

An elective, theory-informed four-week interprofessional disaster preparedness course using problem-based learning, repeated 3LC exercises and MRMI/MACSIM-informed simulation

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Abstract

Background

Disasters, and public health emergencies, irrespective of their etiology, require health professionals who can work across clinical, prehospital, public health and organizational boundaries. Although disaster medicine has been advocated in medical and health professions education, curricula remain heterogeneous, variably assessed and often insufficiently interprofessional. Elective courses may offer a feasible route for motivated learners across professions while avoiding overload of already crowded compulsory curricula.

Methods

We developed a theory-informed elective curriculum using Kern's six-step model, constructive alignment, problem-based learning, experiential learning, adult learning, interprofessional education, simulation-based education, deliberate practice, reflective practice, communities of practice and prospective evaluation frameworks. Selected disaster medicine education models, competency frameworks, tabletop literature, mass-casualty simulation principles and current postgraduate preparedness programs informed the design.

Results

The proposed course is a four-week intensive elective of approximately 80–100 learning hours for medical and paramedical students, open to other health and emergency-response-related learners. It includes online preparation, seminars, skills workshops, six repeated table-top exercises, structured debriefings, a final major incident simulation and an individual scholarly paper as the written examination. The curriculum is organized around ten previously published competency domains and uses aligned assessments of participation, teamwork, triage, communication, simulation performance, reflection and academic writing.

Conclusions

The elective model translates established disaster medicine education principles into a feasible, theory-informed and performance-oriented curriculum. Explicit integration of problem-based learning strengthens the role of tabletop exercises as authentic, collaborative and evolving disaster problems. The course may provide an undergraduate and early professional foundation for later postgraduate disaster medicine education and continuing professional development.

Background

Disasters and public health emergencies challenge health systems by creating sudden or prolonged mismatches between needs and available resources. Such events include mass-casualty incidents, pandemics, armed conflict, terrorism, cyber disruption, hospital evacuation, infrastructure failure, climate-related emergencies and chemical, biological, radiological and nuclear incidents. Although each event has specific features, disaster response commonly requires situational awareness, role clarity, command and coordination, risk communication, triage, flexible resource use, ethical prioritization, interprofessional collaboration and continuity of care [1–5].

Health professionals are expected to contribute to preparedness and response, yet many students enter clinical practice with limited formal education in disaster medicine. Previous reviews have described undergraduate disaster medicine education as heterogeneous in content, duration, educational methods and assessment [6–8]. Training often improves knowledge, confidence and self-reported preparedness, but the literature remains limited by short-term evaluations, lack of validated outcome measures, insufficient assessment of team performance and limited evidence of durable behavior change or system-level impact [7, 9–10].

An earlier group of researchers anticipated several persistent concerns in the field. Their European disaster management course proposal highlighted deficiencies in existing responder training, called for standardization and minimum standards, and recommended blended, competency-based teaching using lectures and exercises to improve intercultural, interdisciplinary and interagency performance [11–12]. A subsequent global disaster management education proposal identified competency domains and argued for structured education across managerial levels and response roles [13].

Other studies and frameworks have broadly supported these findings. Consensus-based disaster medicine and public health preparedness frameworks have identified domains and competencies needed across health personnel groups [14, 15]. The WHO Health Emergency and Disaster Risk Management (EDRM) framework emphasizes an all-hazards, whole-health-system approach across prevention, preparedness, readiness, response and recovery [1]. Recent curriculum reviews and national studies continue to report uneven undergraduate integration and a need for more standardized, evidence-informed and competency-based education [6, 8, 16].

The educational challenge has therefore shifted. It is no longer sufficient to argue that disaster medicine should be included in health professions education. The more important question is how existing competency frameworks, collaborative exercise models and simulation methods can be translated into feasible courses that learners and institutions can realistically adopt. An elective format may be especially useful. It allows institutions to create a high-quality intensive course without displacing compulsory curriculum time, while attracting learners with genuine interest in disaster medicine, emergency care, public health, humanitarian response, crisis management or prehospital systems.

Postgraduate work also supports the need for earlier foundations. The Swedish PRAD-MED program introduced and evaluated proactive postgraduate education in disaster medicine and preparedness in Sweden, using theoretical, practical and collaborative learning approaches to strengthen individual and

organizational preparedness and to prepare future instructors [17, 18]. However, postgraduate training should not compensate for absent undergraduate preparation. Instead, undergraduate and early professional education should provide foundational disaster literacy, role awareness and interprofessional preparedness upon which advanced programs can build.

Three practical concepts are especially relevant to the proposed course. Three-level collaboration (3LC) is used as a scenario-based tabletop exercise format to train collaboration across operational, tactical and strategic response levels, while CSCATTT (Command and control, Safety, Communication, Assessment, Triage, Treatment and Transport), used in Major Incident Medical Management and Support (MIMMS), provides a shared operational structure for major incident response [19–22]. MRMI/MACSIM-informed simulation is used as a final integrative exercise to connect scene management, triage, treatment, transport, hospital reception, coordination and command [4, 23].

This paper presents an elective, theory-informed, four-week interprofessional disaster preparedness course for medical and paramedical students, open to other health and emergency-response-related learners. The course integrates problem-based learning, repeated 3LC exercises, MRMI/MACSIM-informed final simulation and an individual scholarly paper as the written examination. It also considers contemporary issues such as recovery, crisis communication, social media, misinformation, emerging digital technologies and the relationship between simulated learning and real preparedness systems. In the following sections, the **Theoretical foundations** section explains *why* the models and concepts are appropriate, and the **Methods** section explains *how* those models were operationalized in the curriculum-development process.

Theoretical foundations and design concepts

The course is designed as an elective because disaster preparedness must compete for time within already crowded undergraduate and paramedical curricula. Electives may create space for more intensive and authentic learning while attracting learners with genuine interest in disaster medicine, emergency care, public health, humanitarian response, crisis management and interprofessional preparedness [24]. However, the elective format should not imply that disaster preparedness is peripheral. Rather, the course is conceptualized as an intensive early professional learning environment and as a bridge to postgraduate training, continuing professional development and instructor pathways such as PRAD-MED [17].

The course is positioned within a broader disaster medicine education continuum. Undergraduate and early professional learners are not expected to become disaster medicine experts after four weeks. They are expected to develop disaster literacy, role awareness, interprofessional understanding, basic triage and communication skills, ethical sensitivity, system awareness and motivation for further learning. These foundations can support more advanced clinical, leadership and instructor competencies later in postgraduate or continuing education.

Educational design principles

The theoretical foundation combines curriculum-development, learning and evaluation frameworks. Kern's six-step model provides the curriculum-development structure, moving from problem identification and needs assessment to objectives, educational strategies, implementation and evaluation [25]. Constructive alignment provides the internal pedagogical logic: intended learning outcomes determine the choice of learning activities and assessment methods [26]. This is particularly relevant in disaster medicine, where competence is often demonstrated through performance. Learners expected to participate in interprofessional disaster response must therefore practise interprofessional response and be assessed through observed role clarity, communication, teamwork and decision-making [27, 28].

Problem-based learning (PBL) underpins the use of disaster scenarios as authentic, evolving problems rather than fixed factual questions [29–33]. In the proposed course, learners must define the problem, identify missing information, negotiate priorities, justify decisions and reflect on consequences. This PBL logic is operationalized through scenario seminars, group tasks, repeated tabletop exercises (e.g., three level collaboration: 3LC) and the individual scholarly paper. Foundational content may also be delivered through a flipped-classroom approach, allowing face-to-face time to be used for discussion, exercises, simulation, debriefing and feedback.

Experiential learning, deliberate practice, simulation-based education and reflective practice justify the repeated exercise design [34–38]. Disaster preparedness cannot be developed solely through lectures because the core challenges include uncertainty, prioritization, stress, communication, interprofessional interaction and system complexity. Repeated scenarios provide concrete experience; debriefings support reflection; seminars and readings support conceptualization; and later scenarios allow learners to test revised strategies. This progression is strengthened by escalating scenario complexity and structured feedback.

Interprofessional education and communities of practice support the inclusion of learners from medical, paramedical, nursing, public health, psychology, pharmacy, social work, hospital administration, civil protection, military medical and humanitarian backgrounds [2, 39–40]. Disaster preparedness requires shared language, role awareness and collaboration across professional and organizational boundaries. Where feasible, the course may therefore include community-practice elements, such as guest sessions or observational visits to emergency medical dispatch centres, emergency departments, hospital command centres, rescue services, public health authorities or regional disaster-management organizations. These elements can connect simulated learning with real preparedness systems and help learners move from peripheral participation toward a more informed professional identity.

Practical disaster medicine concepts

The curriculum integrates three practical disaster medicine concepts. Three-level collaboration (3LC) is a scenario-based tabletop exercise model that trains collaboration across operational, tactical and strategic levels of disaster response [19–21]. Its value lies in making interdependencies visible: frontline decisions create information and resource needs at coordination levels, while strategic decisions shape what frontline teams can do. CSCATTT—Command and control, Safety, Communication, Assessment, Triage, Treatment and Transport—is used as a shared operational framework, commonly associated with MIMMS, to help novice learners structure priorities during major incidents [22]. It is presented as a cognitive scaffold rather than a rigid checklist [5].

MRMI, or Medical Response to Major Incidents, provides an educational concept for understanding coordinated medical response across the incident scene, transport, hospital reception, command, communication and ongoing care [4]. MACSIM, or mass-casualty simulation, provides a simulation approach for representing major incident response in a realistic but controlled environment [23]. In this course, the final exercise is described as MRMI/MACSIM-informed rather than as a certified MRMI course, because formal certification should only be claimed when delivered according to relevant standards and by appropriately authorized instructors.

Contemporary scope of disaster preparedness

The course also addresses themes that extend beyond immediate response. Recovery is treated as an integral component of disaster management, including psychosocial recovery, rehabilitation, organizational learning and after-action review [1, 3, 4, 14, 15, 39, 41]. Crisis communication includes communication with teams, patients, families, authorities and the public, as well as contemporary challenges related to social media, misinformation, disinformation and emerging digital technologies, including artificial intelligence [42–44]. Leadership is addressed through role clarity, followership, decision-making, coordination and reflection across the repeated exercises [1, 5, 14, 15, 19–21, 23, 35].

Evaluation and quality improvement framework

Kirkpatrick’s four-level model provides a prospective framework for evaluating learner and course outcomes, moving from reaction to learning, behaviour and results [45]. This encourages evaluation beyond satisfaction alone. The CIPP model, developed by Stufflebeam, evaluates programs through four dimensions: Context, Input, Process and Product, and is particularly useful for curriculum evaluation and continuous quality improvement and complements Kirkpatrick [45–47]. Together, these frameworks allow future evaluation to examine both learner outcomes and the educational conditions required for sustainable implementation (Table 1).

Table 1
Planned evaluation and quality improvement logic using Kirkpatrick and CIPP.

Framework	Focus	Examples in the proposed course
Kirkpatrick Level 1: Reaction	Learner response	Course evaluation, perceived relevance, satisfaction and acceptability.
Kirkpatrick Level 2: Learning	Knowledge, skills and attitudes	Pre/post-test, triage exercises, 3LC performance, simulation performance and scholarly paper.
Kirkpatrick Level 3: Behavior	Transfer to practice or later training	Follow-up during clinical placements, future exercises, use of CSCATTT and interprofessional collaboration.
Kirkpatrick Level 4: Results	Broader educational or organizational effects	Contribution to preparedness culture, future instructors, collaboration capacity and disaster medicine engagement.
CIPP: Context	Need and relevance	Fit with curricular gaps, institutional preparedness needs and learner groups.
CIPP: Input	Resources and planning	Faculty, simulation resources, interfaculty collaboration, time and community-practice opportunities.
CIPP: Process	Implementation quality	Fidelity, participation, debriefing quality, feasibility and barriers.
CIPP: Product	Course outputs and improvement	Learning outcomes, performance, written work, sustainability and curriculum refinement.

Methods

Design

This paper reports a curriculum development study. The output is a proposed elective curriculum rather than outcome data from an implemented educational intervention. The curriculum was developed through evidence-informed and theory-informed synthesis of selected literature on disaster medicine education, competency frameworks, collaborative exercise models, postgraduate preparedness education, simulation-based learning and medical education theory [16, 25, 48–49].

The course was designed for undergraduate and early professional learners who may have limited previous exposure to disaster medicine, but who may later participate in clinical, prehospital, public health, organizational, humanitarian or civil protection roles. The elective format was chosen to improve feasibility within crowded curricula and to attract learners with strong interest across professional groups.

Literature selection and source material

This manuscript does not report a systematic review or scoping review. Instead, selected literature was used purposively to inform the development of a theory-informed curriculum framework. Priority was given to peer-reviewed articles, established educational frameworks, international guidance documents and studies directly related to disaster medicine education, health emergency preparedness, interprofessional learning, collaborative exercises, simulation-based training or curriculum evaluation.

The selected literature represented five broad areas: disaster medicine and disaster preparedness education [3, 6, 8, 10, 14–17, 38, 45]; competency-based and blended disaster education models [12–15]; practical exercise and simulation approaches, including 3LC, CSCATTT, MRMI and MACSIM [10–21, 23, 32–51]; postgraduate and continuing preparedness education [17, 18]; and medical education theories relevant to curriculum development, PBL, interprofessional education, simulation, reflection, assessment and self-directed learning [16, 25, 29–33, 45, 52–54].

The selected literature was not intended to provide an exhaustive synthesis of the field. Rather, it established a coherent evidence-informed and theory-informed foundation for the proposed elective. Several selected sources originate from the authors' own or affiliated research environments. These sources were included because they directly describe educational components central to the proposed curriculum, including three-level collaboration exercises, flexible surge capacity, MRMI/MACSIM-informed simulation, postgraduate disaster medicine education and the Swedish disaster medicine education context.

To reduce the risk of over-reliance on a single research tradition, these sources were combined with independent international frameworks, consensus-based competency literature, systematic and scoping reviews, and established medical education theories. The purpose was not to privilege author-related publications, but to use the most directly relevant literature for the specific curriculum components being integrated.

Curriculum development process

Kern's six-step model was used operationally to structure the curriculum-development process [25]. Problem identification and general needs assessment were informed by literature describing inconsistent disaster medicine education, variable curricular content, limited interprofessional learning and insufficient performance-based assessment. The targeted needs assessment defined medical and paramedical students as the primary learners, with optional inclusion of other health, emergency-response and crisis-management learners.

Course goals and learning objectives were derived from disaster medicine competency frameworks [9, 14, 15], WHO Health Emergency and Disaster Risk Management principles [1, 2, 48], CSCATTT [5, 22], 3LC literature [19–21], MRMI/MACSIM principles [4, 23, 49], flexible surge capacity literature [50, 51] and postgraduate preparedness education [17]. Educational strategies were then selected through constructive alignment with these objectives and with the learning theories. Implementation was

structured as a four-week intensive elective of approximately 80–100 learning hours, combining online preparation, seminars, group work, repeated 3LC exercises, structured debriefings, an MRMI/MACSIM-informed final simulation and an individual scholarly paper.

Target learners and course setting

The primary target learners are medical and paramedical students. The elective may also include nursing, public health, pharmacy, psychology, social work, hospital administration, military medical, civil protection, crisis-management and humanitarian response learners. Learners may have different levels of prior clinical or emergency-response experience but should share an interest in disaster preparedness and interprofessional response.

The four-week duration was selected as a pragmatic balance between educational depth and curricular feasibility. It allows progression from foundational concepts to applied clinical and public health response, system-level collaboration and final integrated simulation, while providing time for six 3LC exercises, debriefings, preparation for the final simulation and completion of the scholarly paper. At the same time, the format remains feasible as a stand-alone elective, summer course, certificate module, advanced undergraduate block or bridge to postgraduate disaster medicine training.

Planned evaluation

Evaluation was planned using learner-level, performance-level and program-level outcomes [27–28, 45–47]. Kirkpatrick's model may be used to assess learner reaction, learning, behaviour and longer-term results, while CIPP may be used to guide continuous quality improvement of the curriculum context, resources, implementation process and products. Because the present paper reports a curriculum framework rather than an implemented intervention, these frameworks are used prospectively rather than to report course effectiveness.

Ethical considerations

This paper presents a curriculum framework and does not report data from human participants. Formal ethical approval is therefore not required for the manuscript itself. If the course is implemented and evaluated using student data, ethical review or institutional approval should be obtained according to local regulations. Participation in research evaluation should be separated from course grading when required.

Results

Overview of the elective curriculum

The resulting curriculum is a four-week intensive elective that combines conceptual learning, flipped online preparation, problem-based seminars, repeated 3LC exercises, interprofessional simulation, structured debriefing, optional observational encounters with preparedness organizations and individual

scholarly writing. Six 3LC exercises are distributed across the first three weeks, at least twice weekly, and the final week culminates in an MRMI/MACSIM-informed major incident simulation. Each student submits an individual short academic paper as the written final examination.

Course aims

The course aims to develop foundational and applied disaster preparedness competencies among medical, paramedical and other health or emergency-response-related students through a theory-informed, problem-based, interprofessional and simulation-rich elective curriculum.

Course goals and competency domains

1. Explain core concepts in disaster medicine, disaster risk, health emergency preparedness and the disaster management cycle.
 2. Describe personal and professional roles before, during and after disasters.
 3. Apply CSCATTT to analyze and structure disaster response.
 4. Demonstrate basic mass-casualty triage and clinical prioritization principles.
 5. Participate effectively in interprofessional and multiagency problem-solving exercises.
 6. Recognize the importance of command, safety, communication, assessment, triage, treatment and transport in major incidents.
 7. Discuss public health emergencies, CBRN incidents, hospital evacuation, flexible surge capacity, vulnerable populations and ethical decision-making.
 8. Communicate risk, uncertainty and priorities during disaster scenarios.
 9. Reflect on personal preparedness, teamwork, professional identity and learning needs.
 10. Produce a short academic paper that critically examines a selected disaster preparedness topic.
- The following tables (Table 2 and Table 3) illustrate suggested competency domains included and the course structure:

Table 2
The necessary domains for disaster medicine education and their outcomes.

Domain	Example outcome
Disaster risk and all-hazards preparedness	Explain how hazard, exposure, vulnerability and capacity shape disaster risk.
Personal and professional preparedness	Describe personal safety, professional obligations and preparedness responsibilities.
Health-system organization and incident command	Explain command, coordination and hospital preparedness structures.
Mass-casualty triage and clinical prioritization	Apply basic triage principles during simulated mass-casualty incidents.
Public health emergencies	Describe outbreak response, infection prevention and population-level measures.
CBRN and special incidents	Identify safety priorities and coordination needs in CBRN scenarios.
Risk communication and information management	Communicate clearly with teams, patients, families, media or authorities, including awareness of social media, misinformation, disinformation and emerging digital technologies.
Ethics, law and vulnerable populations	Discuss scarce-resource allocation and protection of vulnerable groups.
Interprofessional teamwork and multiagency collaboration	Demonstrate role clarity and collaborative decision-making.
Recovery, resilience and after-action learning	Participate in recovery planning, psychosocial recovery, rehabilitation, organizational learning and after-action review.

Consistent with the design rationale described above, the course is organized into four progressive weekly themes: disaster literacy and preparedness foundations; clinical and public health disaster response; interprofessional coordination and system preparedness; and integrated major incident management and recovery. Each week combines related learning activities, 3LC or MRMI/MACSIM-informed simulation components, structured debriefing and assessment activities, as summarized in Table 3.

Table 3
The table shows the proposed structure for a four-week course

Week	Theme	Main activities	Simulation/exercise component	Assessment
Week 1	Disaster literacy and preparedness foundations	Online modules, seminars, role mapping, CSCATTT orientation	3LC 1: local mass-casualty incident; 3LC 2: hospital surge; optional system orientation	Pre-test, preparedness self-assessment, reflection
Week 2	Clinical and public health disaster response	Triage workshop, outbreak case, CBRN seminar, ethics and risk communication	3LC 3: infectious disease outbreak; 3LC 4: CBRN/hazardous-material incident	Triage accuracy, communication rubric, case quiz
Week 3	Interprofessional coordination and system preparedness	Flexible surge capacity, evacuation, leadership, multiagency planning	3LC 5: hospital evacuation; 3LC 6: cascading infrastructure failure	Teamwork rubric, peer feedback, paper outline
Week 4	Integrated major incident management and recovery	Final simulation, after-action review, recovery, crisis communication and resilience seminar	MRMI/MACSIM-informed major incident simulation; optional observational visit or guest session	Post-test, simulation performance, individual scholarly paper

The course progresses from foundational disaster literacy to applied clinical and public health response, system-level coordination and integrated major incident management. The first three weeks include two 3LC exercises per week, providing repeated exposure to increasingly complex scenarios and structured debriefing. The final week consolidates learning through an MRMI/MACSIM-informed simulation, after-action review and submission of the individual scholarly paper. This progression is intended to move learners from awareness and role recognition toward collaborative, performance-oriented preparedness (Fig. 1).

The model illustrates the progression from foundational disaster literacy to collaborative problem-solving, system-level simulation and scholarly reflection. Weeks 1–3 use repeated three-level collaboration (3LC) exercises, while Week 4 culminates in an MRMI/MACSIM-informed major incident simulation and submission of an individual scholarly paper. The model links curriculum design, inquiry, practice, collaboration, reflection and professional identity formation.

The course may also include brief community-practice components, such as guest teaching or observational visits involving emergency dispatch, rescue services, emergency departments, hospital command centres, public health authorities or regional disaster management organizations. These components are not intended to turn the elective into a prehospital or operational placement course, but

to strengthen the connection between classroom-based simulation and the real organizations that participate in preparedness and response.

Individual scholarly paper as written examination

Each student writes an individual short academic paper of approximately 1,500-2,500 words, excluding references. The paper serves as the written final examination and supports deeper learning, self-directed inquiry and individual accountability. Students select a topic by the end of Week 1, submit a short aim or outline during Week 2, receive optional formative feedback in Week 3 and submit the final paper at the end of Week 4 (Table 4).

Table 4
Rubric criterion and pass-level expectation for the complementary written examination.

Rubric criterion	Pass-level expectation
Relevance	The topic is clearly linked to disaster preparedness or disaster medicine.
Aim and focus	The paper has a clear aim, question or problem statement.
Use of literature	Relevant scientific, policy or course literature is used.
Conceptual understanding	Key concepts or frameworks are accurately explained.
Critical analysis	The paper discusses limitations, challenges, implications or controversies.
Integration with practice	The paper connects theory to 3LC, simulation, debriefing or real-world preparedness.
Reflection	The student reflects on learning, professional role or future development.
Structure and clarity	The writing is organized, coherent and academically appropriate.
Referencing	Sources are cited consistently and adequately.

Suitable topics include CSCATTT, command and control, safety in CBRN incidents, risk communication, social media, misinformation, artificial intelligence in crisis communication, situational assessment, mass-casualty triage, treatment under scarcity, transport and patient distribution, flexible surge capacity, hospital evacuation, ethical decision-making, vulnerable populations, psychological first aid, public health emergencies, climate-related disasters, armed conflict, recovery, rehabilitation, after-action review and the role of students in disaster response.

Assessment strategy

Assessment combines formative feedback and summative judgments. Formative assessment occurs through quizzes, debriefings, peer feedback, facilitator feedback, paper outline feedback and reflection. Summative assessment includes participation, development across 3LC exercises, final simulation performance and the individual scholarly paper (Table 5).

Table 5

This table shows the necessary components in the course assessment strategy and the suggested weight for each component. The individual scholarly paper is given more weight because it demonstrates the depth of knowledge achieved by each student.

Component	Suggested weight
Participation in seminars, workshops, 3LC exercises and debriefings	20%
Development across repeated 3LC exercises	20%
Final MRMI/MACSIM-informed simulation performance	25%
Individual scholarly paper	35%

To clarify the relationship between learning outcomes, educational activities and assessment, the assessment strategy is presented as a constructive alignment matrix (Table 6). The matrix demonstrates how each intended competency is operationalized through specific learning activities and assessed through corresponding methods. This structure ensures that assessment is not an isolated final step, but an integrated element of the curriculum design. It also illustrates how the elective combines knowledge-based, performance-based, reflective and scholarly assessment to address the cognitive, practical, collaborative and professional dimensions of disaster preparedness.

Table 6

Illustrates the constructive alignment matrix for the proposed course.

Competency	Learning activity	Assessment method
Explain disaster risk and all-hazards preparedness	Online module and seminar	Knowledge quiz
Identify own and others' roles	Role mapping and 3LC	Reflection and observation
Apply CSCATTT	Repeated 3LC and final simulation	CSCATTT checklist
Perform basic triage	Triage workshop and scenario	Triage accuracy test
Communicate risk under uncertainty	Role play, and simulation	Communication rubric
Collaborate inter-professionally	Mixed-group exercises	Teamwork rubric and peer feedback
Understand surge and evacuation	Case seminar and 3LC	Group plan and debrief
Discuss ethical issues	Case-based seminar	Paper or written analysis
Reflect on professional preparedness	Debriefings and portfolio	Reflective assignment
Analyze a selected topic in depth	Individual scholarly work	Final academic paper

The curriculum should therefore be understood as an evidence-informed and theory-informed proposal based on selected foundational literature, rather than as the product of a formal evidence synthesis or expert consensus process. Consistent with the theoretical evaluation framework described in the theoretical section, future evaluation of the course may be structured using Kirkpatrick's four levels.

Discussion

This paper proposes an elective, theory-informed, four-week interprofessional disaster preparedness course for medical, paramedical and other relevant learners. Its main contribution is not the introduction of any single new educational method, but the integration of established educational theories and disaster medicine training concepts into a coherent, constructively aligned curriculum. The course responds to a persistent challenge in disaster medicine education: how to move from fragmented awareness-raising activities toward structured, progressive and assessable preparedness learning.

Educational innovation

The principal innovation of this curriculum lies in combining problem-based learning with repeated 3LC exercises, CSCATTT, MRMI/MACSIM-informed simulation and individual scholarly writing. Each element has been used previously in health professions education or disaster medicine training, but the proposed elective integrates them into a single progression from foundational disaster literacy to collaborative problem-solving, system-level performance and reflective academic inquiry. This integration is important because disaster preparedness requires more than factual knowledge: it requires adaptive reasoning, role clarity, communication, teamwork, ethical judgement and awareness of how individual decisions affect wider response systems [1, 14, 15, 19–21, 23, 49].

The elective format: opportunity and limitation

The elective format is both a strength and a limitation. It may be institutionally realistic because compulsory medical and health professions curricula are already crowded, and extensive disaster medicine teaching may be difficult to introduce as mandatory content. An elective can create space for a more intensive and authentic learning experience without displacing other required teaching. It may also attract learners with genuine interest in disaster medicine, emergency care, public health, humanitarian response, prehospital systems, military medicine or crisis management, thereby increasing motivation, engagement and peer-to-peer learning [24].

However, the elective format also has limitations. Electives may provide rich and motivating learning opportunities, but the literature cautions that they require careful structure, supervision and educational purpose to avoid becoming uneven or missed learning opportunities [24]. In the context of disaster preparedness, an elective may also create a coverage problem: learners who self-select into the course may gain deeper preparedness training, while other students may receive little or no comparable exposure.

The proposed elective should therefore not be interpreted as a complete solution to undergraduate disaster medicine education. Rather, it may function as an intensive model for motivated learners, a pilot for broader curricular integration and a pathway into postgraduate preparedness education.

From content delivery to adaptive problem-solving

A central argument of this curriculum is that disaster preparedness cannot be taught adequately as content transmission alone. Disaster response involves uncertainty, incomplete information, time pressure, competing priorities, emotional stress, resource constraints and interdependence between actors and institutions. These features make problem-based learning particularly relevant. The 3LC exercises are therefore not merely tabletop simulations; they are structured problem-based learning events in which learners must define the problem, identify missing information, negotiate priorities, justify decisions and revise their reasoning as the scenario evolves [19–21, 29–33, 38].

This is important because disaster medicine education can otherwise become overly algorithmic. Frameworks such as CSCATTT are valuable because they provide structure, but there is a risk that novice learners may treat them as fixed checklists rather than cognitive scaffolds for dynamic decision-making [5]. The repeated use of 3LC may reduce this risk by requiring learners to apply CSCATTT across different scenarios, system levels and professional roles. In this way, the course uses structure without assuming that disasters themselves are linear or predictable [49].

From individual competence to system competence and community practice

Much health professions education focuses on the competence of the individual learner. Disaster preparedness, however, depends equally on system competence: communication pathways, role clarity, command structures, surge capacity, transport coordination, hospital readiness, public health integration and organizational learning. The proposed course attempts to bridge this gap by combining individual learning objectives with interprofessional and system-level exercises [4, 17–21, 23, 38–39, 49].

The link between simulation and community practice could be strengthened through optional observational visits or guest sessions with emergency dispatch centers, hospital command centres, emergency departments, rescue services, public health units or regional disaster management organizations [17, 49–51]. Such components need not transform the elective into a prehospital placement course; rather, they would expose learners to the real organizations, professional communities and coordination structures that shape preparedness and response. This may help students connect 3LC-based simulation with the operational realities of disaster management [19, 21, 51].

Nevertheless, there is a tension between educational realism and learner level. Undergraduate and early professional learners may not yet have enough clinical or organizational experience to fully understand hospital command, regional coordination or public health decision-making. The course must therefore

calibrate complexity carefully, using simulation and selected real-world exposure to introduce system thinking without overwhelming learners.

Contemporary communication, leadership and recovery

Contemporary disaster preparedness should address communication and leadership as cross-cutting competencies rather than as isolated topics. Competency frameworks, Health EDM principles and collaborative exercise literature emphasize role clarity, communication, teamwork, ethical judgement, leadership and awareness of how decisions at one level affect wider response systems [1, 5, 14, 15, 19–21, 23, 35]. Crisis communication increasingly includes social media, misinformation, disinformation and emerging digital technologies, including artificial intelligence, which may influence public risk perception, information flow and decision-making [42–44]. These issues can be addressed through scenario injects, role-play, debriefing and scholarly paper topics. Recovery should likewise be addressed as an integral component of disaster management, including organizational learning, psychosocial recovery, rehabilitation, continuity of care and after-action review [1, 3, 4, 14, 15, 41, 49–51].

Relationship to earlier disaster medicine education work

The proposed curriculum builds on earlier work calling for standardized, competency-based, blended and exercise-supported disaster management education [11–16]. It also aligns with PRAD-MED as a postgraduate implementation example of structured disaster medicine education [17]. The added value of the present elective is its positioning earlier in the education continuum. Rather than duplicating postgraduate programs, it aims to create a foundation of disaster literacy, role awareness, interprofessional understanding and motivation for further training.

This distinction is important. Postgraduate programs can develop advanced clinical, leadership and instructor competencies [17], but they should not be expected to compensate entirely for absent undergraduate preparation. Conversely, undergraduate courses should not overclaim. A four-week elective cannot produce disaster medicine experts. Its more realistic contribution is to prepare learners to understand the field, participate more effectively in basic roles, communicate across professions and enter later training with a stronger conceptual and practical foundation.

From awareness to performance

Many disaster medicine courses evaluate learner satisfaction, confidence or short-term knowledge gain. These outcomes are useful but insufficient if the educational aim is preparedness. The proposed course therefore incorporates repeated performance opportunities through 3LC and final MRMI/MACSIM-informed simulation. This progression from introductory scenarios to a larger integrated exercise is consistent with experiential learning, deliberate practice and simulation-based education [23, 27, 28, 32–36].

At the same time, performance assessment in simulated disaster education must be interpreted cautiously [27, 28, 39]. Simulation can reveal communication patterns, role confusion, prioritization

errors and teamwork challenges, but it cannot fully reproduce the stakes, complexity or emotional burden of real disasters. Improved simulation performance should therefore be understood as evidence of educational progress, not proof of real-world response capability. Future evaluation should examine not only immediate performance but also retention, transfer to later training, participation in drills and contribution to organizational preparedness.

The role of the individual scholarly paper

The individual scholarly paper addresses a different educational need from the simulations. Group exercises develop collaboration and applied reasoning, but they may obscure individual learning gaps. Written work requires each student to define a problem, search and use literature, analyze implications and connect theory with course experience. It may therefore support self-directed learning, reflective capacity and individual academic accountability [52–54].

However, the paper should not be treated as evidence that deep learning has occurred unless it is assessed with appropriate criteria. A poorly structured written assignment risks becoming a superficial summary rather than a scholarly analysis. The assignment therefore needs a clear rubric, expectations for literature use and alignment with course objectives. Its value lies in complementing simulation, not replacing performance assessment. Together, the written paper and simulation exercises allow the course to assess both conceptual understanding and applied collaborative performance.

Implementation feasibility, scalability and sustainability

Successful implementation of the proposed curriculum requires more than educational design alone. Institutional commitment, interfaculty collaboration, trained facilitators and sustainable organizational support are essential prerequisites. Logistical challenges may include access to suitable rooms, scheduling across professional programs, coordination of facilitators, scenario preparation and the absence of conventional clinical placement opportunities. Financial constraints are also relevant, particularly if institutions assume that disaster preparedness requires high-fidelity technology [55–56].

Although the curriculum emphasizes simulation-based learning, successful implementation does not necessarily require expensive high-fidelity simulation technology. Tabletop exercises, structured scenarios, role cards, maps, written injects, timelines and facilitated debriefing may provide substantial educational value while reducing costs [19, 20, 35–37]. Institutions with greater simulation capacity may add simulated patients, moulage, digital dashboards, command-centre simulation, hybrid participation or larger modular field components [4, 17, 23].

Faculty competence represents one of the most important determinants of successful implementation. Facilitators should possess expertise in disaster medicine, interprofessional education, simulation methodology and structured debriefing [56–58]. Without such competence, repeated exercises may become unstructured discussions or logistical games rather than meaningful learning events. Faculty development is therefore essential, and postgraduate programs such as PRAD-MED may contribute by

preparing clinicians and other professionals to act as instructors, debriefers and scenario developers [17].

The curriculum was intentionally designed to be flexible and scalable, allowing adaptation to institutions with different educational resources, professional programs and healthcare systems. Future developments may include digital or hybrid delivery models, broader international collaboration and longitudinal integration into undergraduate and postgraduate disaster medicine education. Continuous evaluation using both Kirkpatrick and CIPP can support sustainability by linking learner outcomes with ongoing curriculum quality improvement [45–47].

Implications for curriculum development

The proposed elective has implications beyond the specific four-week course. First, it can serve as a testbed for identifying which disaster preparedness competencies should be introduced to all students and which are appropriate for advanced elective learners. Second, it can create an interprofessional community of learners and educators who may support future drills, research and preparedness initiatives. Third, it can help institutions align undergraduate education with postgraduate disaster medicine training and continuing professional development.

The course also highlights the importance of community-based integration in disaster preparedness education. Flexible surge capacity emphasizes that disaster response cannot rely solely on hospitals, emergency departments or formal institutional resources, but may require coordinated use of community resources, volunteers, primary care, municipal services, civil protection actors, Emergency Medical Teams and other community-affiliated organizations [50–51, 59–60]. Although efforts to establish and deploy Emergency Medical Teams are important, their effectiveness depends partly on how well they integrate with local institutions, healthcare systems and community structures. The elective should therefore expose learners to community-affiliated actors and coordination mechanisms through scenario roles, guest sessions or observational visits, thereby strengthening understanding of how institutional and community resources can be connected during preparedness, response and recovery.

A possible long-term model is a tiered curriculum: brief mandatory exposure for all health professions students, an intensive elective for motivated learners, postgraduate courses for clinicians and leaders, and continuing professional development for instructors, organizational preparedness roles and community-affiliated response actors. In this model, the elective is not a substitute for core preparedness education, but a bridge between basic awareness, advanced competence and broader system integration.

Limitations and future evaluation

Several limitations of this curriculum development study should be acknowledged. First, the manuscript presents a proposed curriculum framework rather than implementation or outcome data; feasibility,

acceptability, educational impact and transferability therefore remain to be tested. Second, the literature was selected purposively rather than through a formal systematic or scoping review, and relevant sources may have been omitted. Third, several selected sources originate from the authors' own or affiliated research environments, which may introduce author-related selection bias despite their direct relevance to the proposed curriculum components. Fourth, the four-week duration and elective format are pragmatic design choices rather than empirically established optimal formats.

Future studies should implement and evaluate the elective using mixed methods. Outcomes should include knowledge, preparedness self-efficacy, triage accuracy, communication, teamwork, role clarity, simulation performance, reflective learning, learner satisfaction, feasibility and retention after 3–6 months. Multi-institutional and comparative studies would be valuable to assess transferability and determine whether repeated 3LC exercises produce greater gains in teamwork and system understanding than lecture-only or single-simulation formats. CIPP-informed evaluation should also examine context, resources, implementation fidelity and curriculum sustainability over time.

Conclusions

Disaster preparedness is a core responsibility of health systems and the professionals who work within them. Medical and paramedical students should have opportunities to develop disaster literacy, role awareness, interprofessional collaboration, triage principles, communication, ethical reasoning and system understanding before entering clinical practice. An elective format provides a feasible and motivating route for learners with genuine interest across professional groups.

The proposed four-week elective integrates problem-based learning, repeated 3LC exercises, MRMI/MACSIM-informed simulation, individual scholarly writing and optional connections to real preparedness organizations within a theory-informed curriculum. By combining conceptual learning, collaborative problem-solving, system-level simulation, crisis communication, recovery-oriented thinking and reflective academic work, the course aims to move disaster preparedness education from passive awareness toward performance-oriented, interprofessional and scholarly competence.

Abbreviations

3LC
Three-level collaboration
CBRN
Chemical, biological, radiological and nuclear
CIPP
Context, Input, Process, Product
CSCATTT
Command and control, Safety, Communication, Assessment, Triage, Treatment and Transport
EMS

Emergency medical services
FSC
Flexible surge capacity
Health EDRM
Health Emergency and Disaster Risk Management
IPE
Interprofessional education
MACSIM
Mass casualty simulation
MRMI
Medical Response to Major Incidents
PBL
Problem-based learning
PRAD-MED
Preparedness and Disaster Medicine
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

Not applicable. This manuscript presents a curriculum framework and does not report data from human participants. If the curriculum is implemented and evaluated using student data, ethical review or institutional approval should be obtained according to local requirements.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

A. K-M conceptualized the manuscript. and developed the curriculum framework. J. B. contributed to the literature synthesis and theoretical framing. A. K-M drafted the manuscript. A. K-M and J.B. critically revised the manuscript and approved the final version.

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Availability of data and materials

No datasets were generated or analyzed for the present manuscript. The curriculum tables and figure are included in the manuscript.

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Figures

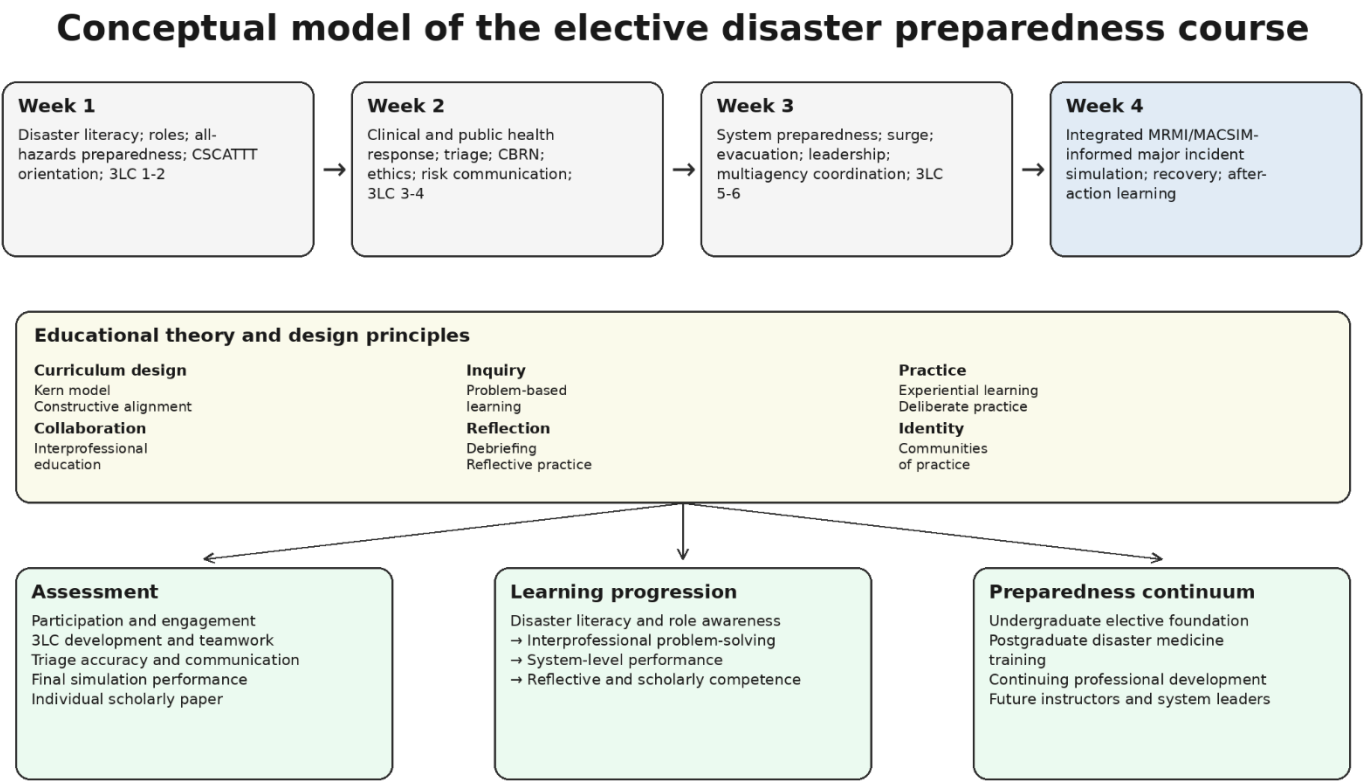


Figure 1

Conceptual model of the elective disaster preparedness course.