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ORIGINAL ARTICLES

UNLOCKING THE EDUCATIONAL POTENTIAL OF SIMULATION EQUIPMENT THROUGH DEPARTMENTAL RELEVANCE MAPPING

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ABSTRACT

INTRODUCTION: Simulation-based education is integral to modern medical training, supporting technical skills, clinical decision-making, and professional behaviours across multiple health professions. Despite widespread implementation, centralized simulation centres often experience underutilisation of equipment due to limited awareness of available resources and their pedagogical applicability.

Aim: This study presents a structured framework for mapping simulation equipment to academic departments, aiming to support wider and more strategic use of simulators across multiple faculties and to unlock their full educational potential.

MATERIALS AND METHODS: The official academic structure of the Medical University of Varna serves as the mapping reference. Two experienced faculty members independently map each simulator to one or more departments based on intended application, curricular alignment, and complexity, resolving disagreements through consensus. A secure web-based platform with hierarchical filters documents departmental associations. Multidisciplinary coverage is assessed across categories and individual simulators using descriptive statistics such as counts and percentages.

RESULTS: The database includes 44 simulators, covering 71.7% of academic departments. Basic task trainers predominate, reflecting the foundational role of controlled, safe environments for acquiring essential clinical skills. Most simulators (93.18%) are linked to multiple departments, demonstrating substantial multidisciplinary potential and opportunities for interprofessional training.

CONCLUSION: By explicitly associating simulators with relevant departments, the mapping framework improves visibility and provides teaching staff with clearer guidance for educational use. It supports broader and more flexible integration of simulation resources, facilitates interdisciplinary learning across professional groups, and enables institutions to optimise utilisation without additional infrastructure investment.

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INTRODUCTION

Simulation-based education is an established component of contemporary medical training, supporting the development of technical skills, clinical decision-making, and professional behaviours across a wide range of health professions (1). Ongoing advances in simulation technologies have expanded the scope, realism, and educational potential of simulators, enabling their application across undergraduate education, postgraduate training, and continuing professional development (2,3).

Despite these advances, the integration of simulation-based training within universities is not always accompanied by proportional growth or systematic organisation of the available training infrastructure. Universities may adopt either centralized or decentralized models for managing simulation resources (4). In decentralized centres, simulators are typically purchased for the needs of individual departments and remain locally allocated, which can limit access for other instructors and reduce opportunities for multidisciplinary training. Centralized simulation centres are more common, with simulators located in a single facility and, in principle, accessible to instructors from across the institution (5). While such arrangements support shared use, they may also make it difficult for academic staff to maintain a clear and up-to-date overview of available simulators, their educational scope, and their relevance to specific departmental teaching activities.

Limited awareness of available simulation resources has been identified as a contributing factor to the underutilisation of equipment, even in centralized centres with well-developed infrastructure (6,7). For teaching staff, the challenge extends beyond knowing that simulators exist to understanding how these resources align with departmental curricula, learning objectives, and disciplinary contexts. When simulation equipment is primarily documented through inventory-oriented or technically focused systems, its broader educational applicability may remain insufficiently visible, constraining its use to established instructors, familiar scenarios, and habitual teaching practices.

To address this gap in centralized settings, there is a need for approaches that explicitly link simulation resources to their pedagogical relevance within the university's academic structure. On this basis, an internal web-based database documenting the simulation equipment available at the Medical University of Varna is currently being developed as part of an institutionally funded infrastructure project (8). A central element of this initiative is a relevance mapping framework that associates each simulator with one or more academic departments according to its intended educational use.

AIM

This study presents a structured framework for mapping simulation equipment to academic departments, aiming to support wider and more strategic use of simulators across multiple faculties and to unlock their full educational potential.

MATERIALS AND METHODS

Defining Mapping Framework

The official academic structure of the Medical University of Varna serves as the reference framework for departmental relevance mapping of simulators. The university comprises four faculties, Medicine, Dental Medicine, Pharmacy, and Public Health, and the Medical College. Each faculty and the college include multiple academic departments responsible for discipline-specific teaching activities. Academic departments form the primary unit of mapping.

Relevance Mapping Procedure and Criteria

Relevance mapping of simulators to academic departments is conducted independently by two faculty members with experience in simulation-based education. Each reviewer assigns simulators to one or more departments based on predefined criteria. In cases of divergent assessments, the final mapping is determined through joint review and agreement between the two reviewers.

The mapping criteria include:

- Intended application as specified in the manufacturer's documentation.
- Alignment with university curricula and associated learning objectives.
- Complexity and prior knowledge required.

Descriptive statistics, including counts and percentages, are used to summarise simulator distribution across departments and categories.

Table 1. Department coverage.

Faculty	Number of Departments	Departments with >1 Simulator	Departments Without Simulator	Coverage (%)
Medicine	27	16	2	92.59%
Dental Medicine	7	2	1	85.71%
Pharmacy	8	1	6	25.00%
Public Health	10	2	4	60.00%
Medical College	8	2	4	50.00%
Total	60	23	17	71.67%

Technical Implementation

The content management system is implemented as a secure online platform accessible exclusively via IP-based restrictions within the university network. The front-end is developed using HTML, CSS, and JavaScript, with Bootstrap used for responsive layout. The back-end is built using a PHP-based framework following the Model-View-Controller architecture. Simulator data and departmental associations are stored in a MySQL database.

Departmental associations are entered and managed through an administrative interface. During simulator entry or editing, administrators select departments from predefined lists using checkbox controls, allowing multiple departmental associations for a single simulator.

Faculty members can access these associations through a hierarchical dropdown menu. The filter operates at two levels: across the complete simulator database and within each simulator category. The platform organises simulators into five predefined categories: high-fidelity simulators, complex task trainers, basic task trainers, software-based simulators, and standardized patients.

RESULTS

The current state of the simulator database allows an overview of the distribution of simulators across faculties and departments.

Department Coverage

Departmental relevance mapping demonstrates a high overall level of simulator coverage across the academic structure of the university (Table 1). Simulators are associated with departments in all faculties and in the Medical College, resulting in coverage of 71.67% of all academic departments.

The Faculty of Medicine shows the broadest coverage, with simulators mapped to the majority of its departments and only a small number remaining without any associated simulator. Similarly, high levels of coverage are observed in the Faculty of Dental Medicine. In contrast, lower coverage is evident in the faculties of Pharmacy and Public Health, as well as in the Medical College, where a substantial proportion of departments currently have no simulator mapped to their teaching activities.

Across all faculties, nearly two thirds of departments with assigned simulators are linked to more than one simulator, indicating varying degrees of access to simulation resources at the departmental level.

Category Coverage

Multidisciplinary coverage varies across simulator categories (Table 2). All high-fidelity and software-based simulators are associated with more than one academic department, resulting in full multidisciplinary coverage within these categories.

Basic task trainers also show a high level of multidisciplinary relevance, with the majority mapped to multiple departments. Complex task trainers demonstrate slightly lower multidisciplinary coverage, as several simulators in this category are associated with a limited number of departments. These include highly specialised trainers primarily intended for postgraduate or specialist training, such as arthroscopy, angiography, and laparoscopy simulators.

The category of standardized patients is included in the database structure as a distinct simulator group. Although standardized patients are not yet

Table 2. Category coverage.

Category	Number of Simulators	Simulators with >1 Department (n)	Multidisciplinary Coverage (%)
High-fidelity	4	4	100%
Complex task trainers	10	8	80.00%
Basic task trainers	27	23	85.19%
Software simulators	3	3	100%
Standardized patients	N/A	N/A	N/A
Total	44	38	86.36%

implemented as an educational resource within the university, their inclusion reflects the intention to represent the full spectrum of simulation modalities supported by the database. This category is therefore incorporated for structural completeness and future development, despite the absence of active entries at the present stage.

Simulator Assignment

Analysis of simulator-to-department assignments indicates that most simulators are associated with multiple academic departments (Table 3). Only a small proportion of simulators are mapped to a single department (6.82% of all simulators).

Table 3. Simulator distribution across departments.

Number of Dep. Mapped	Number of Simulators	% of Total Simulators
1	3	6.82%
2	18	40.90%
3	10	22.73%
4 or more	13	29.55%
Total	44	100%

The largest share of simulators is linked to two departments, followed by simulators associated with three departments. Nearly one third of the simulator inventory is mapped to four or more departments, reflecting broad applicability across multiple teaching contexts. Overall, more than 90% of simulators demonstrate multi-departmental relevance within the database.

DISCUSSION

The present study describes the development and application of a departmental relevance mapping framework for simulation equipment within an institutional simulator database. Rather than treating simulators primarily as technical assets, the proposed approach emphasises their alignment with academic departments as the main organisational units of teaching activity. This perspective shifts attention from the existence of simulation resources to their educational applicability within specific curricular and disciplinary contexts.

Differences in departmental coverage observed through relevance mapping appear to reflect variations in curricular focus and the nature of practical training across faculties. In particular, the comparatively lower coverage within the Faculty of Pharmacy may be related to the specific profile of pharmaceutical education, which is traditionally centred on laboratory-based training, formulation, and drug-related competencies rather than on direct patient interaction. In contrast, faculties whose curricula place stronger emphasis on clinical skills, procedural training, and patient-facing activities are more likely to rely on simulation-based methods for developing hands-on competencies. While this interpretation remains tentative and does not account for the full diversity of teaching practices within pharmacy education, it provides a plausible contextual explanation for the observed distribution of simulator relevance across faculties.

Examination of simulator categories provides further insight into the observed patterns of departmental coverage. The predominance of basic task trainers within the simulator database can be interpreted in light of the foundational aims of simula-

tion centres as controlled and safe learning environments. Simulation-based education is explicitly designed to allow learners to acquire and practise essential clinical skills without risk to patients, making basic procedural training a core component of institutional simulation infrastructure. Simulators supporting skills such as injection techniques, catheterisation, and other fundamental manipulations are therefore expected to constitute a substantial proportion of available equipment, as they address early and recurrent learning needs across multiple health professions.

At the same time, the high level of multidisciplinary coverage observed across simulator categories in Table 2 is particularly indicative of the need for structured relevance mapping. Mapping simulators to academic departments based on pedagogical relevance addresses a commonly reported challenge in simulation-based education: limited awareness among teaching staff of available resources and their potential use in teaching (6,7). In centralized simulation centres, equipment may be physically accessible but remain pedagogically distant when its relevance to departmental curricula is not readily apparent. Inventory-oriented or technically focused documentation systems often fail to support instructors in identifying how simulators can be meaningfully integrated into their own teaching activities.

Closer examination of departmental mappings shows that most simulators are linked to multiple departments, with only a small proportion (6.82%) associated with a single department. This finding highlights the inherent multidisciplinary potential of simulation equipment, which is frequently underutilised in practice (9,10). By explicitly linking simulators to all relevant departments, the mapping framework makes this potential visible and provides teaching staff with clearer information on how the available resources can be used. Simulators that support patient-centred or scenario-based training are particularly well suited for interdisciplinary learning involving multiple professional groups. Such resources can facilitate shared educational experiences among medical students, nursing students, and postgraduate trainees, contributing to the development of teamwork, communication, and collaborative clinical practice (11). Previous research indicates that shared simulation-based training can achieve comparable learning outcomes across professional groups while also strengthening interprofessional collaboration (12). Making the multidisciplinary relevance of these simulators explicit at the departmental level can support wider use of such training formats.

The relevance mapping process relies on predefined criteria and independent evaluation by experienced faculty members, providing a structured and reproducible approach. However, the study has limitations related to the absence of systematic feedback from a wider group of instructors. Incorporating user feedback, monitoring actual simulator usage, or linking mapping data to educational outcomes could further refine the framework and support its ongoing adaptation to curricular changes and emerging educational needs.

CONCLUSION

This study presents a structured approach for mapping simulation equipment to academic departments within a centralized medical simulation centre, with the explicit aim of unlocking the educational potential of existing simulation resources. By using the official academic structure of the institution and defining departments as the primary unit of pedagogical relevance, the proposed framework supports clearer alignment between simulation equipment and departmental teaching activities.

Departmental relevance mapping moves beyond inventory-based documentation by making the educational applicability of simulators more visible to teaching staff. In doing so, it helps reveal opportunities for broader and more flexible use of simulation equipment, including applications outside established user groups and familiar teaching scenarios. The framework also highlights the multidisciplinary relevance of selected simulators, thereby supporting the extension of simulation-based education across different disciplines and training levels.

The proposed approach offers a practical and adaptable model for institutions seeking to expand the use of simulation-based education without relying on additional infrastructure investment. By improving visibility, pedagogical alignment, and recognition of unused educational capacity, departmental relevance mapping provides a foundation for more effective integration of simulation resources into

medical curricula and for guiding future analyses of simulator utilisation and educational outcomes.

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