ISSN 2732-3781 DOI: https://doi.org/10.52398/gjsd.2023.v3.i2.pp66-84

GiLE Journal of Skills Development

Setting Students up for Success: Developing Interdisciplinary Skills in a Medical Sciences Graduate Program

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Abstract

Acknowledging the importance of skill development in graduate programs, Western University in Canada developed an innovative master's program in interdisciplinary medical sciences. The program aims to promote students' academic, professional, and personal skills by engaging them in experiential and interdisciplinary learning that adopts an explicit and reflective approach in focusing on seven core skills: problem-solving, communication, leadership, critical reflection, working in diverse teams, project management, and decision making. This paper draws on the experiences and reflections of the inaugural cohort of students enrolled in the program to address the following research questions: 1) How does the MSc IMS program impact students' skill development? and 2) How did students practise the seven core interdisciplinary skills outlined in the program? The study utilizes a mixed methods approach by collecting quantitative and qualitative data using pre- and post-online surveys administered to the students. The findings highlight the program's positive impact in terms of students' reflection on their level of competence in the seven core skills, especially in complex problem-solving, oral and written communication skills, and critical reflection. Results also show that students specifically appreciated the contribution of experiential learning components of the program in advancing their skills. The paper emphasizes the importance of addressing students' skill development in higher education in an explicit and

intentional approach and engaging students in reflective practise on their skill development. Implications for the design and review of graduate programs are also discussed.

***Keywords*:** skill development; medical sciences education; interdisciplinary; higher education; program design

1. Introduction

With the increasing complexity of the job market and the rapidly evolving nature of many industries, graduate students must continually develop their skills to remain competitive and advance their careers. Colagrossi (2019) indicates that skills have recently gained more traction than formal degrees. They point out that prestigious companies no longer require a college degree for work and that a lot of what is being taught in postsecondary institutions is irrelevant to the day-to-day functions of a real job. In Canada, for instance, job posting data shows that employers reduced university degree requirements by 13% between 2012 and 2022 (Hill, 2023). Fuller et al. (2023) reached the same conclusion in the US context after analysing 51 million jobs posted between 2017 and 2020. This indicates that many companies are moving towards skill-based hiring, especially for middle-skill jobs. At the same time, the extent to which university graduates are equipped with 21st-century skills to enter the job market is questionable. For instance, Crosta et al. (2023) highlight a mismatch between the actual value of these skills and the level of training provided by European universities to their students in this regard. Similarly, Grayson (2021) reports on low skill levels among university students and graduates in Ontario, Canada. Crosta and Banda (2022) call for improving soft skill preparation in universities, especially critical thinking, collaboration, and self-direction, to increase young graduates' preparedness for the marketplace.

In programs where degrees are essential, such as medical science education and engineering, there is still a need to address and document students' skill development explicitly rather than implicitly (Almeida & Morais, 2023; Fuller et al., 2023). Correspondingly, to address the complexity of issues that medical science students are expected to tackle upon graduation, there is a dire need for an interdisciplinary approach in graduate science programs. For instance, Wilkerson et al. (2009) highlight the importance of integrating biomedical sciences with the social and clinical sciences. Greene et al. (2018) suggest the integration of foundational science and clinical science education in healthcare educational programs so that students explore the relevance of their learning and its future applications.

1.1. The MSc IMS Program

Acknowledging the importance of interdisciplinary skill development in higher education, and specifically in graduate medical science programs, the Schulich School of Medicine and Dentistry at Western University in Canada developed a new course-based one-year Master of Science degree in Interdisciplinary Medical Sciences (MSc IMS). Table 1 provides a brief overview of the major program components. Through courses and seminars, experiential learning rotations, capstone projects, and e-portfolio development, the program exposes students to a breadth of topics in basic and clinical sciences.

TABLE 1. SUMMARY OF THE MSC IMS PROGRAM COMPONENTS

Component	Title	Overview
Block Courses (4-week consecutive courses; 24 hours of instruction each)	Communicating science in the 21st century	This course discusses different types of oral and written scientific communication and how to communicate with different audiences effectively.
	Designing, analysing, and interpreting medical science research	This course teaches experimental design's theoretical framework and important scientific method aspects.
	Science policy	This course simulates a policy-focused work environment where students learn the foundational principles of Canadian science policy and government regulation.
	Ethical research practises	This course examines the ethical implications of advanced research, emphasising the importance of integrating solid ethical principles in scientific exploration.
	Academic integrity and professionalism	This course examines ethics and academic integrity in research. Students openly discuss what constitutes ethical behaviour and the implications of academic misconduct.
	Data Science	This course provides students with a foundational understanding of data science's role in research design, data collection, analysis, interpretation, and presentation of findings to various audiences.
	Research excellence through diversity	This course emphasises the importance of diversity and inclusion in medical research, addressing implicit bias and exploring the impact of diverse teams and study populations on enhancing research excellence.
	Intellectual property, implementation, and commercialisation	This course will examine the business and intellectual property challenges that must be overcome for successful clinical translation.
Skill Development Seminars (24 hours of instruction each)	Interdisciplinary skill development and career development	This course will provide students with workshops focused on the personal and professional skills needed to work in collaborative interdisciplinary environments.
	Career development and communication skills	This course teaches students how to effectively communicate complex health research in written and oral forms, emphasising diverse presentations, feedback techniques, and self-reflection skills for career development.
Experiential Learning (~48 hours each)	Basic science rotation	This rotation provides students with a breadth of exposure to a specific field in basic medical science research.
	Clinical science rotation	This rotation provides students with a breadth of exposure to a specific clinical medical science research field.
	Community-engaged learning	This rotation provides students with a breadth of exposure to a specific field outside of academia.
Milestones	Capstone Project	The capstone project connects theory and practice from the courses and rotations.
	e-Portfolio	The e-portfolio showcases the student's personal, professional, and academic achievements throughout the program.

Source: own compilation

Concurrently, the program focuses on the development of the following seven core interdisciplinary skills: complex problem solving, communication, leadership, critical reflection, working in diverse teams, project management, and evidence-based decision

making. The program adopts an explicit and reflective approach (Abd-El-Khalick & Lederman, 2000) in addressing students' skill development as evident in the titles of some of the offered courses and other program features. Each core skill includes three constituent sub-skills (see Table 2). The skills and sub-skills were derived based on an extensive environmental scan that mapped and validated the most relevant skills in medical science graduate programs (Campbell et al., 2022).

TABLE 2. THE SEVEN CORE SKILLS ADDRESSED IN THE MSC IMS PROGRAM AND THEIR CONSTITUENT SUB-SKILLS

Core Skills	Constituent Sub-skills
1. Complex problem solving	1. Apply design thinking strategies to personal, professional, and academic problems. 2. Identify the scope of a problem. 3. Integrate knowledge from multiple disciplines to solve complex problems.
2. Leadership	4. Articulate personal strengths. 5. Identify areas of growth and create a plan to develop these character traits in the future. 6. Demonstrate integrity and accountability in personal, professional, and academic settings.
3. Communication (oral and written)	7. Produce scientific materials for a wide variety of audiences and in a variety of formats. 8. Communicate complex scientific concepts using various mediums. 9. Effectively use storytelling to engage various audiences in different contexts.
4. Critical reflection	10. Identify personal learning goals and evaluate progress. 11. Critically evaluate prior expectations, beliefs, feelings, attitudes, and judgements. 12. Integrate key insights from personal reflection to influence future personal, professional, and academic development.
5. Working in diverse teams	13. Collaborate with individuals with diverse personal and professional experiences. 14. Create or be part of diverse, equitable, and inclusive teams. 15. Identify and work to eliminate barriers to diversity, equity, and inclusion.
6. Project management	16. Identify clear project goals, timelines, and final deliverables. 17. Continuously engage with stakeholders from organisations and various disciplines. 18. Complete project deliverables on time and as specified.
7. Evidence-based decision making	19. Understand the assumptions and limitations inherent to research. 20. Collect and analyse data appropriately. 21. Interpret various forms of information (e.g., raw data, published literature, stakeholder feedback) to make a recommendation or solve a problem.

Source: own compilation

Furthermore, to ensure that students are aware of their skill acquisition and are capable of articulating their development, the program engages students in on-going reflective practises (Minott, 2011). Reflection is viewed as the most important transferable skill in lifelong learning as it affects continuous personal and professional development. It allows learners to

contemplate their new experiences and how they are associated with past experiences and ultimately encourages them to focus on future transformation (Colomer et al., 2020; Ironsi, 2023). Acquiring this skill helps prepare students to appropriately use their knowledge in complex systems to provide solutions in routine and non-routine situations (Orsino & Ng, 2019). Additionally, students' ability to reflect on their skills and communicate their competence with potential employers is linked to their employability (Carpenter et al., 2022). In practice, Marshall et al. (2022) note that reflection can be facilitated through dialogues between peers, more experienced colleagues, and/or facilitators. Accordingly, in the MSc IMS program, students reflect on their experiences through end-of-course progress reports, end-of-rotation progress reports, end-of-term progress reports, end-of-term individual meetings with the program director, peer discussions, and the development of personalised e-portfolios.

1.2. The Seven Core Skills Addressed in the MSc IMS Program

As previously mentioned, the seven core interdisciplinary skills were derived following an extensive inspection by the program's curriculum development team. An environmental scan and a literature review were performed to determine a comprehensive yet broadly applicable list of skills students needed to develop to succeed in the program and their future endeavours. These seven core skills and their importance in medical science education are described below.

1.2.1. Complex problem solving

Despite 21st-century advancements, humanity is witnessing more complex problems that are notoriously difficult and require an interdisciplinary approach. These are often called wicked problems (Kawa et al., 2021). Accordingly, to prepare future citizens to be able to solve them, higher education institutions must address wicked problems in their programming (Veltman et al., 2019) by advancing students' problem-solving skills.

Problem-solving is associated with transfer, defined as using a concept learned in one context to solve a problem in a different context (Norman, 2009). Several studies highlight the importance of transfer in medical science education, in which primary science students apply their knowledge and solve problems in clinical settings (Collard et al., 2016; Norman, 2009). From a pedagogical perspective, the incorporation of problem-based learning in higher education health science programs has shown success in promoting students' problem-solving skills, enhancing meaningful learning, and concurrently developing interpersonal skills, communicative skills, reflective skills, and leadership skills (Sistermans, 2020).

1.2.2. Communication

Marbach-Ad and Marr (2018) report notable gaps in science graduate students' oral and written communication skills. They highlight the importance of training students to communicate their research to diverse audiences. Additionally, Shipps et al. (2023) highlight how a graduate interdisciplinary program in Physical and Engineering Biology incorporated student-led communication workshops to promote their communication skills. The study also shows the positive impact of these workshops on students' discussion skills and community building, which would lead to interdisciplinary research collaborations and enhanced participation in science outreach efforts. These findings highlight the direct and indirect effects of developing students' communication skills in medical science programs.

1.2.3. Leadership

Shipps et al. (2023) discuss the importance of providing students with leadership opportunities through peer mentoring and group activities. Such initiatives empower students, leading to high student retention rates and successful program recruitment. In accordance, James et al. (2021) evaluate leadership training in medical education. They highlight that several leadership intervention types exist, such as workshops, stand-alone non-curricular courses, and curricular courses aimed at promoting leadership, change agency, and teamwork. However, James et al. (2021) argue that such leadership training must be contextualised within medical science programs to ensure students' mastery of leadership skills related to interprofessional, ethical, and evidence-based medicine and practice.

1.2.4. Critical reflection

Reflection positively impacts students' learning of diverse subjects, comfort with learning in complex situations, and engagement in learning. Reflection is a habit that can be developed with practice (Winkel et al., 2017). Lázaro et al. (2022) report on a study on using learning logs as a tool of reflection and metacognition in a bioethics course. They show that learning logs successfully promote complex reflective and self-reflective processes and that such recognition of one's learning process promotes critical thinking.

1.2.5. Working in diverse teams

Interdisciplinary research and teamwork are indispensable to each other (Borrego & Newswander, 2010). Bleske et al. (2016) present how team-based learning leads to students showing greater confidence in performing higher-order tasks, including therapeutic recommendations and critical thinking, compared to lecturing teaching styles. Multiple studies document the positive impact of working in teams on both students' self-driven and cooperative learning (Marbach-Ad & Marr, 2018) as well as enhanced trust among members in interprofessional healthcare education settings that motivate them to collaborate with other professions once they enter the workforce (Burgess et al., 2020).

1.2.6. Project management

According to the Project Management Institute (2017), project management is "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements" (p. 10). Shirley (2020) summarises the guidelines for understanding what must be done in project management in the healthcare environment. These include defining the project, developing the work breakdown structure, estimating time and budget, developing the schedule, monitoring the project's progress, controlling the project, and closing it out. Bond-Barnard et al. (2018) highlight the important role of project team trust and collaboration in determining the success of the entire project.

1.2.7. Evidence-based decision making

Straus et al. (2019) highlight that evidence-based medicine requires integrating the best research evidence with clinical expertise and the patient's unique values and circumstances. This requires practitioners to seek the best available evidence for selecting, adapting, and implementing treatment. Ongoing progress monitoring aids such professional judgement and makes the patient play an active part in the decision-making process (Spencer et al., 2012). Baba and HakemZadeh (2012) propose five dimensions to assess the rigour and relevance of

evidence, including methodological fit, contextualisation, replicability, transparency, and scholarly and expert consensus.

1.3. Research Questions

Acknowledging the founding nature of the program, it is crucial to evaluate its impact from inception to provide ongoing quality assurance and improvement. Accordingly, this paper will draw on the experiences and reflections of the inaugural cohort of the MSc IMS program to address the following research questions: 1) How does the MSc IMS program impact students' skill development? and 2) How did students practise the seven core interdisciplinary skills outlined in the program?

2. Methodology

This study utilised a mixed methods approach (Creswell & Creswell, 2018) by collecting quantitative and qualitative data using pre- and post-online surveys distributed to the inaugural cohort of students enrolled in the program between May 2021 and April 2022.

2.1. Participants

The participants consisted of 15 students (three students identified as males and 12 identified comprised 15 students (three identified as males and 12 as females). The students were from different academic backgrounds, reflected by their bachelor's degrees, with four of them in medical sciences, three in biology, two in biology and medical sciences, two in psychology, two in life sciences, one in forensic science, and one in psychology and health studies. The inaugural cohort of students enrolled in the MSc IMS program comprised 15 students. Hence, the participation rate was 100% of the students registered in the program.

2.2. Data Sources

This paper reports the findings of pre-and post-surveys, in which students reflected and self-reported on their personal and professional skill development. The pre-survey was administered on the first day of the program in May 2021, whereas the post-survey was administered on the last day of classes in the program in April 2022, both using Qualtrics online software. The pre-and post-surveys included 21 Likert 5-scale items for students to self-assess their competence in the seven core skills outlined by the program and the subsequent sub-skills. Students were asked to rate their competence level in the 21 sub-skills presented in Table 2 from 1 to 5, where 1 being "Novice" would be the least competent and 5 being "Proficient" would be the most competent. Additionally, the post-survey included six Likert 5-scale items related to the evaluation of various program components (1 being "Not effective at all" and 5 being "Extremely effective") for students to reflect on the effectiveness of these components in developing their skills. As such, the pre-survey included 21 Likert 5-scale items, whereas the post-survey included 27 Likert 5-scale items. Furthermore, the post-survey included one open-ended question developed by the research team, asking students to detail how they practised each of the seven skills in the program. The question stated: "*Provide one or more examples of how you practised the following skills in this program [list of the 7 skills provided]. You can describe any course, assignment, rotation, etc.*"

2.3. Data Analysis

Quantitative data obtained from the Likert scale items were analysed using Microsoft Excel and SPSS. The analysis on Microsoft Excel included descriptive statistics such as calculating average and standard deviation. Each core skill is a composite variable constituted of three sub-skills. As such, the sub-skills were considered as aggregate items that formed the constructs i.e., core skills. For example, students' self-recorded competence in the core skill 'complex problem solving' was determined by calculating the average of its three constituent sub-skills 1, 2, and 3 (shown in Table 2). Similarly, the level of core skill 2 was calculated as the average on sub-skills 4, 5, and 6. Furthermore, SPSS was used to perform inferential statistics such as the Wilcoxon test to evaluate the significance of change between the pre- and post-surveys (Connolly, 2007).

Qualitative data obtained from open-ended questions were analysed through an interpretational analysis framework (Stake, 2020) to corroborate the quantitative results. Two research team members collaboratively performed thematic coding to address the research questions. To enhance the qualitative data analysis trustworthiness (Creswell & Creswell, 2018), a third member of the research team reviewed the analysis and collaborated on finalising the emerging themes. It is worth noting that the open-ended responses obtained from all 15 participants were analysed and discussed in the opening paragraphs of sections 3.2.1 to 3.2.7. Yet, selected quotes are included in this paper. To address the research question on how students practised the seven core interdisciplinary skills outlined in the program, the research team included quotes that are more detailed and more relevant and insightful to readers.

Although the study participants are all the students of the inaugural cohort of the MSc IMS program, the authors acknowledge that the sample size is relatively small for a solely quantitative study. As such, we adopted a mixed-method design to ensure a rigorous analysis of the data and to support the quantitative analysis. The quantitative and qualitative data were integrated by merging and explaining each other. This integration minimises the limitations of both approaches, offers additional insight beyond the information provided by either one alone and gives a more comprehensive understanding of the research findings (Creswell & Creswell, 2018).

3. Results

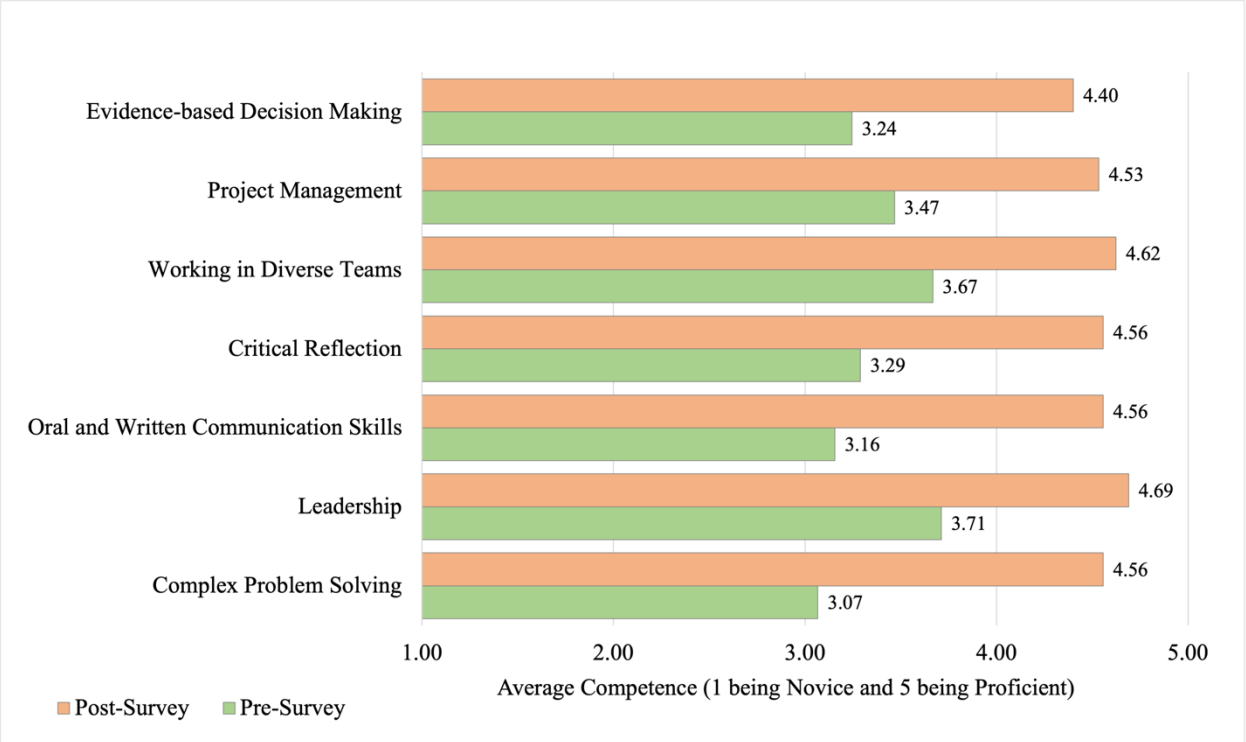
The section below presents the results pertaining to each of the two research questions.

3.1. Impact of the Program on Skill Development

To draw on the experiences and reflections of the MSc IMS program and explore its impact on skill development, students were asked to rate their level of competence in the seven core interdisciplinary skills. Figure 1 highlights the average responses of students' initial and final self-reported ratings on these Likert-scale items, with 1 being novice and 5 being proficient. Results show an overall improvement in students' responses on all items, with all post-survey responses recording a mean value ranging between 4.40 and 4.69, indicating high proficiency in those skills. Additionally, the highest difference between the post-survey and the pre-survey levels was recorded on complex problem-solving (difference = 1.49) and oral and written communication skills (difference = 1.40), followed by critical reflection (difference =

1.27). In contrast, despite the improvement, the lowest difference was recorded in leadership (difference = 0.98) and working in diverse teams (difference = 0.96).

FIGURE 1. STUDENTS' REFLECTIONS ON THEIR COMPETENCE IN VARIOUS SKILLS



Source: own calculations

Furthermore, the results of the Wilcoxon test indicate that the pre-post change was significant on all seven skills:

1. Complex problem solving: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program ($M = 0.00$, $n = 15$) compared to the beginning of the program ($M = 0.00$, $n = 15$), $z = 3.31$, $p < .001$, with a strong effect size, $r = .61$.
2. Communication (Oral and Written): The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program ($M = 0.00$, $n = 15$) compared to the beginning of the program ($M = 0.00$, $n = 15$), $z = 3.14$, $p = .002$, with a strong effect size, $r = .57$.
3. Leadership: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program ($M = 0.00$, $n = 15$) compared to the beginning of the program ($M = 0.00$, $n = 15$), $z = 3.32$, $p < .001$, with a strong effect size, $r = .61$.
4. Critical Reflection: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program ($M = 0.00$, $n = 15$) compared to the beginning of the program ($M = 0.00$, $n = 15$), $z = 3.35$, $p < .001$, with a strong effect size, $r = .62$.
5. Working in diverse teams: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program ($M = 0.00$, $n =$

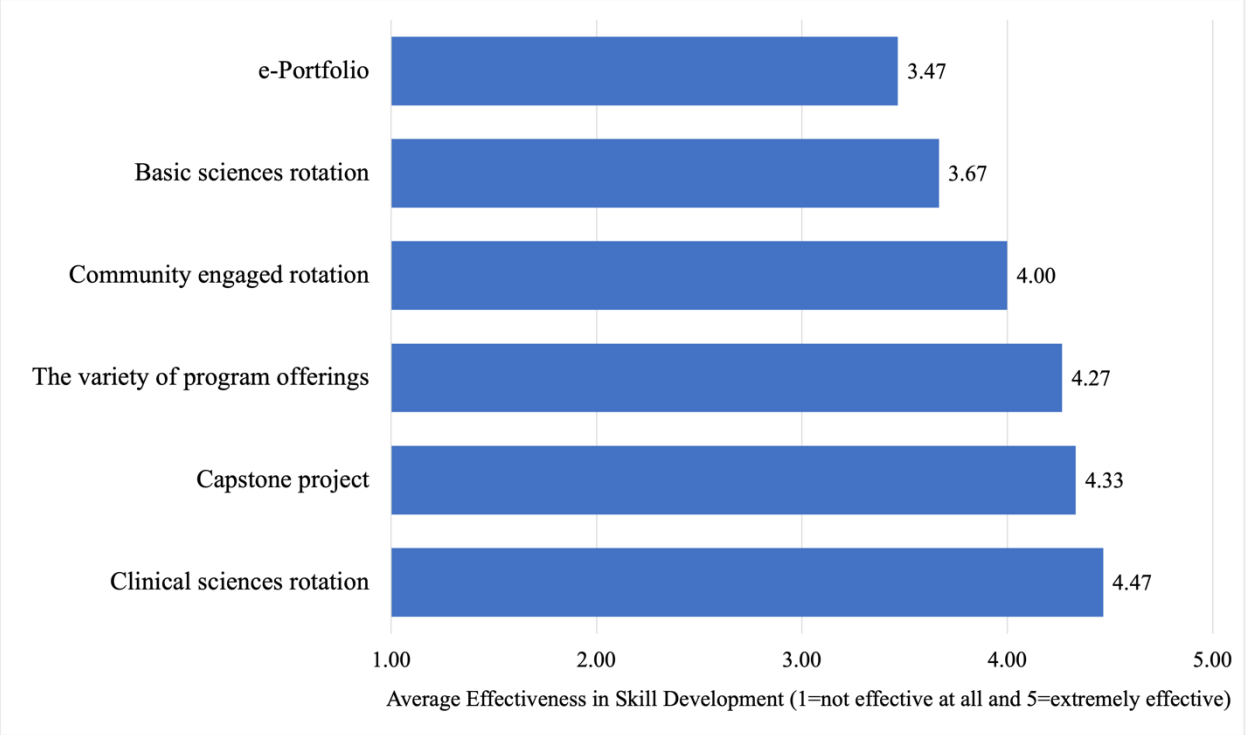
15) compared to the beginning of the program (M = 0.00, n = 15), z = 2.85, p = .004, with a strong effect size, r = .52.

6. Project Management: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program (M = 0.00, n = 15) compared to the beginning of the program (M = 0.00, n = 15), z = 3.33, p < .001, with a strong effect size, r = .61.
7. Evidence-based decision making: The Wilcoxon signed rank test revealed that students' self-reported competence was significantly higher at the end of the program (M = 0.00, n = 15) compared to the beginning of the program (M = 0.00, n = 15), z = 3.31, p < .001, with a strong effect size, r = .60.

3.2. How Students Practised the Skills

In the post-survey, students rated the effectiveness of each program component in developing their skills on a 5-point Likert scale with 1 being not effective at all and 5 being extremely effective (See Figure 2). Four program components scored between 4 and 4.47, implying very to extremely effective. These components included the clinical sciences rotation (M = 4.47, SD = 0.64), capstone project (M = 4.33, SD = 0.72), the variety of program offerings (M = 4.27, SD = 0.70), and community-engaged experiential rotation (M = 4.00, SD = 1.13). However, the basic sciences rotation (M = 3.67, SD = 0.98) and e-Portfolio (M = 3.47, SD = 1.25) ranged between moderately and very effective.

FIGURE 2. STUDENTS' EVALUATION OF THE EFFECTIVENESS OF VARIOUS PROGRAM COMPONENTS IN DEVELOPING THEIR SKILLS



Source: own calculations

Correspondingly, students' responses to open-ended questions on how they practised each skill in the program corroborated the quantitative findings above.

3.2.1. Complex problem solving

Most students related complex problem solving to their capstone project, as they were required to address a wicked problem and suggest solutions by considering the literature and reported best practises. Two students said:

> *I practised complex problem solving almost in all courses and rotations in this program. In particular, the capstone project on COPD {Chronic Obstructive Pulmonary Disease} is about which problem we want to address and what actions we could take to reduce the increasing prevalence of COPD in Canada. (Student 2)*

> *Complex problem solving was a core skill that I practised through many experiences in the program. One experience, for example, was when my capstone group and I needed to provide and define calls to action for our wicked problem. I need to approach solving this wicked problem in a non-traditional fashion. From this experience, I learned that complex problem solving requires critical thinking that requires one to consider all perspectives of the problem. Since this was a yearlong project, finding solutions to this complex problem, I needed to work collaboratively with my group and brainstorm ideas. Over time, an important part of this skill of complex problem-solving that I learned was the importance of collaboration and communication. (Student 3)*

Additionally, some students expressed a relational understanding of complex problem-solving. Those students reported on this skill being practised as they encountered specific group conflicts or dealt with personal problems while trying to manage their coursework and assignments. For example, Student 4 said:

> *I think troubleshooting and persevering through a difficult CEL {community engaged learning} rotation is an example of how my group engaged in problem-solving. We had some hurdles to get over, but we were able to seek support and move past these.*

3.2.2. Communication

Students reflected positively on their ability to practise written communication skills in their courses by completing the reflective progress reports at the end of each course, collaboratively writing an academic article, writing a final report based on complex scientific information, and creating an e-portfolio. Additionally, oral communication skills were practised with different audiences, such as course presentations to peers and instructors, microteaching a concept in one of the courses, communicating with peers in group projects, presenting to community partners in the community-engaged rotations, and engaging in public speaking by presenting the capstone projects to the academic community in a showcase at the end of the program. Some students highlighted the importance of two specific courses in addressing these skills: the “Communicating Science in the 21st Century” course and the “Career Development and Communication Skills” seminar. Students also emphasised the importance of instructors’ feedback, ongoing reflections, and constant practice in developing their communication skills.

> *My communication skills improved significantly since the start of this program. Through the science communication course, I learned more ways how messages could be delivered. From the micro-teach sessions to larger presentations such as the EDI {equity, diversity, and inclusion} project to our final capstone showcase, I had so many opportunities to practise and improve myself by incorporating the feedback I received. (Student 2)*

Throughout this program, I have had many opportunities to enhance my public speaking, written reflections, and assignments. At the beginning of the program, one of my goals was to improve my public speaking and confidence in communicating with a large audience. I was able to reach this goal through the practise, and feedback that I received from my peers, instructors and staff that helped me to achieve my oral and written communication goals. (Student 3)

There are so many examples of where I improved in my oral and written communication skills however, most notably, I significantly improved on my oral communication skills. I have had plenty of experience now with presenting through the various course assignments and update presentations and I have a newfound confidence with presenting and public speaking. (Student 4)

In the Community Engaged Rotation, my group and I worked to develop a PowerPoint presentation for our partners to use for clients. In this way, we ensured the presentation was easy to understand, eliminated jargon, and was visually appealing to follow along. (Student 6)

Communication was a tremendously developed skill for me this year. I was already proud of my communication skills but learning to tailor it to suit specific target audiences was a big learning curve for me. I also learned to communicate through various mediums i.e., presentations, publications, and more creative formatting. (Student 8)

3.2.3. Leadership

All students referred to the importance of ongoing group activities as a major program component that promoted their leadership skills. Students specifically highlighted their collaborative work in all three rotations and the capstone project, which necessitated assuming leadership tasks and capitalising on their strengths at many instances. Students mentioned how they took on leadership roles to interact with the various stakeholders, professors, and professionals during experiential rotations, set and managed group deadlines, led group meetings, and respected group dynamics.

I practised leadership skills through working with my capstone team and doing group projects in all the courses. In particular, at the start of the program where science was a bit heavier. I was able to make plans and help out with my team members. I learned that each of us has our own strengths and weaknesses. A big part of leadership is to optimize the final performance by acknowledging the strengths of everyone. (Student 2)

As part of my capstone group… I recognized that each of my group members had different leaderships styles and while this was difficult at first to understand how we could best utilize each of our unique leadership skills effectively, I felt that having leadership position to organize, delegate task and communicate with my group became part of my leadership style. I find that I was able to become a calm, collective and quiet leader who motivated my group to accomplish tasks well and efficiently throughout the year. (Student 3)

In the Clinical Science rotation, I acted as a leader for my group as our rotation was centred on an area that I would like to pursue as my career. I used my prior knowledge from work and volunteering to guide my group members and improve our competency in this field as a whole. (Student 6)

3.2.4. Critical reflection

Most students emphasized the importance of writing progress reports at the end of each course, rotation, and term to develop their reflective skills. Additionally, some students highlighted the significance of the e-portfolio and the end-of-term meetings with the program director in showcasing their accomplishments and challenges in the program. Notably, some students mentioned that these required exercises led them to naturally engage in ongoing reflection about their achievements and plans, even at times when they were not asked to formally submit a reflective piece. Additionally, one of the students noted that engaging in ongoing reflections positively impacted their achievement in the program.

> *At the end of each course and stage of the program, we wrote a progress report that included SMART goals and reflections on our learning. Critical reflection was also developed during the development of the e-portfolio as I looked back on past work. It also occurred for me naturally at different times in the program where I would make a realization of what I have been able to accomplish and where we are in the program to date. (Student 1)*

> *Through our reflection after each course, I was able to develop a reflective habit that has continued to contribute to my personal, professional, and academic development. More specifically, I had the opportunity to showcase individual work in front of peers and the director in our final reflection at the end of term meetings (3 in total throughout the program). (Student 3)*

> *I worked to improve my critical reflection this year to gain the most from each rotation. If I hadn't done this, I don't think I would have gained nearly the same experiences from the rotations. Additionally, having a difficult group environment at times caused me to reflect on how I could resolve the conflict and move forward. (Student 8)*

3.2.5. Working in diverse teams

In conjunction with leadership skills, students referred to group activities in the courses and the rotations in which they worked in diverse teams. Students reflected on how they dealt with new group members in different activities, navigated differences, and networked with community and academic partners in their rotations. They also emphasised the importance of the collaborative capstone project in nurturing this skill.

> *I have had many opportunities to practise working in diverse teams, whether that be with my capstone group or on group assignments, I was able to work with and have a chance to gain perspective on each of my classmates' work ethic and diverse expertise. It was a privilege to get to know each of my classmates on a professional and academic level as well as understanding the importance of everyone's individual goals and values. I was able to practise working in a diverse team continuously throughout the year and practicing this has made the experience a wonderful learning opportunity. (Student 3)*

> *The members in my capstone group all came from different academic and personal backgrounds which contributed to the success of our group. We all shared different perspectives and built a respectful and open environment together. (Student 4)*

> *Working in diverse teams was a huge component to the program and my learning. Different from undergrad, we were expected to complete most components within groups,*

working together to come up with a positive product. This was at times difficult within my capstone group, when I felt workload was not being evenly distributed but I have learned how to work through these difficult situations and come out stronger. (Student 8)

3.2.6. Project management

Students' responses on how they practised project management can be classified into two categories. Some generally reflected on their work in the program as a whole and considered it as a project. This included prioritizing tasks, deadlines, and assignments in coursework, rotations, and capstone work. Other students considered project management to be highly evident in the capstone project in which they broke down a lengthy project into smaller more manageable tasks, set and managed deadlines to ensure progress was on track, organized deliverables, and came up with solutions using decision-making skills.

Due to the compressed time frame of the program and the courses, project management was important for all tasks and deliverables throughout the entire program. There were consistently multiple tasks to manage and project management was key to ensuring all the work got done. It was also very highlighted in the capstone milestones, where the project management needed to be decided amongst peers. (Student 1)

My group and I worked in our rotations and Capstone project to manage various tasks and deliverables that had to be completed. We did this by holding ourselves accountable (i.e., holding regular meetings), keeping an organized Teams Channel, and working on tasks on a daily basis. We were also flexible with each other's schedules and lives outside of school, which allowed us to succeed as a whole. (Student 6)

3.2.7. Evidence-based decision making

Students drew on several experiences in the program in which they practised evidence-based decision making, such as the capstone project by proposing a solution to a wicked problem, various experiential learning rotations, and research activities in certain courses in which they had the opportunity to conduct a scoping review and perform an environmental scan to make scientific arguments based on available data.

There have been several opportunities where I have had the experience of integrating my knowledge and through evidence-based decision making. For example, during my clinical science rotation, alongside my group, I was required to explore cancer research and making clinical connections through evidence-based decision making. (Student 3)

In our community-engaged rotation, my group and I used evidence in the literature surrounding the best exercise interventions for various forms of arthritis to incorporate these into a slideshow presentation for individuals that are living with the disease. We also used evidence on best practices when presenting scientific information to patients and made sure our slideshow was laid and easy to follow along. (Student 6)

4. Discussion and Conclusion

This paper draws on the experiences and reflections of the inaugural cohort of the MSc IMS program to address the following research questions: 1) How does the MSc IMS program impact students' skill development? and 2) How did students practise the seven core interdisciplinary skills outlined in the program?

The pre-post survey comparison highlights the positive impact of the program in terms of students' reflection on their level of competence in the seven core skills outlined in the program, especially in complex problem solving, oral and written communication skills, and critical reflection. These findings address a major gap in medical science education research and practise highlighting the need for developing students' skills in these three areas specifically (Collard et al., 2016; Lázaro et al., 2022; Marbach-Ad & Marr, 2018; Norman, 2009; Shipps et al., 2023). Conversely, based on the quantitative and qualitative data analysis, and despite the improvement noted by students, three skills stood out as the ones that students need to develop further: leadership, working in diverse teams, and evidence-based decision making. This finding parallels the literature recommendations on engaging medical science graduate students in more leadership opportunities (James et al., 2021; Shipps et al., 2023). It also sheds light on the need for medical graduate students to practise teamwork and evidence-based decision making as these two skills are crucial in learning medical sciences (Bleske et al., 2016; Borrego & Newswander, 2010; James et al., 2021; Shipps et al., 2023).

Moreover, students rated the effectiveness of various program components in developing their skills. Results show that they were highly satisfied with the experiential learning components of the program, in particular the capstone project, the clinical sciences rotation, and the community-engaged rotation, in addition to the various topics covered in the courses. Students especially appreciated being immersed in a real-life scenario for their capstone project in which they tackled a wicked problem using an interdisciplinary lens. This finding was further corroborated as these experiential learning experiences were mentioned by most students in the open-ended responses in which they explained how they practised each of the seven core skills. These results parallel existing literature emphasising the importance of capstone projects (Lee & Loton, 2019) and experiential learning opportunities (Carson et al., 2018; Crosta & Banda, 2022; Hodza-Beganovic et al., 2021). In contrast, the quantitative data showed that the e-portfolio was rated as the least effective among program components. This finding confirms similar reported challenges on e-portfolios (Fisher & Hill, 2017). Yet, the open-ended responses highlighted that some students were able to link the importance of the e-portfolio to developing their reflective practice and personal skills (Greviana et al., 2020).

Finally, the findings reiterate the importance of addressing students' skill development in higher education and specifically in graduate medical science programs through an explicit and intentional approach (Carpenter et al., 2022; Claydon et al., 2021; Crosta et al., 2023; Demaria et al., 2018; Gross & Sohl, 2021; Hart & McKinney, 2020; Jahn & Kenner, 2018; Pitan, 2017). The results also emphasize the importance of engaging students in reflective practise on their skill development (Carpenter et al., 2022; Minott, 2011). This explicit and reflective approach is essential to ensure that students not only acquire interdisciplinary skills but are also aware of and able to articulate their accomplishments and areas of improvement. Additionally, the adopted explicit and reflective skill-based training model highlights the importance of scaffolding student skill development throughout the coursework and experiential experiences. This balance between practising the skills on several occasions in the courses and concurrently in the experiential learning rotations and the capstone project would help students acquire a more complex understanding of and higher proficiency in those skills.

One limitation of this paper is the reliance on self-reported student reflections as the major source of data in exploring the impact of the MSc IMS program on students' skills. Future research can corroborate those findings by exploring instructors' feedback, and longitudinal

analysis of students' practises in relation to the seven core skills in their future studies or careers. Research can also extend the findings of this paper by exploring the impact of differences in skill development depending on students' academic backgrounds, age, prior experiences, and gender. The findings of this study offer insights to develop future research within the MSc IMS program, given the projected growth in its student enrolment and beyond the program.

Despite these limitations, this research offers valuable implications for designing new and reviewed existing graduate programs to ensure that program developers and educators incorporate components that address students' skill development to set them up for success in their future endeavours.

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Declaration Statements

Conflict of Interest
The authors report no conflict of interest.

Funding
The author received no financial support for this article's research, authorship, and/or publication.

Ethics Statement
This research has acquired ethical approval from Western University- Canada Non-Medical Research Ethics Board.

Open Access Agreement

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