

Enhancing Education in Disaster Management With the Responding Lab

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Abstract

This article presents innovative training concepts in disaster management with the Cologne Responding Lab (CRL), emphasizing the integration of theoretical instruction with practical application. A “learning by doing” approach fosters experience-oriented learning, developing both subject expertise and key skills such as teamwork, resilience, and problem-solving. Instructors with practical experience in risk management, crisis response, and emergency medicine supervise students during realistic deployments, enabling rapid qualification and role differentiation. Student feedback is collected and external reviewers evaluate the program, which is highlighted for its strong practical focus. The CRL acts as a bridge between emergency responders and leadership researchers, facilitating knowledge transfer. For example, after the devastating flood in the Ahr Valley, CRL supported the construction of a temporary bridge using video technology, enabling the Federal Agency for Technical Relief to relocate its On-Site Operations Coordination Centre to a safer location. This approach prepares personnel to perform complex tasks such as situation assessment and coordination. The Institute for Rescue Engineering and Civil Protection (IRG) fosters collaboration between science and civil protection by applying current research to practice through large-scale exercises and real deployments, ensuring academic training evolves with disaster management challenges. TH Köln established a Commission on Responsibility in Science, involved since CRL’s founding, ensuring data safety and participant well-being. The concept relies on strong networks with first responders. Despite high initial costs, IRG’s 15 years of research provide necessary expertise and connections.

Keywords: digitalization, disaster management, drone technology, research transfer, higher education

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Introduction

Emergencies and crises are often complex, dynamic, and time sensitive. Due to the nature of emergencies, leaders must make decisions based on diffuse information. Command systems and tools are meant to support them in this. Command systems are undergoing a fundamental renewal through advancing digitalization.

Large parts of the integrated civil protection system in Germany fall under the legislative competence of the federal states and are the responsibility of local authorities. These structures sometimes complicate the adoption of technological advancements and innovations, such as the widespread general digitalization progressing in many areas. Particularly in the management of large-scale damage situations, there would also be a need for standardizing interfaces and tactical frameworks (Bundesministerium des Innern, 2023; Sauerland et al., 2020).

Cologne Responding Lab

Cologne University of Applied Sciences (TH Köln) operates a laboratory for large-scale incidents. For over 15 years, this laboratory has been conducting research projects focusing on large-scale disaster situations. As part of these projects, large-scale exercises are regularly carried out and scientifically evaluated.

Since 2024, TH Köln has established an organizational structure to support emergency response forces in real-world disaster situations. For this purpose, the Institute of Rescue engineering and Civil Protection (IRG) founded the Cologne Responding Lab (CRL). The CRL at Cologne University of Applied Sciences exemplifies how TH Köln integrates practical experience and scientific research to enrich teaching and create direct societal benefits.

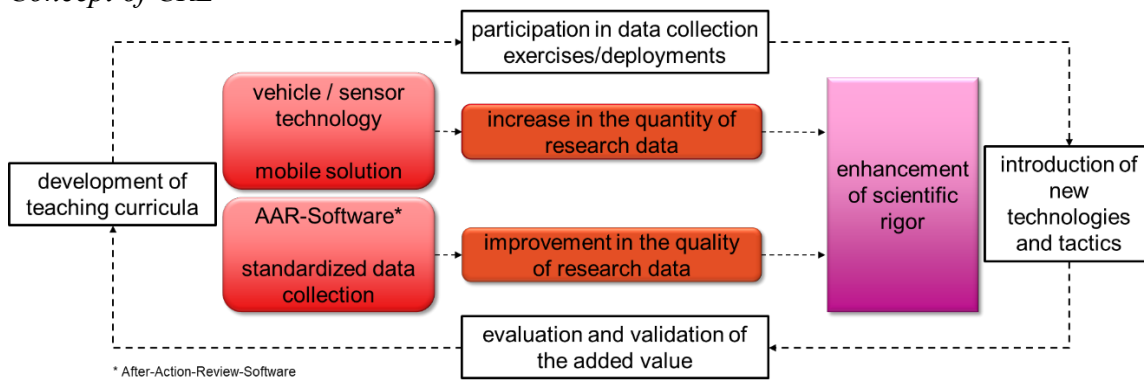
Figure 1

The System of Responding Lab: Vehicle and Container With Drones and Modern Measurement and Communication Technologies



The Cologne Responding Lab promotes the exchange between science and emergency services to translate current insights into applicable concepts. Activities such as participating in large exercises and real deployments augment the research, while results and data are made available to users.

Figure 2
Concept of CRL



Transformative Teaching

The IRG actively contributes to an open transfer of knowledge with society. Both society as a whole and the students benefit from a shift in perspectives through the active integration of real-world labs in teaching. This approach enables students to develop hardware and training concepts, for example, for fire safety education or to support local disaster management.

Figure 3
CRL at Local Fire Department



Figure 4
Deployment of CRL



The CRL consistently relies on the “learning by doing” philosophy, considered the core of modern training and professional development in disaster management. The goal is not to impart theoretical knowledge in isolation, but to apply it directly in a realistic, practice-oriented environment. Learning thus becomes an experiential process that strengthens not only professional expertise but also key competencies such as teamwork, resilience, and problem-solving. This didactic approach enables learners to test and further develop their knowledge in a safe yet authentic environment.

Impact

The exercises at the CRL are not only based on theoretical knowledge but also draw directly on current, real-world disaster situations. For example, the CRL supported the Federal Agency for Technical Relief (THW) in relocating its command team during the construction of a temporary bridge after the flooding in the Ahr Valley by developing and testing technical

solutions for video transmission during operations. This direct link between real-world deployment and training raises awareness of the complex challenges of crisis management. Participants experience complex situations that they must actively structure, assess, and coordinate, such as the establishment of temporary infrastructure after natural disasters. In addition to technical aspects, participants hone their decision-making skills and leadership experience. Continuous support from experienced instructors enables thorough reflection and immediate feedback. This is complemented by comprehensive feedback from participants and external evaluations, which ensure the continuous improvement of the training programs.

Figure 5
CRL Integrated Into the Incident Command Post



Figure 6
Fully Erected Temporary Bridge



Another practical example of combining technical expertise and leadership skills is the conversion of two Ford Transit vans by CRL students. These vehicles were equipped with a fully functional workstation, including a chartplotter, video transmission hardware, and server technology. In doing so, the students acquire classic engineering skills such as planning, installing, and maintaining complex technical systems. Simultaneously, they develop leadership qualities by independently handling cross-team coordination, project management, and decision-making within the technical conversion process. This approach not only provides participants with outstanding technical qualifications but also strengthens their role as

multipliers—many of them volunteer in disaster relief and thus directly apply their newly acquired skills to their units and their professional lives. This significantly contributes to societal resilience, as well-trained specialists and leaders enable effective and coordinated crisis management.

Figure 7

Ford Transit Interior Fittings



Conclusion

The responding Lab offers an opportunity to complete a technology transfer into emergency management while allowing scientists to be safely integrated as spontaneous helpers in real damage situations. A new research project entitled Protego is already in the application phase.

The CRL exemplifies how “learning by doing” better reflects the complex demands of modern disaster management than purely theoretical training concepts. Through targeted practical exercises under realistic conditions, participants are empowered to act quickly, flexibly, and in a coordinated manner in an emergency. The intensive integration of theory and practice not only creates technical qualifications but also a deep understanding of operational challenges and leadership tasks.

One of the major challenges in implementing the “learning by doing” approach at the CRL is the high cost of acquiring and operating the technical equipment and the complex training scenarios. Furthermore, to ensure the safety of participants, the involvement of an external body, such as an ethics committee, is essential. This committee ensures that no physical or psychological strain occurs during use and that all ethical guidelines are followed. In the case of TH Köln, the IRG benefits from its many years of expertise and a broad network of partners, which enables reliable third-party funding. Moreover, the positive public image of the CRL has attracted various sponsors who support the concept. The well-being of participants and compliance with data protection and other ethical considerations are consistently ensured at the IRG through close collaboration with the Commission for Responsibility in Science at TH Köln.

A concept for a SEG (Rapid Deployment Unit) research unit is to be developed. This way, other universities could follow the example of TH Köln.

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