020\_6130). All participants were informed that completing the pre- and post-surveys was optional, before starting the course content and before each survey.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

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