

*“AN INTRODUCTION TO HEALTH RESEARCH: FROM IDEA TO PUBLICATION”* – DESIGNING AND IMPLEMENTING A VIRTUAL HANDS-ON RESEARCH COURSE FOR HEALTHCARE STUDENTS

Running head: Designing and implementing a virtual hands-on research course for healthcare students

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## Abstract

### *Introduction*

Early exposure to medical research is essential for healthcare professionals, to shape their careers and enhancing patient care. However, students face significant obstacles, such as lack of prior knowledge and mentorship. Malta's healthcare students lack hands-on research teaching.

### *Methods*

To address this gap in knowledge, a tailored elective virtual research course was designed using the analysis, design, development, implementation and evaluation (ADDIE) framework. Titled "An Introduction to Health Research: From Idea to Publication," the course comprised eight weekly lectures covering theoretical and practical aspects of research. Teaching consisted of didactic teaching and problem-based learning tasks. Conducted via the University of Malta's DegreePlus program, it allowed hands-on group work and active participation through online conferencing platforms. All students enrolled in the course completed pre- and post-course surveys, to assess whether the course affected students' perception towards research.

### *Results*

Most (57.14%, CI95%: 32.55 – 78.66) were in pre-clinical years, predominantly female (78.57%, CI95%: 51.68 – 93.16). 85.71% (CI95%: 58.81 – 97.24) lacked research experience or publishing opportunities. Main barriers included lack of opportunity (50.00%), time (21.40%), and training (28.60%). Post-course, significant improvements ( $p < 0.05$ ) were observed in research knowledge and confidence in conducting research. Qualitative analysis revealed that respondents expressed feelings of “*empowerment through education*” and appreciation for the “*effective course design and delivery*” of the course.

### *Conclusion*

Engaging medical students in research during training is crucial despite challenges like limited opportunities and foundational skills. A virtual research course has significantly improved students' confidence, knowledge, and skills in conducting research, showcasing its potential to enhance research training globally and advance healthcare delivery.

**Keywords:** medical education, medical students, research skills, research training, students' perspectives

## Introduction

Medical research is an integral element within the realm of medicine, playing a pivotal role in propelling medical advancements and improving patient care (Subbiah, 2023). It equips medical professionals with the knowledge and innovative skills required to tackle intricate medical challenges (Lee et al., 2021; Mass-Hernández et al., 2022). The introduction of research exposure, encompassing both theoretical frameworks and hands-on opportunities, during a doctor's formative years in medical school is essential (Frishman, 2001; Houlden et al., 2004;). This early involvement not only enhances an individual's academic portfolio but also nurtures an enduring experience that continually shapes the trajectory of a medical practitioner's career (Boyle et al., 2017; Mahmood Shah et al., 2017). The knowledge and skills obtained from research are not merely embellishments to a medical professional's qualifications; they serve as enduring tools that exert a profound influence on clinical practice, facilitate evidence-based decision-making, and ultimately contribute to the overall well-being of patients (Craig et al., 2001; Laidlaw et al., 2012; Lee et al., 2021).

Despite the significant importance of early exposure to research, medical students embarking on research initiatives often encounter significant obstacles during their quest for scientific exploration (Pearson et al., 2017). Chiefly the absence of prior research knowledge and the intricacies of the scientific process present a steep learning curve for these aspiring medical researchers (Unnikrishnan et al., 2014; Anbari et al., 2015; Noorelahi et al., 2015; Kharraz et al., 2016; Althubaiti et al., 2017; Chellaiyan et al., 2019; Dadipoor et al., 2019; Kumar et al., 2019; Pallamparthy & Basavareddy, 2019; El Achi et al., 2020; Elmannan et al., 2021; Ferdoush et al., 2021; Assar et al., 2022; Alhabib et al., 2023). Time and financial constraints, restricted access to research mentors, and limited funding opportunities further compound the hurdles they face (Kumar et al., 2019; Pallamparthy & Basavareddy, 2019; Assar et al., 2022). These barriers collectively underscore the pressing need for comprehensive support systems and adaptable research opportunities, which are indispensable in empowering medical students to excel in their pursuit of research excellence (Chang & Ramnanan, 2015; Stone et al., 2018).

These challenges are also present in Malta, a small European island state and member of the European Union, has one sole public university. Under the auspice of the University of Malta, the Faculty of Medicine and Surgery offers a German accreditation agency (ASIIN) and the Association of Medical Schools (AMSE) accredited Doctor of Medicine and Surgery degree. This program spans a duration of five years, encompassing pre-clinical and clinical phases of medical education. The pre-clinical years, which constitute the initial two years of the curriculum, encompass a comprehensive array of subjects including anatomy, physiology, embryology, cell biology, and histology. Preclinical students are also required to undertake a mandatory research study module; however, this module is primarily theoretical in nature, lacking hands-on research components. Subsequently, the clinical years cover a broad spectrum of specializations in clinical medicine, surgery, paediatrics, obstetrics, gynaecology, public health, and psychiatry (University of Malta, 2023a).

The introduction of an intercalated year in 2018 marked a significant addition to the medical curriculum at the University of Malta. This intercalated year offers students an opportunity to pursue a "Bachelor of Science (Honours) in Medical Sciences" by temporarily interrupting their medical course at the end of their pre-clinical studies. During this intercalated year, students delve into research, embarking on a supervised project with a predefined thesis title, typically involving laboratory-based investigations. Although this year fosters research skills and knowledge, it curtails students' autonomy to pursue their individual research interests.

Moreover, as of 2022, students also have the option to further prolong their intercalated study duration by an extra year to attain a Master’s of Science in their chosen academic discipline (University of Malta, 2023a, 2023b).

In alignment with the prevailing global perspective within the medical community (Chang & Ramnanan, 2015; Stone et al., 2018), medical students in Malta have been noted to have an inclination towards engaging in research and have actively pursued avenues to acquire the essential knowledge and skills required to carry-out research (Cuschieri & Cuschieri, 2021; Cuschieri, 2022). Nevertheless, Maltese medical students do not have accessible formal educational courses which provide practical and interactive teaching on research skills, and it is not known whether providing such courses improve medical students’ confidence in conducting research. Thus, this study aims to assess whether the provision of an elective research course to University of Malta medical students alters students’ confidence towards conducting research while also striving to assess students’ perceptions towards conducting research.

### Methods

To address this knowledge gap, identified by prior locally conducted observational surveys (Cuschieri & Cuschieri, 2021; Cuschieri et al., 2023), and to equip participants with essential research skills, as outlined by the General Medical Council (GMC) and the World Medical Association (World Medical Association, n.d.; General Medical Council, n.d.), we designed a research course tailored to the needs of Maltese students using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework (Table 1) (Deepika et al., 2020).

*Table 1: Course development according to analysis, design, development, implementation and evaluation (ADDIE) principles (Deepika et al., 2020).*

<b>ADDIE principle</b>	<b>How the principles were applied</b>
<b>Analysis</b>	Observational studies involving medical students and allied health-care professional students enrolled with the University of Malta identified that students lack the necessary skills and confidence to carry-out self-directed research or be part of hands-on research projects (Cuschieri & Cuschieri, 2021; Cuschieri et al., 2023).
<b>Design</b>	Students previously demonstrated their preference towards an elective virtual course to fill their perceived gap in-knowledge. Learning outcomes were based on expected research skills for medical professional as outlined by the general medical council (GMC) and World Medical Association (World Medical Association, n.d.; General Medical Council, n.d.).
<b>Development</b>	Based on students’ perceived gaps towards conducting research, which were triangulated through literature review, and the authors’ experience, a course curriculum was developed. The final programme consisted of an 8-lecture programme, which included narrated lectures whose theory was reinforced through problem-based learning scenarios. This culminated in participants presenting a self-designed research proposal with the receipt of constructive feedback by the end of the course.
<b>Implementation</b>	A promotional flier was disseminated through student social media platforms. The course was delivered virtually during summer 2023 through the University of Malta Degreeplus programme

<b>Evaluation</b>	Mixed-methods online questionnaires were disseminated before and after conducting the course.
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A virtual elective course was considered as an optimal format to deliver this course as it allows prospective students to enrol while balancing formal academic commitments with flexibility (Houlden et al., 2004; Cuschieri & Cuschieri, 2021; Noorali et al., 2021; Blackard et al., 2022; Asghar et al., 2023). The virtual format was also chosen to facilitate wider participation, building on our group's prior success in effectively conducting collaborative research endeavours solely through virtual means (Cuschieri, 2022; Cuschieri & Cuschieri, 2023).

The course was entitled "An Introduction to Health Research: From Idea to Publication," as it provided a step-by-step guide to formulate a health-related research idea (theory) to conducting a study (practical) and finally writing a scientific article. The course comprised eight lectures delivered weekly (Table 2). As noted in Table 2, the course programme covered theoretical aspects of research, including various research designs, preparing a research proposal, conducting a cross-sectional study, understanding required permissions, and writing a scientific article. Practical examples were provided, with participants engaging in hands-on research tasks under guidance, culminating in the presentation of individualized research proposals. This approach aimed to reinforce theoretical knowledge and motivate participants through scenario-based learning (Asghar et al., 2023).

Delivered through the University of Malta's DegreePlus program (<https://www.um.edu.mt/study/degreeplus/>), the course was limited to 14 students to facilitate hands-on, one-to-one feedback, and active participation. It was delivered online via ZOOM® in accordance with University of Malta regulations, breakout rooms were utilized to sub-divide participants into small groups for collaborative research tasks.

*Table 2: Course description and learning outcomes.*

<b>Lecture</b>	<b>Brief description</b>	<b>Learning outcomes</b>	<b>Tasks</b>
<b>Week 1: Introduction to clinical research</b>	Overview of the fundamentals and importance of clinical research.	<ul style="list-style-type: none"> <li>• Understand the basics of clinical research.</li> <li>• Recognize the significance of clinical research in healthcare.</li> <li>• Understanding the importance of ethical and data protection clearance.</li> <li>• Understanding what the different types of research misconduct are.</li> </ul>	Students were tasks to identify a research topic they would like to pursue and formulate a tentative research question
<b>Week 2: Research study designs</b>	Exploration of the various study designs used in research, such as experimental, observational, and cross-sectional.	<ul style="list-style-type: none"> <li>• Differentiate between various research study designs.</li> <li>• Identify the appropriate study designs based on research objectives.</li> </ul>	Students were divided into 4 groups (break-out rooms) and each group provided with a different research question. Students had to identify the best study design

			accordingly. Then each group had to present their answer with an explanation to the rest of the students.
<b>Week 3: Kick starting research</b>	Initiating the research process, including formulating a research Hypotheses, a budget and planning resources.	<ul style="list-style-type: none"> <li>• Develop research question and proposal.</li> <li>• Plan the initial steps to a research project.</li> <li>• Be familiar with the equator network guidelines.</li> <li>• Develop a budget and associated Gantt chart</li> </ul>	Students were tasked to formulate a research proposal, a budget and Gannt chart to their proposed research question developed during week 1.
<b>Week 4: How to conduct a systematic literature review</b>	Guidance on conducting a comprehensive and structured review of existing literature in a specific field of study.	<ul style="list-style-type: none"> <li>• Be familiar with the PRISMA guidelines.</li> <li>• Be familiar with different databases and repositories of scientific literature.</li> <li>• Understand how to formulate a search strategy.</li> <li>• Understand how to evaluate risk of bias.</li> </ul>	Students had to create a search strategy to complement their research question developed during week 1.
<b>Week 5: How to conduct an observational study</b>	Overview of observational study design, data collection methods, and analysis.	<ul style="list-style-type: none"> <li>• Understand the principles of observational studies.</li> <li>• Be familiar with sampling techniques.</li> <li>• Be familiar on how to collect data.</li> <li>• Be familiar with simple data analysis techniques</li> </ul>	Students were tasked to identify the appropriate observational study design for their research question.
<b>Week 6: Structuring a scientific article for a journal and a conference abstract</b>	Guidance on organizing and writing a scientific article for journal publication and creating a conference abstract	<ul style="list-style-type: none"> <li>• Learn the structure of a scientific article.</li> <li>• Understand the key components of a conference abstract</li> </ul>	Students were divided into 4 groups (break-out rooms) and each group provided with a different jumbled up abstract, with instructions to identify the different IMRaD sections.
<b>Week 7: Identifying an appropriate journal</b>	Strategies for selecting a suitable journal for publishing research findings.	<ul style="list-style-type: none"> <li>• Identify various factors in choosing the best journal.</li> <li>• Identify criteria for matching research article</li> </ul>	Students were tasked to familiarize themselves with different journal databases

		with appropriate journals. <ul style="list-style-type: none"> <li>• Identify predatory journals.</li> </ul>	
<b>Week 8: Research Presentations</b>	Tips and techniques for effectively presenting research findings to various audiences, through individualised feedback based on presentations of research proposals	<ul style="list-style-type: none"> <li>• Develop skills for creating engaging research presentations.</li> <li>• Learn effective communication techniques for presenting research outcomes.</li> </ul>	Students had to present their research proposal and receive peer and tutor feedback

*IMRaD – Introduction, Methods, Results and Discussion*

Self designed questionnaires pre- and post-course were formulated by the authors based on their experience, the local research landscape as well as previous peer-reviewed questionnaires to assess for the students’ perception towards research before and after following the Degreeplus course (Cuschieri & Cuschieri, 2021; Cuschieri et al., 2023). Pilot testing was not conducted due to the small cohort of students who were able to follow the elective research course. The first part of the questionnaires collected non-personalised demographic information, including any prior scientific publishing experience, and any reasons for not conducting research (if applicable). The second part of the questionnaires explored for perceptions regarding the conduction of research by following a Linkert Scale as follows: Strongly disagree; Disagree; Somewhat disagree; Somewhat agree; Agree; Strongly agree. Copies of the questionnaire can be found as part of the Supplement material. For tabulation purposes only (Table 3), these responses were combined and presented as “Agree” and “Disagree” respectively.

The anonymous questionnaire was disseminated through an online Google Form among all enrolled students using the university’s virtual learning environment (VLE) platform a week prior to commencement of the course. The same questionnaire was disseminated among the same students just after completion of the course. All questions were mandatory except for the free text that was only available as part of the post-course questionnaire, where students could share any comments pertaining to the course.

Descriptive analysis through frequencies was carried out. The Linkert scores used for students’ perspectives on research before starting the course were compared to the same perspective questions after finishing the course using the McNemar’s chi-squared test.

The free text section of the survey followed a two-stage coding and triangulation protocol to identify common themes between responders. Ethical clearance was granted by the University of Malta Research and Ethics Committee (MED-2023-00177).

### **Findings/Results**

All enrolled students to the Degreeplus course responded to the pre- and post- course survey ( $n=14$ ). The majority (57.14% CI95%: 32.55 – 78.66) of the students were in their pre-clinical years (first two-years of medical school) with a female predominance (78.57% CI95%: 51.68 – 93.16). Most (85.71% CI95%; 58.81 – 97.24) reported a lack of experience in research

conduction without any prior publishing opportunities in local or international peer reviewed scientific journals. The commonest reason for not engaging in any research projects was due to lack of research opportunity (50.00 % CI95%; 23.04 – 76.96), followed by and inadequate training (28.60 % CI95%; 8.39 – 58.10) and knowledge and lack of time (21.40 % CI95%; 4.66 – 50.80) .

Comparisons between different perspectives regarding research before and after attending the Degreeplus course showed significant difference in the knowledge and attitude towards conducting research, as shown in Table 3. Participants reported to be more knowledgeable and confident in conducting research following the completion of the course.

*Table 3. Comparisons of research perspectives before and after completing the Degreeplus course*

Perspectives	Pre-course (N=14)		Post-course (N=14)		p-value
	Agree	Disagree	Agree	Disagree	
I am knowledgeable on the different study designs I can conduct	6	8	14	0	<b>0.01</b>
I am not confident I have the necessary skills and training to participate in a research project	9	5	1	13	<b>0.02</b>
I am confident working in a team whose purpose is to conduct research	3	11	14	0	0.29
I am not confident handling research data	9	5	6	8	0.55
I am confident being relied upon to contribute to a research project	13	1	14	0	0.34
I am confident in undergoing a literature review	11	3	14	0	<b>0.04</b>
I am confident in critically analysing information	11	3	13	1	<b>0.07</b>
I think having research skills are not important skills to have as future doctors	0	14	1	13	1.00
Research will not help with my career progression	0	14	0	14	0.68
I am knowledgeable about the process of publishing research in peer reviewed international journals	4	10	13	1	<b>0.001</b>
I am knowledgeable about the research process	4	10	14	0	<b>0.001</b>

Thematic stratification of qualitative responses obtained through the post-course survey identified (1) ‘Empowerment through education’ and (2) ‘Effective course design and delivery’ as major prevailing themes (Table 4).

*Table 4: Qualitative responses and thematic stratification*

Theme	Qualitative responses
<b>Empowerment through education</b>	<ul style="list-style-type: none"> <li>“I barely knew anything about research but now I know that if I ever had the opportunity to conduct research, I will take it right away as I am more knowledgeable and further learnt about the importance of research for my medical career.”</li> </ul>



	<ul style="list-style-type: none"> <li>• “It was an interesting course, as it helped me understand more the process of research publication.”</li> <li>• “I think it can really help people grow, since it was an apt stepping stone between not knowing how to conduct research, to understanding the process.”</li> <li>• “[The course] provided all the necessary information to help us students start conducting our own research.”</li> <li>• “This course made us more aware on the research process and prepared us for future researches we will have to conduct in our career. Lecturer explained everything very clearly and made it a comfortable environment for students to learn.”</li> <li>• “The tasks made things more hands on and I learnt the most from that.”</li> <li>• “The student task at the end of each session helped me tackle the topic we went through in the session and understand better.”</li> <li>• “The course was extremely insightful and interesting to follow.”</li> </ul>
<p><b>Effective course design and delivery</b></p>	<ul style="list-style-type: none"> <li>• “The fact that we were a small number facilitated conducting research.”</li> <li>• “It was very interesting especially the way it was delivered with breakout rooms.”</li> <li>• “The course was approached schematically, and this gave it an order.”</li> <li>• “This course wasn't just lectures, but was also hands on, and gave us the way to start conducting a research.”</li> <li>• “Online is very well-suited and that was very convenient.”</li> </ul>

### **Discussion**

Medical students face significant barriers in pursuing research due to limited opportunities and foundational knowledge (Cuschieri & Cuschieri, 2021; Alhabib et al., 2023). Despite these challenges, engaging in research is crucial for fostering critical thinking and understanding healthcare practices, though students need proper guidance and support to succeed. (Mahmood Shah et al., 2017; Anbari et al., 2015; Elmannan et al., 2021; Cuschieri & Cuschieri, 2021; Alhabib et al., 2023). To address these issues, a virtual course aiming to deliver theoretical and hands-on practical teaching was designed, implemented and evaluated through pre- and post-questionnaires. The course provided a structured framework for students to gain comprehensive research knowledge and skills. Combining theoretical instruction with hands-on opportunities, it equipped students with the tools needed to navigate the complexities of medical research, leading to increased confidence and knowledge among participants.

The study underscores the effectiveness of such elective research courses in preparing medical students to initiate and conduct their own research. Gender disparities among participants were noted, reflecting the greater number of female medical students enrolled within the medical program. However, pre-clinical students emphasized the importance of research for their future careers, highlighting a contrast between perceived importance and reported lack of opportunities.

The research course exhibits global significance by addressing the significant challenges encountered by healthcare students internationally regarding accessing knowledge concerning and conducting research (Unnikrishnan et al., 2014; Anbari et al., 2015; Noorelahi et al., 2015;

Kharraz et al., 2016; Althubaiti et al., 2017; Chellaiyan et al., 2019; Dadipoor et al., 2019; Kumar et al., 2019; Pallamparthi & Basavareddy, 2019; El Achi et al., 2020; Elmannan et al., 2021; Ferdoush et al., 2021; Assar et al., 2022; Alhabib et al., 2023). Its tailored design, implementation strategies, and evaluation methods offer a replicable model for institutions seeking to enhance research training. Leveraging online platforms enhances accessibility, transcending geographical barriers. Improvement in participant research knowledge and confidence, underscore the potential of such courses to shape the next generation of healthcare professionals. By fostering a culture of inquiry and evidence-based practice, the course contributes to advancing healthcare delivery and patient outcomes on a global scale, epitomizing innovation in medical education.

Based on the findings of the study, several recommendations can be made to enhance research training for medical students. Institutions should consider implementing tailored virtual opt-in research courses, similar to the one described in this study, to provide comprehensive instruction and hands-on experiences in research methodologies. These courses should be designed using frameworks like ADDIE to ensure alignment with students' needs and educational objectives. Additionally, efforts should be made to expand access to research opportunities and mentorship for medical students, particularly those in their pre-clinical years. This could involve establishing research mentorship programs, facilitating collaborations with faculty members, and promoting research activities within the curriculum. Furthermore, initiatives aimed at addressing systemic barriers to research participation, such as time constraints and lack of funding, should be prioritized to create a more supportive environment for medical students interested in research. Ongoing evaluation and refinement of research training programs are essential to ensure their effectiveness and relevance, with a focus on long-term outcomes such as research productivity and career trajectories. By implementing such recommendations, institutions can better prepare medical students to engage in research and contribute to advancing medical knowledge and patient care.

While the study provides valuable insights into the effectiveness of a tailored virtual research course for medical students, this study's limitations should be acknowledged. Firstly, the study's sample size is relatively small, comprising only 14 participants, which may limit the generalizability of the findings. Additionally, the study focused on a single institution, the University of Malta, which may restrict the applicability of the results to other contexts. Differing medical curricula and attitudes for research may further limit generalisability and this study's global application. Furthermore, the study relied on self-reported data from participants, which could be subject to response bias and social desirability bias. The pre- and post-course surveys may also suffer from recall bias, as participants were asked to reflect on their knowledge and attitudes retrospectively. Moreover, the study lacked a control group or comparison with alternative research training methods, making it challenging to assess the unique impact of the virtual research course, affecting this study's validity. In addition, due to the small sample size, the questionnaire could not be validated or piloted beforehand, potentially affecting the study's interpretation.

Notwithstanding, this study exhibits several strengths that enhance its credibility and value. This study addresses a significant gap in medical education by designing and implementing a tailored virtual research course to enhance research skills among medical students. This proactive approach demonstrates a commitment to meeting the evolving needs of healthcare professionals. Additionally, the study utilized a rigorous methodology, including the use of established frameworks like ADDIE for course development and evaluation. The inclusion of both quantitative and qualitative data collection methods provided a comprehensive

understanding of participants' experiences and perceptions. Moreover, the study's focus on participant feedback and thematic analysis of qualitative responses allowed for the identification of key areas of improvement and satisfaction within the course content and delivery. Furthermore, the study's findings have implications beyond the local context, offering insights and recommendations that can be applied globally to enhance research training for medical students.

### **Conclusion**

While the challenges facing medical students in research are significant, the importance of engaging in such endeavors during training cannot be overstated. Despite limited opportunities and a lack of foundational research skills, research experiences cultivate critical thinking and problem-solving abilities, enriching students' comprehension of healthcare practices. To address these challenges, a virtual research course was developed, providing structured instruction and hands-on experiences to empower students in navigating medical research complexities. Comparisons of students' pre- and post-course perceptions towards conducting research demonstrated a significant improvement in students' perceived confidence, knowledge and skills in conducting research. This success underscores its potential to shape the research landscape of the next generation of healthcare professionals. However, the limited number of participants and single centre study design limits generalisability. Yet, this study's global significance lies in its adaptability and ability to address similar challenges faced by healthcare students worldwide, offering a replicable model for enhancing research training. By fostering a culture of inquiry and evidence-based practice, such initiatives contribute to advancing healthcare delivery and improving patient outcomes on a global scale, epitomizing innovation in medical education.

### **Ethics statement**

Ethical approval was granted by the Faculty Research Ethics Committee (FREC) by the Faculty of Medicine and Surgery, University of Malta [MED-2023-00177].

### **Competing Interests**

All authors declare that they do not have any competing interests.

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