

Research Article

Assessing the Ripple Effects of a Research Module: A Mixed Method Study

Shamaila Manzoor¹, Muhammad Mazhar ul Haq², Hina Munir³, Hifza Ishtiaq⁴

¹Assistant Professor Medical Education, AJK Medical College, Muzaffarabad, Pakistan

²Senior Registrar Anesthesia, Armed Forces Institute of Urology (AFIU), Rawalpindi, Pakistan

³Assistant Professor Physiology, AJK Medical College, Muzaffarabad, Pakistan

⁴Demonstrator, Medical Education, AJK Medical College, Muzaffarabad, Pakistan

Corresponding Author: Shamaila Manzoor, Assistant Professor Medical Education, AJK Medical College, Muzaffarabad, Pakistan, Email: shamaila1.manzoor@gmail.com

Received: 18.12.25, Revised: 06.03.26, Accepted: 22.03.26

ABSTRACT

Objective: This scientific investigation was carried out to measure the effectiveness of the research module on the undergraduate medical students by assessing participants' reactions and behavioural changes utilizing the Kirkpatrick Model of Evaluation as a theoretical framework.

Study Design: A mixed-methods study design was used.

Place & duration of study: This study was conducted over an eight-week period (August–October 2024) involving third-year medical students, using non-probability consecutive sampling, at Azad Jammu & Kashmir Medical College (AJKMC), Muzaffarabad, Pakistan.

Methodology: Following Institutional Review Board (IRB) approval, quantitative data was collected via pretest and post-test. Qualitative data was gathered through semi-structured interviews using purposive sampling from the same cohort. Quantitative analysis was performed using paired t-tests in SPSS, while qualitative data were processed through thematic analysis, manually.

Results: Quantitative findings revealed a statistically significant increase ($p < 0.05$) in post-assessment scores compared to pre-assessment baselines in participants' mastery of research ethics, methodologies, and statistical analysis. Qualitatively, four main themes emerged: as research methodologies, research ethics, statistical analysis and challenges. Participants reported high satisfaction levels and increased self-efficacy in applying research concepts to practical scenarios, bridging the gap between theoretical knowledge and real-world application.

Conclusion: The research education module significantly improved student competency and fosters responsible research practices at undergraduate level. The integration of Kirkpatrick's levels confirms that a balanced, structured educational approach is effective in equipping medical students with essential investigative skills.

Keywords: Kirkpatrick Model, Program Evaluation, Research Education.

Operational Definitions

Ripple effect: Quantifiable spread of research-oriented behaviours, academic outputs, and shifts in professional identity among undergraduate medical students resulted by the completion of a structured research module.

Resource Marker: An increased request for institutional access to databases (like PubMed, ERIC or Scopus) following the module.

INTRODUCTION

Exploration of scientific evidence, its validation and implementation are just a touch away, in today's Digi sphere. This is very true for Evidence Based Medicine (EBM) which entails critically appraising the available literature and its application to real life scenarios¹. The interweaving of EBM (research) is mandatory for undergraduates to learn, "how to expand this knowledge with their increasing level of expertise?"². Many Medical schools are running integrated curriculum with research as a

mandatory part of it. Focusing research early on.... crafts inquisitive minds and lifelong learners. This would not only strengthen their professional identity but would also improve the level of health care services for the community around them. It is evidenced that research courses have a deep impact on the learners, making them professionally competent thus leading to more accurate diagnosis & clinical decision making. Moreover, research helps nurturing EBM in clinical settings and promotes medical students' interest in research-based

residency program³. Evidenced by a study that 80% of students working in research programs later became academicians.

However, most of the undergraduate students consider research module as an independent entity. They believe it has nothing to do with disease, patients, healing and clinical environments. Because they do not have clear concepts of research where, focus is on individuals and the results always translate into tangible changes for the masses. Many medical schools have made it mandatory for undergraduates to gain sufficient research experience before graduation⁴. Therefore, the evaluation of such modules becomes an essential practice for any institution committed to delivering exemplary learning experiences to its learners. This evaluation encompasses a purposeful, systematic, and meticulous process involving the collection and analysis of

information to ascertain the effectiveness and outcomes of these basic units of curriculum⁵. The importance of this evaluation lies in its ability to provide evidence-based insights into further improvement and decision-making⁶. The process involves collecting and analyzing data to determine the effectiveness and impact of educational programs. Effective evaluations ensure that resources are optimally utilized and that educational objectives are met. Kirkpatrick's model has been extensively used across diverse educational and training contexts, rendering it versatile and suitable for evaluating the research education module. Its relevance, comprehensiveness, adaptability, and practicality provides this model clear and measurable criteria for assessment & facilitating the establishment of meaningful evaluation metrics^{7,8}.

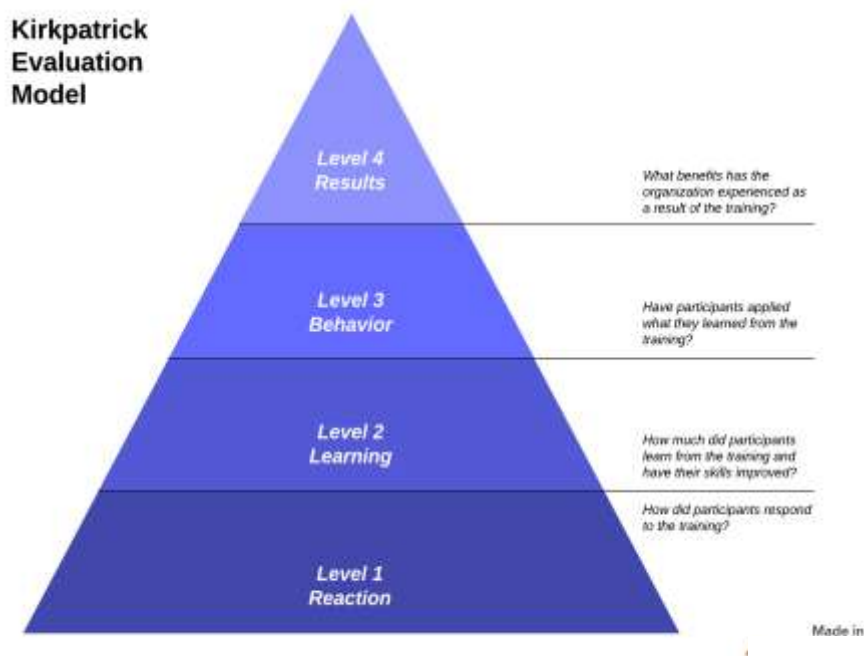


Figure 1: Kirkpatrick Evaluation Model

Previously, the evaluation of research module was done subjectively (by measuring student's perspectives) without objectively measuring the behavioral impact of this valuable course. Therefore, Kirkpatrick's four levels of evaluation were chosen for evaluating the research education module developed earlier. The aim of this study was to scale the module's influence (ripple effect) on participants' behavioral change. Here, ripple effect is defined as quantifiable spread of research-oriented behaviours, academic outputs, and shifts in professional identity among undergraduate

medical students resulted by the completion of a structured research module⁹.

The objective of this research was to measure the module's impact on participants' learning outcomes, reactions and overall behavioral changes. The four levels encompass a holistic spectrum of evaluation, incorporating not only learning outcomes but also participant's reactions, behavioral change, and broader impact.

METHODOLOGY

An explanatory sequential mixed method study design was used to collect data¹⁰. The study

was conducted at Azad Jammu & Kashmir Medical College (AJKMC), Muzaffarabad, Pakistan; a public sector medical college, running the modular integrated curriculum. Research module is an integral part of the longitudinal theme "PERL" running across all five years. Basics of research were taught in first two years by using student centered instructional strategies. In third year, research module has eight weeks duration, with learning objectives to learn critical appraisal of literature, scientific discussion, academic writing, statistical skills mastery, problem-solving, and development of research questions, along with soft skills such as communication skills and research ethics. Students are encouraged to complete their research projects under the supervision of

trained faculty, while working in teams. Data was collected during the eight weeks' time of research module (Aug 24-Oct 24). Study population was third year MBBS students, as they are encouraged to submit their manuscript by the end of this module. Making them most appropriate population to assess the impact of research module. The nonprobability sampling was done using consecutive technique, to lower the bias and promote generalizability of results in alike settings¹¹.

Inclusion & Exclusion criteria: Participants were included in study from the group of students enrolled in the research education module for the first time. All those students who are taking remedial of research module or detained in third year were excluded from the study. Sample size was calculated using

Confidence Level	95%
Margin Error	5%
Population Proportion	97%
Population Size	110
Sample Size	45

A total of 50 students participated in quantitative phase. Written consent was obtained from all the participants. After institutional review board (IRB) approval (letter no: ERC/DME/25 Dated: 15-7-2024),

quantitative data was collected prior and at the end of the module. The quantitative questionnaire used, was an adapted version of the Möller and Shoshan questionnaire¹². It was an online form based on a 5-point Likert Scale.

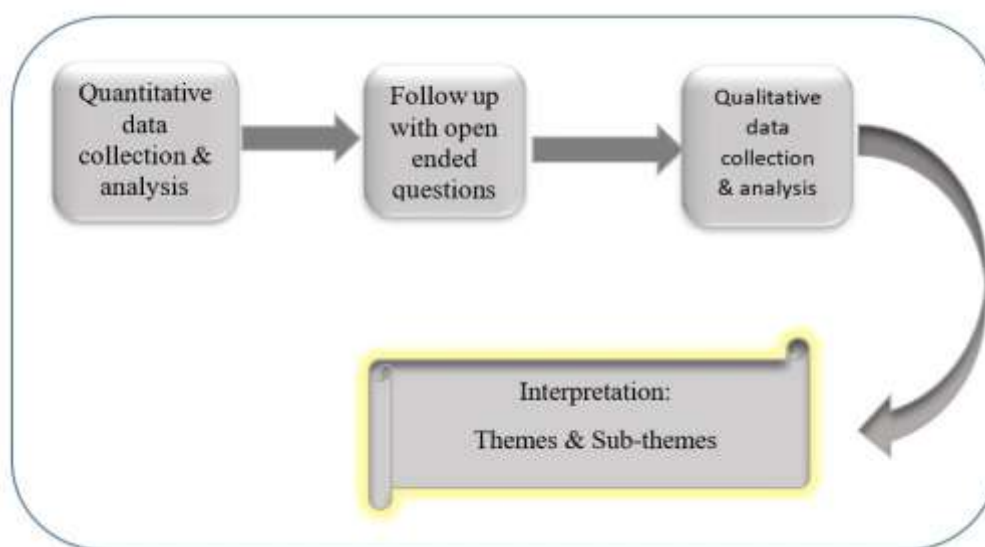


Figure 2: Explanatory Sequential Design (Mixed Method Study)

Phase I questionnaire covered key concepts in research ethics, research methodologies, and statistical analysis. A pre-assessment test was administered at the beginning of the module to gauge participants' baseline knowledge; later posttest assessment was carried out after completion of module to compare the change in level of learning and behavior of participant.

This posttest included a related questionnaire to assess the knowledge and skills participants acquired during the module. Participants' responses to the assessment questions were scored (both pre & posttest), and their scores were used to quantify the improvement in their knowledge, skills and change in the behavior (*level 1: reaction*). The gathered data depicted

the participants' knowledge and skills enhancement in research ethics, applying research methodologies, and performing statistical analysis. Therefore, the '*primary ripple effect*' of this structured module was seen. Next, quantitative data was analyzed using SPSS version 23.0, pre- and post-assessment scores were subjected to statistical analysis using paired t-tests (*level 2: learning*). In next phase, semi-structured interviews (based on phase I results) were conducted from the participants of Phase I cohort, depending on their availability (purposive sampling), for in-depth qualitative insights¹³. These interviews were based on a question guide which was developed by the investigators based on quantitative results trends and frequencies. Qualitative data was gathered through semi structured interviews in Focus Group Discussions (FGDs); data was collected through an iterative process till saturation. Total four FGDs were conducted comprising six participants each (from the phase I). Data was recorded, subsequently, transcribed verbatim and analyzed manually by a team of researchers. Transcripts were e-mailed to the participants to ensure the validity & credibility of data. All interviews were scrutinized by

researchers after developing a code book. Next, careful handling of data was done; open and axial codes were formulated, consequently themes were developed after percent agreement by the researchers.

RESULTS

The quantitative analysis aimed to determine the effect of research education module on participants' research knowledge and skills behavior. A sample size of fifty students (n=50) was included in quantitative survey, where male participation was 38.5% in comparison to 61.5% females. The average age of participants was approximately 21 years. The analysis of pre- and post-assessment scores revealed that mean assessment score has significantly improved to 73.8 from a baseline of 51.5, with a confidence interval of 95%. Paired t-tests showed statistically significant increases ($p < 0.05$) in post-assessment scores compared to pre-assessment scores for all fifty participants. This indicates a substantial enhancement in participants' understanding of research ethics, methodologies, and statistical analysis.

Table 1: Statistical analysis of Pretest and Post-test

Participant ID	Pre-Assessment Score	Post-Assessment Score	Score Difference	Statistical Analysis
Participant 1....50	48.....53	72.....69	+24....+16	Paired t-test: $p < 0.05$ (<i>same value for all participants</i>)

In phase II the qualitative analysis revealed participants' responses to the research education module and their perceptions of its impact. Four main themes were developed, naming research methodologies, research ethics, statistical analysis and challenges. Participants expressed high levels of satisfaction with the module's content and reported increased confidence in applying

research methodologies in real time projects (*level 3: behavior*). While discussing some of the challenges (statistical analysis concept difficulty) they also provided valuable suggestions for enhancements, highlighting the module's effectiveness in addressing their research education needs. Analysis of post-module semi structured interviews revealed the following findings:

Table 2: Findings of qualitative data

Themes	Codes	Example responses
Research Methodologies	Relevant & Logical Organization	'The module content was highly relevant to my research goals'
		'Engaging teaching methods made the module enjoyable'
		'The gradual progression from basics to complex was good'
		'The way topics were organized made it easy to follow'
	Hands on Practice & relevant resources	'I feel more confident in applying research methodologies now'
		'More practical exercises would further enhance the learning experience'
		'Additional resources on specific topics would be helpful'
Research Ethics	Integrity & Contemplations	'Understanding research ethics is crucial for maintaining integrity in my work.'
		'Knowing ethical considerations is essential in any study'
		'I saw a noticeable improvement in my research assignments after the module.'
Statistical Analysis	Student centered techniques and Real-World Scenarios	'Learning about quantitative methods was eye-opening'
		'I enjoyed the hands-on approach to quantitative research.'
		'I feel much more confident in handling statistical data'
		'I've learned techniques that I can apply to my research'
		'Practical sessions helped me apply theory to real cases'
		'Practical exercises deepened my understanding'
Challenges	Concept Difficulty	'I found some statistical concepts quite challenging'
		'Statistics were tough; I needed more detailed explanations'

**Figure 3:** Themes from qualitative data

The qualitative findings encompassed participant feedback, satisfaction ratings, perceived relevance of the content and informal spread of research culture in student body

through journal club or mentoring of juniors for critical appraisal of literature, statistics & academic writing. Subsequently, data gathered through 'resource marker' to evaluate how

effectively participants applied their newly acquired knowledge during research assignments and practical exercises. An increased request for institutional access to databases (like PubMed, ERIC or Scopus) following the module¹⁴. Thus, depicting the

overall '*secondary ripple effect*' (level 4: *Result/impact*). Subsequently, the compiled results have shown the module's impact on participants' research projects, academic performance, and their sustained understanding of research concepts.

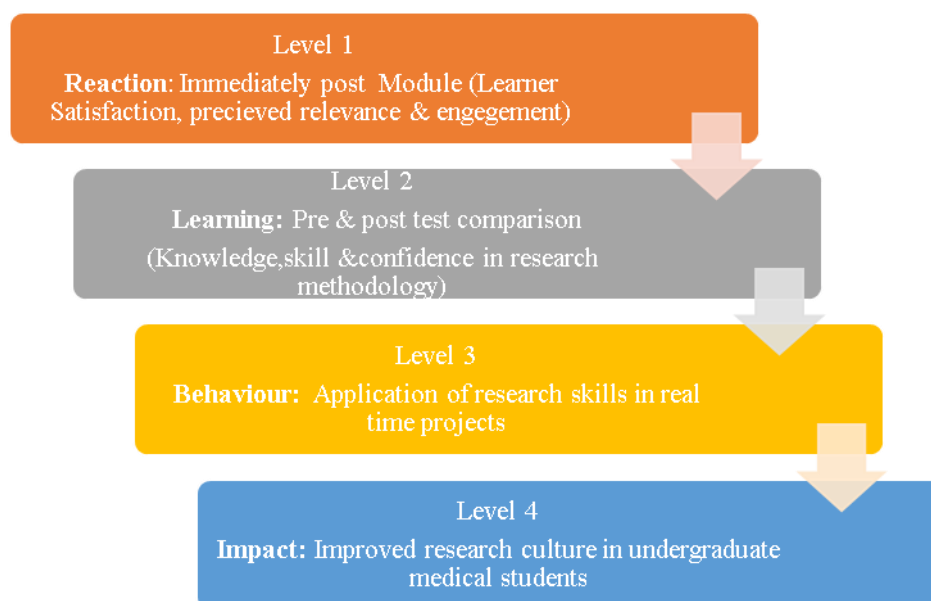


Figure 4: Flow diagram depicting the behavioral change of learners

DISCUSSION

This study utilized *Kirkpatrick's Four Levels of Evaluation* to provide a rigorous and holistic appraisal of a research module within a health education context. The response of this study revealed that participants were not merely satisfied with the module, but they feel ready to the tangible application of complex research methodologies.

The results have shown statistically significant improvement in knowledge and skills of all the participants, especially in analysis and research methodology, aligned with many earlier studies. Like, these findings are mirrored to a previous work which summed up that well designed longitudinal research modules results in considerable increase in grasp of cognitive domain¹⁵. However, a persistent gap in the literature is found between "theory and practice", where learners gain theoretical knowledge but lack practical implications in real world scenario. This gap could be bridged by the focus on instructional design strategy used¹⁶. Equally our results have shown that by hands-on practice and student-centered activities bridge this gap completely.

Moreover, by implementing a tailored teaching strategy, the decline in the learnt skills (with time) can be prevented, usually occurs once intervention is over. Like in this study "just-in-time" learning strategy was applied —where

statistical theory is explained immediately preceding its application to a raw dataset. This approach resulted in higher retention rates as compared to traditional lecture-based curricula. Thus, affirming the evidence based concept that experiential learning is the most effective tool for translating theoretical research philosophies into real world scenarios¹⁷. Similarly, by engaging/ involving in active data management and interpretation, our study has revealed that novices have transformed into experts then mere passive recipients. This shift promotes the "Cognitive Apprenticeship" model often cited as the gold standard in health professions education.

Interestingly, our finding remains contradictory to some previous research work. Some researchers have reported that undergraduate students find qualitative research less rigorous or challenging than quantitative one. As previous surveys have revealed that students prioritize *p values* than thematic analysis. However, our participants find qualitative component both engaging and informing. This discrepancy might be due to methodological integration, quantitative and qualitative tools were used as contemporary to each other, rather than operating in silos. Moreover, by analyzing real world scenarios, the 'epistemological shock' was prevented which

affects participants badly in many interventions¹⁸.

The strength of this study lies in its robust mixed methods technique, that is, quantitative 'what' and qualitative 'why' == will validate module effectiveness through objective assessment and by revealing underlying mechanism by student engagement, respectively¹⁹. This dual lens will affirm that the module has generated a genuine shift in participants' perspective. Where participants have moved forward from rote memorization to practical implication of statistical tests and their inferences.

Though we have positive outcomes, this study has *several limitations*. The small sample size has limited the scope of this study. The short duration of study and evaluation has limited the level 4 (results) impact on the community health outcomes. The model focuses on observable outcomes rather than mindset change in operations of our healthcare setting. To ensure lasting impact of research on undergraduates a longitudinal tracking should

be implied to assess that acquired skills are sustained after 6 to 12 months' post intervention. Participants pool should be expanded from other health care disciplines would increase the external validity of results. Moreover, *tertiary ripple effect* can be assessed by longitudinally tracking the career choices of these novices. whether they opt to research laden residency path or not!

CONCLUSION

To conclude, this study reveals that a balanced research module will enhance research literacy for undergraduate medical students. However, the outcome may vary due to contextual nature of educational interventions. The success of this module has laid a foundation for evidence-based practice and responsible research in undergraduate curricula.

Conflict of Interest & financial disclosure:

No conflict of interest & no funding resources.

Acknowledgements (if any):

None.

Disclosure: Nothing to disclose.

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Abbreviation

Evidence Based Medicine ----EBM

Azad Jammu & Kashmir Medical College ----AJKMC

Focus group Discussions ----FGD