

# Curriculum Diversity in BS Medical Laboratory Technology: A Comparative Analysis of National and International Universities

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## ABSTRACT

**Objective:** Given the growing role of Medical Laboratory Technology (MLT) in healthcare for precise diagnosis, there is a considerable emphasis on improving the training quality of MLT professionals. The present study conducted a comparative curriculum analysis of Bachelor of Science (BS) in Medical Laboratory Technology.

**Methodology:** This study was conducted between October 2023 to January 2024. It was an applied descriptive cross-sectional and comparative study. The data were acquired through an electronic search on the universities' website. A comparative analysis was conducted between the curriculum of nine national and six foreign universities. The data collection instrument comprised a checklist developed by the researchers, which was used to retrieve relevant information.

**Results:** A review of BS MLT curricula revealed a substantial expansion in the BS MLT discipline within Pakistan, growing from two universities in 2005 to over 32 universities with diverse programme titles. Comparative analysis of BS MLT programmes showed a mix of similarities and differences. This included both the range of courses offered and the content within those courses. A few of the courses taught at our national universities are not part of foreign universities and vice versa.

**Conclusion:** The results indicated that there is a need for a standardized national curriculum to guarantee uniformity and excellence in MLT education.

**Keywords:** MLT, Curricula, University, Education, Pakistan

## Introduction

The primary objective of medical universities is to educate and prepare skilled professionals who possess the requisite knowledge, attitude, and abilities to uphold and enhance public health.<sup>1</sup> We are all cognizant of the importance of physicians in healthcare. However, in recent decades, there has been a substantial rise in the public's reliance on medical laboratory personnel. Medical Laboratory Technology (MLT) is crucial in the healthcare industry as precise and reliable laboratory diagnosis forms the basis for disease management and prevention.<sup>2</sup>

With a range of professional prospects and a significantly quicker growth rate projected in the years ahead, investing time and money in a MLT career is a prudent decision with several opportunities for future career progression.<sup>3</sup> In order to meet the legal requirements for employment in clinical laboratory services, the majority of MLT positions necessitate either a two-year diploma (equivalent to Higher Secondary School Certificate) obtained after completing Secondary School Certificate (SSC) education or a four-year university

degree programme, namely a BS in Medical Laboratory Technology.<sup>4</sup> MLT education has undergone significant transformation worldwide in recent decades, with a shift in approach towards competency-based trainings.<sup>5</sup>

The main challenges that our future Medical Laboratory Technologists will encounter are the implementation of digitized and computerized healthcare systems,<sup>6,7</sup> the rapid progression of medical knowledge,<sup>8</sup> advances in medical research,<sup>9</sup> the impact of globalization, and the problems posed by an ageing society.<sup>10</sup> Therefore, MLT education should prioritize comprehending patients' requirements and guiding students to be more aware of their surroundings and society. Presently, the students are compelled to adopt a mindset of passive assimilation of knowledge (which allows them to accumulate as much information as they can over extended periods of learning) rather than one centred on reflective thinking, inquisitiveness, and investigation. The knowledge obtained in this manner is fragmented rather than assembled into a

comprehensive whole, and it never develops into wisdom. Moreover, this approach to education promotes a keen focus on any given activity, disregarding both the surroundings and one's own self. MLT students may become so absorbed in acquiring knowledge and skills that they may lose their sense of direction in society, occasionally even neglecting the patient, who is the primary purpose of their profession.

The Higher Education Commission (HEC) of Pakistan developed an Undergraduate Education Policy (UGEP) in 2023, which provided a set of standards, guiding principles, frameworks for curricula, learning outcomes, and assessment methodologies for all stages of education and training at the undergraduate level. The policy is applicable to the associate degree and bachelor's degree programmes offered by the Pakistani universities and Degree Awarding Institutes (DAIs).<sup>11</sup> These standards and guidelines by HEC ensure that all universities and DAIs develop and implement uniform curricula to enable students to achieve learning outcomes required as graduates and practice safely and competently.

The Shaheed Zulfiqar Ali Bhutto Medical University (SZABMU) is a public university in Islamabad, Pakistan, accredited by the HEC. Established on 21 March 2013, SZABMU offers undergraduate and postgraduate courses in medicine, surgery, dentistry, basic medical sciences, and allied health professions. Currently five MLT institutes / colleges are affiliated with SZABMU namely, Islamabad Medical and Dental College, College of Medical Laboratory Technology - NIH, College of Medical Technology - PIMS, Bashir Institute of Health Sciences, and Prime Institute of Health Sciences. The BS MLT curriculum at the SZABMU was initially developed during the 2014-15 academic year through a consultative process primarily involving experts from the Pakistan Institute of Medical Sciences (PIMS) and the National Institutes of Health (NIH). Following feedback from affiliated and constituent institutions, a curriculum reform was undertaken in 2020-21 and subsequently implemented from 2022.

Curriculum planning is an essential component of education that significantly contributes to the effective development of human resources. A curriculum is a comprehensive plan that outlines the

educational activities and objectives of a programme or course of study. If the curriculum is not rational and realistic, it will not produce the desired results, and it may also lead to irreversible negative impacts.<sup>12</sup> Hence, it is imperative to exercise caution in order to prevent any negligence and inefficient use of resources. Additionally, it is crucial to implement strategies that guarantee the high standard of the curriculum, such as the identification and effective management of its components. Curriculum evaluation is an integral aspect of the educational system and a crucial component of every curriculum. By resolving the deficiencies, the curriculum can be enhanced.<sup>13</sup>

One effective approach in curriculum modernization is to conduct comparative studies and analyses. These studies help identify the differences or similarities in curricula, which in turn allows for the resolution of educational problems and issues. Additionally, they reveal the various factors and contexts that contribute to the successes and failures of the educational system.<sup>14</sup>

As the HEC has not yet formulated a single national curriculum for BS MLT, universities and DAIs in Pakistan have their own versions of the BS MLT curriculum, leading to a lack of standardization. This variability can result in graduates with differing levels of knowledge and skill sets, depending on where they studied and ultimately impacting the quality of healthcare services provided by the medical laboratory technologists.

The aim of the current study was to perform a comparative analysis of BS MLT curricula from national and international universities and degree awarding institutions (DAIs).

## Methodology

This present study was conducted from October 2023 to January 2024. It was an applied descriptive cross-sectional and comparative study. The data gathering was conducted through an electronic search on the universities' website. Each of the chosen curricula, which represented the most recent curriculum implemented by the universities under study, was thoroughly examined. As needed, we complemented the material by referring to published articles that detail the curriculum of a specific university.

The inclusion criteria involved the curriculum to be presented in English, and for the curriculum to be available online. The exclusion criteria consisted of institutions that did not offer online curricula and universities that offered curricula in languages other than English. The universities were chosen using a non-probability convenience sampling technique.

According to the inclusion criteria, the samples of the present study included nine national universities including:

1. Shaheed Zulfiqar Ali Bhutto Medical University (SZABMU), Islamabad
2. Iqra University Islamabad Campus (IUIIC), Islamabad
3. National Skills University (NSU), Islamabad
4. Ibadat International University (IIU), Islamabad
5. University of Health Sciences (UHS), Lahore
6. Bahria University Karachi Campus (BUKC), Karachi
7. Dow University of Health Sciences (DUHS), Karachi
8. University of Azad Jammu and Kashmir (UoAJK), Muzaffarabad, AJK
9. Khyber Medical University (KMU), Peshawar

Likewise, six international universities/institutes were selected for analysis including:

1. Griffith University, Australia
2. University of Cincinnati, USA
3. Gulf Medical University (GMU), Dubai, UAE
4. The Open University (TOU), Sri Lanka
5. Ministry of Health & Family Welfare (MoHFW), India
6. Tehran University of Medical Sciences (TUMS), Iran

The 'four steps of comparison model' by George Bereday and Franz Hilker<sup>15</sup> was used in the current study. This comparison model is an absolute and abstract method of comparative study methods that includes four stages of description, interpretation, juxtaposition, and comparison in comparative studies. The necessary information regarding the BS MLT curriculum was gathered from credible sources (websites) and thoroughly examined and analyzed. The data were organized into tables and an assessment was conducted to identify similarities and differences among all the universities studied in terms of curricular aspects. Considering these similarities and differences, specific recommendations were developed.

Key aspects considered for comparative analysis included curriculum structure, course content, practical training, credit hours, assessment methods, and alignment with HEC Undergraduate Education Policy 2023. The data collection instrument

comprised a checklist compiled by the researcher, which was utilized to retrieve pertinent information from the websites of the chosen universities. This checklist comprised of eight categories, including course title, course length, mission, practical training, vision, goals, credit hours, admission process, teaching methods (online, in-person, or both), educational methodologies, and student assessment methods. The study team conducted data extraction to enhance the precision and reliability of the collected data.

## Results

Examining the national MLT curricula showed that there were only two curricula in BS MLT professional education until 2005 (University of the Punjab and University of Karachi), but currently there are more than 32 universities/DAIs that include this field in their curriculum and presented it under different titles that include: Bachelor of Science in Medical Laboratory Technology; Bachelor of Science in Medical Laboratory Science; Bachelor of Science in Clinical Laboratory Technology; and Bachelor of Science in Clinical Laboratory Science.

BS MLT curriculum at the study site, i.e. Shaheed Zulfiqar Ali Bhutto Medical University aims to evaluate both theoretical understanding and practical skills. It includes core courses in clinical chemistry, haematology, microbiology, and molecular diagnostics, with a structured approach to integrating theoretical knowledge with practical skills. The curriculum emphasizes a phased learning approach, with foundational courses in the first two years and advanced specialized courses in the 3<sup>rd</sup> and 4<sup>th</sup> years. Assessment methods at SZABMU include a combination of written exams, practical assessments, and research project (in the form of a thesis or research report).

The written exam of theoretical component at the SZABMU for all subjects of MLT is made up of 100 Multiple Choice Questions (MCQs). The practical assessment's percentage in the final aggregate is only 20%, with the remaining 80% based on the MCQs exam. Other national universities use a mix of MCQs and SEQs (Short Essay Questions) with a 50% aggregate of practical assessment.

The SZABMU's 130 credit hours are spread over a period of 4 years and 8 semesters. The credit hours

in the rest of the eight national universities vary from 128 to 143 that fulfills the minimum criteria of HEC. The credit hours at the international universities are not individually available. Curricula offered by the University of Cincinnati, USA, and the Gulf Medical University, Dubai, UAE, are both accredited by the American Society for Clinical Pathology (ASCP).

BS MLT curricula across various national universities exhibit both commonalities and differences, i.e. variations in course titles, credit hours, and specific content reflecting the diverse educational approaches of different institutions. Each university tailors its curriculum to address local needs and academic standards, resulting in some differences in course structure and emphasis.

In basic sciences such as Anatomy, Physiology, and Biochemistry, the SZABMU offers comprehensive courses each spanning 4 credits. Other institutions like University of Health Sciences, Lahore, and Khyber Medical University, Peshawar also cover these subjects, although the credit distribution and specific course titles may vary. For instance, University of Health Sciences, Lahore integrates Anatomy and Physiology into a single course, while SZABMU maintains separate courses.

SZABMU includes a 2-credit course on Computer Skills, like all other national universities which also offer introductory computer courses. Likewise, SZABMU's curriculum includes two English courses (I and II) for 2 credits each. Other institutions (except University of Health Sciences, Lahore) offer English courses with similar emphasis on communication skills and academic writing.

The core medical laboratory courses such as Haematology, Pathology, Microbiology, Histotechniques, and Clinical Pathology are included in detail in SZABMU curricula. Institutions like Dow University of Health Sciences, Karachi, Iqra University, Islamabad, Ibadat International University, Islamabad, and the University of Azad Jammu and Kashmir, Muzaffarabad, AJK, offer equivalent courses, though course titles and credit hours differ. For example, Dow University of Health Sciences, Karachi has a focus on Clinical Microbiology and specific Haematology topics, whereas SZABMU covers a broader spectrum. The course in Transfusion Medicine (or blood banking) is merged with Haematology in the case of SZABMU while it is a

separate course (of 2 or 3 credit hours) in all other national universities studied.

With regards to specialized and advanced courses, namely Bioinformatics, Molecular Biology, Forensic Medicine, the SZABMU offers these courses. All other universities offer Molecular Biology although the emphasis and depth vary. Bioinformatics is also offered by most of the universities except for University of Health Sciences, Lahore, Dow University of Health Sciences, Karachi, and University of Azad Jammu and Kashmir, Muzaffarabad, AJK. Forensic Medicine (3-credit hour), a core course of SZABMU curricula is not included in the curricula of Iqra University, Islamabad, Ibadat International University, Islamabad, University of Health Sciences, Lahore, Bahria University Karachi Campus, Karachi, and Dow University of Health Sciences, Karachi. Likewise, Molecular Techniques Nanomedicine (4-credit hour) is only available at SZABMU while no other national university has this course in their curricula. First-Aid (2-credit hour) is available at SZABMU and as Emergency Medicine at the University of Azad Jammu and Kashmir, Muzaffarabad, AJK. No other curricula examined offers this course both nationally and internationally.

SZABMU's curriculum includes additional courses in Quality Control and Laboratory Management, as well as a Research Project spanning 6-credit hours. This focus on quality and management quality skills is echoed by all other national universities (except UHS, Lahore) which also emphasize management and quality skills training. Except for University of Health Sciences, Lahore, and Dow University of Health Sciences, Karachi, the 6-credit hour Research Project is available with all national universities, although the credit hours vary, e.g. it is a 3-credit hour course at the University of Azad Jammu and Kashmir, Muzaffarabad, AJK.

Courses pertaining to general education and supporting courses such as Pakistan Studies, Islamic Studies, and Behavioral Science are incorporated in the SZABMU's curricula which are also part of other university programmes, though the specific content and credit hours vary.

When we compared SZABMU's curricula with the international BS MLT programmes, each offer unique strengths. Each of the six university programmes offers a comprehensive education tailored to its

specific educational, regional, and professional context. Griffith University, Australia and the University of Cincinnati, USA emphasize advanced and specialized topics, the Ministry of Health, India, and The Open University, Sri Lanka incorporate practical and traditional subjects with additional local focus, and Gulf Medical University, UAE, and Tehran University of Medical Sciences, Iran balance core and advanced topics with a strong emphasis on laboratory management and modern techniques.

In basic sciences such as Anatomy, Physiology, and Biochemistry, the SZABMU offers comprehensive courses each spanning 4-credit hours. Griffith University, Australia offers a unified curriculum that includes Anatomy, Physiology Systems I & II, and Chemistry of Biological Systems I & II. The University of Cincinnati, USA emphasizes Human Anatomy, Human Physiology, Basic Clinical Biochemistry, and Clinical Biochemistry I, aligning closely with SZABMU's offerings. The Ministry of Health, India presents courses on Human Body Systems I & II, akin to Griffith University's approach but potentially with less integration, and Clinical Biochemistry I & II, similar to those at the University of Cincinnati and SZABMU. The Open University, Sri Lanka provides foundational courses in Theoretical Anatomy, Theoretical Physiology, and Biochemistry. Gulf Medical University, UAE offers Anatomy, Physiology Systems I, General Biochemistry, and Clinical Chemistry I, reflecting a structure similar to Griffith University's. Tehran University of Medical Sciences, Iran addresses Anatomy, Physiology, and Biochemistry without further subdivision into specific systems.

Regarding core Medical Laboratory Technology (MLT) courses such as Haematology, Pathology, Microbiology, Histotechniques, and Clinical Pathology, SZABMU offers comprehensive curricula that cover these subjects in detail. Griffith University, Australia includes Haematology I, Advanced Haematology topics, General Pathology, Clinical Pathology, Microbiology, advanced Clinical Microbiology, and advanced Histotechniques, reflecting a similar approach to SZABMU. The University of Cincinnati, USA provides courses in Basic Haematology and Advanced Haematology topics, alongside General Pathology, Advanced Clinical Pathology, General Clinical Microbiology, Advanced Clinical Microbiology, Fundamentals of

Histology, and Advanced Histopathological Techniques. The Ministry of Health, India includes Applied Haematology, General Pathology, Public Health Microbiology, Clinical Microbiology, Histopathology, and Applied Histopathology. The Open University, Sri Lanka focuses on Advanced Haematology, General Pathology, Clinical Microbiology I, Histopathology, and related techniques. Gulf Medical University, UAE offers Haematology I, Advanced Studies in Haematology, General Pathology, Advanced Pathology, General Microbiology, Clinical Microbiology, Histopathology, and Advanced Histotechniques. Tehran University of Health Sciences, Iran provides coursework in Haematology with advanced components, General Pathology, Clinical Microbiology with advanced elements, and Histology with advanced studies, though it does not cover as many specialized topics as some of the other universities.

Overall, while universities share similarities in the core MLT courses offered, there are variations in the depth and breadth of coverage. Universities like SZABMU, Griffith University, University of Cincinnati, and Gulf Medical University provide extensive coverage with both foundational and advanced topics. The Ministry of Health in India focuses on practical and public health applications, while Griffith University, University of Cincinnati, and Gulf Medical University offer detailed advanced studies. Regional differences in educational focus are evident, reflecting diverse institutional priorities and standards.

When comparing the molecular science subjects, SZABMU and The Open University, Sri Lanka both offer courses in diagnostic Molecular Biology and Genetics, focusing on practical and applied aspects of the field. Griffith University, Australia and Gulf Medical University, UAE include fundamental and applied aspects of molecular biology, though Griffith focuses on the principles of molecular and immunological studies, while Gulf Medical University combines Medical Genetics with Molecular Biology. The University of Cincinnati, USA and Tehran University of Health Sciences, Iran both offer specialized courses in Molecular Diagnostics and Genetics. However, the University of Cincinnati emphasizes diagnostic applications, while Tehran University provides advanced studies in Molecular Biology and Genetics. The Ministry of Health, India

and Tehran University of Health Sciences, Iran cover aspects of Genetics, but the Ministry's courses also include blood banking, adding a clinical dimension that is not emphasized at Tehran University.

SZABMU covers Quality Control and Laboratory Management, focusing on practical and managerial aspects of laboratory operations. This is similar to Tehran University of Medical Sciences, Iran. Griffith University, Australia and The Open University, Sri Lanka include Laboratory Management in their courses, though Griffith University also covers Quality Management, while The Open University adds a focus on Quality Assurance. University of Cincinnati, USA and Gulf Medical University, UAE both feature courses in Laboratory Management and Quality Control, highlighting similar areas but potentially with different emphases or depth. Ministry of Health, India offers a specific course in Medical Laboratory Quality Management & Accreditation, which includes a focus on accreditation processes like ISO 15189, not mentioned by the other universities.

The 6-credit hour Research Project included in the SZABMU curriculum is not part of the curricula at the Ministry of Health, India and Tehran University of Medical Sciences, Iran where rest of the four universities offer this course. Forensic Medicine and Bioinformatics are absent from the curricula of all six international universities examined. Nanomedicine (4-credit hour) is only available at SZABMU while no other international university has this course in their curricula. Additionally, First-Aid or Emergency Medicine is not offered at any of the studied international universities, apart from Gulf Medical University in Dubai, UAE.

There are certain courses offered by national universities, that SZABMU curriculum lacks, although a few of them are partially covered in other course titles (as mentioned against each deficient course). The identified deficiency courses included:

1. Biotechnology
2. Bioethics
3. Arabic
4. Biosafety & Biosecurity (partially covered in Microbiology)
5. Medical Terminology
6. Communication Skills
7. Applied Physics and Eng. Sciences
8. Lab. Innovation and Entrepreneurship
9. Cytology and Cytogenetics

When compared with international universities, the curricula of SZABMU (as well as some other national universities) revealed several deficiencies in course offerings. Although some of these gaps are partially addressed within other course titles, as noted next to each deficiency, there are specific areas where the curricula fall short. The following deficiency courses were identified:

1. Entrepreneurship and New Business Ventures
2. Ethics & Professional Development
3. Communication and Soft Skills
4. Cytopathology
5. Phlebotomy (partially covered in Clinical Pathology and Haematology)
6. Medical Terminology, Record Keeping, and Orientation to MLS
7. Principles of Safety & Protection in Laboratory
8. Health Challenges for the 21st Century
9. Preventive and Social Medicine
10. Introduction to Biomedical Data Analysis (partially covered in Biostatistics)
11. Molecular Medicine (partially covered in Molecular Biology)
12. Community Internship and Partnerships for SDGs
13. Self-Marketing
14. Professionalism and Values
15. Environmental Science
16. General Physics and General Chemistry
17. Toxicology
18. Introduction to Internal Medicine

## Discussion

With each passing year, the field of MLT experience significant advancements in technological knowledge and the application of research findings. These advancements result in improved methods of disease diagnosis, which in turn require MLT students to continuously acquire innovative skills in order to effectively engage in contemporary laboratory practice.<sup>16,17</sup>

Inevitably it is necessary to carefully align and adjust the gained knowledge and skills to the specific region where these services are needed. Simultaneously, it is imperative to eliminate outdated expertise and skills from the existing curriculum.<sup>18</sup> Additionally, the expectations of the society in which the MLT professional operates also evolve with time, necessitating appropriate adjustments to be made in response to these changes.<sup>19</sup> The expansion of MLT education in Pakistan from two universities in 2005 to over 32 highlights a growing recognition of the

field's importance and the need for specialized training. This proliferation has led to a variety of programme titles and curricula across national universities, reflecting a diverse approach to MLT education. At SZABMU, the BS MLT curriculum is designed to provide a comprehensive education, combining theoretical knowledge with practical skills through a phased learning approach.

The assessment pattern at SZABMU's MLT curricula is mostly MCQ-based (80%). Practical skills are critical in MLT, yet practical assessments account for only 20% of the final grading. This limited weight may not adequately reflect students' hands-on abilities and problem-solving skills, which are essential for laboratory work. Students prioritize studying for MCQs over engaging in practical exercises, leading to less motivation to hone their laboratory skills and techniques. To address these concerns, it might be beneficial to balance MCQs with other forms of assessment, such as SEQs, practical exams, and case studies that can help address these limitations and provide a more comprehensive evaluation of students' competencies in MLT. Earlier studies have also proven the fact that students favour a deep learning approach when studying for SEQs (higher-level cognitive questions), whereas they prefer a surface approach for MCQs, which are based on lower-level cognitive skills.<sup>20-22</sup> However, it is pertinent to note that the learning approach is also affected by the design of the assessment tool. Therefore, improving the quality of these assessment tools is necessary to promote deep learning. Further, the examining body should ensure that students receive detailed feedback on both theoretical and practical assessments to help them improve and bridge any skill gaps.

International universities like Griffith University, Australia and the University of Cincinnati, USA emphasize advanced and specialized topics, aligning closely with SZABMU in core areas like Haematology and Clinical Pathology, but with varying depths of coverage. For instance, Griffith University, Australia integrates comprehensive modules on Anatomy and Physiology, while SZABMU maintains separate courses. International programmes frequently include specialized subjects and practical applications, such as Laboratory Management and Quality Control, which are also present in SZABMU's curriculum. Courses such as Laboratory Innovation

and Entrepreneurship, Professionalism and Values, are deficient in the SABMU curricula.

With regards to the deficiency courses in the curricula of SZABMU and other international universities, it indicated a need for more comprehensive course offerings to meet global standards. Key missing courses include topics like Entrepreneurship and New Business Ventures, which are vital for preparing students for modern medical and healthcare environments, and specialized areas like Cytopathology and Molecular Medicine, crucial for advancing medical science education. Additionally, essential subjects such as Ethics and Professional Development, Communication and Soft Skills, are lacking, which could impact students' overall preparedness for professional practice. Some contents of these deficiency courses are partially addressed in existing SZABMU courses but still represent a shortfall in comprehensive training.

The comparative analysis showed some deficiency courses in the curricula of SZABMU and national universities as well, although some contents are partially addressed by other courses. Missing courses include Biosafety and Biosecurity, which, despite partial coverage in Microbiology, is crucial for ensuring laboratory safety and security. Communication Skills and Medical Terminology are essential for effective healthcare delivery and professional communication but are notably absent. Bioethics, a fundamental area for understanding moral issues in healthcare, is missing. Applied Physics and Engineering Sciences, along with Biotechnology and Laboratory Innovation and Entrepreneurship, are vital for integrating technology and innovative practices into medical science. Additionally, advanced topics such as Clinical Diagnostics and Cytology and Cytogenetics, though partially covered in Histo-related courses, are key for comprehensive training.

It is evident from our findings that currently SZABMU curriculum for BS MLT is behind its time and lagging current international educational standards. This includes both the range of courses offered and the content within those courses. Many of the contents we currently use in different courses have become outdated and no longer reflect the latest advancements and practices in the field. Some course titles and content overlap, and there are gaps when compared with international curricula. For example,

certain advanced topics and emerging fields may not be covered as extensively, potentially leaving students less prepared for evolving industry demands. The curriculum may not sufficiently address cutting-edge developments in medical laboratory technology, such as advanced molecular diagnostics or emerging laboratory techniques, which are increasingly important in the field.

There is an urgent need to initiate a reform in the training and education of MLT students. The necessary modifications encompass not only the quantity and nature of the desired information, but also the manner in which this knowledge is obtained.<sup>23</sup> Moreover, it is vital to incorporate literature, art, and philosophy into the curriculum in order to enable an MLT student to establish their position in society. Ultimately, the primary emphasis should be placed on cultivating empathy for a potential medical laboratory technologist to effectively understand and relate to the suffering of patients, as well as recognize the significance of accurate and timely diagnoses.

The MLT educational institutes face the significant challenge of consistently adapting to changes in laboratory practice, maintaining an applicable curriculum, and ensuring that students are not overwhelmed by the amount of knowledge.<sup>24</sup> Our analysis indicated that universities globally necessitate constant modifications and the capacity to respond to evolving circumstances.

The healthcare industry is undergoing changes, which necessitates the reform in medical education, including MLT. With the advent of artificial intelligence (AI), the field of medicine is embracing data-driven decision making, which highlights the importance of effective interaction between medical professionals and AI systems. Artificial intelligence (AI) is poised to become a fundamental component of laboratory diagnosis.<sup>25</sup> With the increasing pace of medical advancements, the utilization of technology like AI becomes imperative for MLT practitioners to efficiently apply this knowledge in their practice.<sup>26</sup> Therefore, it is imperative that MLT professionals receive comprehensive training in this emerging technology, including its benefits in enhancing cost-effectiveness, quality, and accessibility of healthcare, as well as its limitations in terms of transparency and

liability.<sup>27</sup> The AI must be smoothly included into various components of the BS MLT programme.

Further, to align with international standards, national universities should consider integrating the deficiency courses and contents to enhance the curriculum, ensuring graduates are well-equipped with the diverse skills and knowledge necessary for contemporary healthcare challenges.

The Higher Education Commission (HEC) should establish a 'Working Group' with the objective of formulating a cohesive national curriculum for the BS MLT programme. This initiative is essential for establishing a unified educational framework that conforms to national standards and fulfils the requirements of the healthcare industry. The SZABMU, being the only accredited public medical university in the capital city, is keen to take the lead in this significant initiative. The SZABMU is strategically positioned to spearhead this project, utilizing its resources, knowledge, academic network, and its affiliated/constituent institutions to provide a comprehensive and efficient curriculum. This will not only strengthen SZABMU's status as a prominent participant in medical education but also make a substantial contribution to the overall advancement and standardization of MLT education in the country.

## Conclusion

The results indicated that there is a need for a standardized national curriculum to guarantee uniformity and excellence in MLT education. It is time for us to overcome the inertia of the past and find the way to radical MLT training and education. The challenges can only be resolved through efforts to tailor curricula to the practical needs of our healthcare system. The HEC, and the newly established Allied Health Professionals Council (AHPC) can play a crucial role in formulating and enforcing uniform curricula for the MLT programme. Periodic evaluations and revisions of the curriculum, in response to advancements in medical technology and changes in healthcare demands, can ensure the continued relevance and quality of the programme. Addressing these issues could lead to more consistent and high-quality education for students pursuing a career in MLT, ultimately benefiting the healthcare system as a whole.



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## References

1. Farmad SA, Esfidani A, Shahbazi S. A comparative study of the curriculum in master degree of medical education in Iran and some selected countries. *BMC Med Educ.* 2023;23(1):393. <https://doi.org/10.1186/s12909-023-04366-2>.
2. Waheed U. Mushrooming of medical laboratories in Pakistan. *Journal of Nursing and Allied Health* 2023;1(4):98-99.
3. Frank JR, Snell LS, Cate OT, Holmboe ES, Carraccio C, Swing SR, et al. Competency-based medical education: theory to practice. *Med Teach.* 2010;32(8):638-645. <https://doi.org/10.3109/0142159X.2010.501190>.
4. Waheed U, Arshad A, Malik MA, Zaheer HA. Evolution of medical laboratory technology in Pakistan. *Critical Values* 2014;7(2):19-22. <https://doi.org/10.1093/criticalvalues/7.2.18>.
5. Waheed U, Ahmad M, Wazeer A, Saeed M, Saba N, Rasheed F. Medical laboratory science education: Shaping competent and skilled healthcare professionals. *Mirpur Journal of Medical Sciences* 2023;1(1):58-63.
6. Maaz A, Hitzblech T, Arends P, Degel A, Ludwig S, Mossakowski A, et al. Moving a mountain: Practical insights into mastering a major curriculum reform at a large European medical university. *Med Teach.* 2018;40(5):453-460. <https://doi.org/10.1080/0142159X.2018.1440077>.
7. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review. *BMC Med Educ.* 2019;19(1):460. <https://doi.org/10.1186/s12909-019-1891-5>.
8. Karami M, Hashemi N, van Merriënboer J. Medical educators' beliefs about learning goals, teaching, and assessment in the context of curriculum changes: A qualitative study conducted at an Iranian medical school. *BMC Med Educ.* 2021;21(1):446. <https://doi.org/10.1186/s12909-021-02878-3>.
9. Mishra S. Do we need to change the medical curriculum: regarding the pain of others. *Indian Heart J.* 2015;67(3):187-91. <https://doi.org/10.1016/j.ihj.2015.05.015>.
10. Hitzblech T, Maaz A, Rollinger T, Ludwig S, Dettmer S, Wurl W, et al. The modular curriculum of medicine at the Charité Berlin - a project report based on an across-semester student evaluation. *GMS J Med Educ.* 2019;36(5):Doc54. <https://doi.org/10.3205/zma001262>.
11. Higher Education Commission. Undergraduate Education Policy 2023. Curriculum Division. HEC, Government of Pakistan. Available at <https://www.hec.gov.pk/english/policies/Pages/UGEP.aspx> accessed 11 June 2024.
12. Sirat MB. Strategic planning directions of Malaysia's higher education: University autonomy in the midst of political uncertainties. *High Educ.* 2010;59(4):461-473. <https://doi.org/10.1007/s10734-009-9259-0>.
13. Changiz T, Yamani N, Tofighi S, Zoubin F, Eghbali B. Curriculum management/monitoring in undergraduate medical education: a systematized review. *BMC Med Educ.* 2019;19(1):60. <https://doi.org/10.1186/s12909-019-1495-0>.
14. Wolhuter C, Popov N, Leutwyler B, Ermenc KS. Comparative education at universities worldwide. *Bulgarian Comparative Education Society*, 2013; 3<sup>rd</sup> Ed. ISBN 978-954-9842-11-1.
15. Adick C. Bereday and Hilker: origins of the 'four steps of comparison' model. *Comparative Education* 2018;54(1):35-48. <https://doi.org/10.1080/03050068.2017.1396088>.
16. American Society for Clinical Laboratory Science, Practice levels and Educational Needs for Clinical Laboratory Personnel Position Paper, 2009. Available at <http://www.ascls.org/> accessed on 11 June 2024.
17. Waheed U. Changing dynamics of medical laboratory technology in Pakistan. *Ind. J. Allied Health Sci.* 2018;1(4): 254-255.
18. Ryang Y, Kim H, Shin I. A Comparative Study of Medical Technology Curricula with Special Reference to 4 Year University Programs. *Korean Journal of Medical Technologists* 1987;19:43-54
19. Aziz HA, Tille P. A comprehensive assessment plan for medical laboratory science programs. *Clinical Laboratory Science* 2018;31 (1):17-23. <https://doi.org/10.29074/ascls.2018000190>.
20. Chung EK, Elliott D, Fisher D, May W. A comparison of medical students' learning approaches between the first and fourth years. *South Med J.* 2015;108(4):207-210. <https://doi.org/10.14423/SMJ.0000000000000260>.
21. Arooj M, Mukhtar K, Khan RA, Azhar T. Assessing the educational impact of cognitive level of MCQ and SEQ on learning approaches of dental students. *Pak J Med Sci.* 2021;37(2):445-449. <https://doi.org/10.12669/pjms.37.2.3475>.
22. Ul Islam Z, Usmani A. Psychometric analysis of Anatomy MCQs in Modular examination. *Pak J Med Sci.* 2017;33(5):1138-1143. <https://doi.org/10.12669/pjms.33.5.12382>.
23. Nabatchian F, Einollahi N, Abbasi S, Gharib M, Zarebavani M. Comparative study of laboratory sciences bachelor degree program in Iran and several countries. *Payavard* 2015; 9(1):1-16. <http://payavard.tums.ac.ir/article-1-5651-en.html>.
24. Waheed U. Unveiling the economic impact of allied health professionals in Pakistan's healthcare landscape. *Ann Pak Inst Med Sci.* 2024; 20(1):1-2. <https://doi.org/10.48036/apims.v20i1.1039>.
25. Herman DS, Rhoads DD, Schulz WL, Durant TJS. Artificial intelligence and mapping a new direction in laboratory medicine: A review. *Clin Chem.* 2021;67(11):1466-1482. <https://doi.org/10.1093/clinchem/hvab165>.
26. Spirnak JR, Antani S. The need for artificial intelligence curriculum in military medical education. *Mil Med.* 2024;189(5-6):954-958.
27. Grunhut J, Marques O, Wyatt ATM. Needs, challenges, and applications of artificial intelligence in medical education curriculum. *JMIR Med Educ.* 2022;8(2):e35587. <https://doi.org/10.2196/35587>.