Microlearning Approach to Radiological Material Theft Response Training

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Abstract

Building capacity for effective law enforcement response to attempted thefts of radioactive materials requires an innovative approach to quickly and inexpensively train large numbers of response personnel to know enough critical information to protect themselves and their communities while preventing loss of control of these materials. Traditional training methods, such as classroom lecture, tabletop exercises, and webinars, can train limited numbers of people at one time, can take significant time away from the job, and can be expensive to train a large population over time. If training information is not easily relatable to specific work needs, it can be "shelved" and not implemented in the field. Training for new staff and revisions to training materials will be needed over time. The United States (U.S.) National Nuclear Security Administration's Office of Radiological Security (ORS) has deployed a microlearning approach to present the most essential information that law enforcement officers need to understand when making an initial response to a potential radioactive material security event. Learning is delivered by a concise mobile-capable video, customized to their specific city, and featuring their local officers and referred to as a roll-call video. Common information, such as basic radiation safety and security information, can be used in multiple videos, decreasing costs and time associated with creating customized videos. To date, ORS has provided roll-call videos to 24 police departments in the U.S. and has trained over 13,000 officers. Additionally, ORS has provided 3 international partners with roll-call videos, through which an estimated 9,000 officers have received training. These types of microlearning videos are not restricted to law enforcement response training, but also have broad potential application for training across a variety of radiological or nuclear safety and security training topics where there is a need to deploy training broadly, quickly, and economically.

Introduction

Effective radioactive material security strategies rely on the principles of detection, delay, and response. Response to attempted thefts or diversions of radioactive materials falls largely to local law enforcement agencies, which broadly includes city, county, state, or national law enforcement organizations or, in some cases, military responders. Large numbers of radioactive sources with significant radioactivity levels are in use throughout the world, often with several devices located within a single law enforcement jurisdiction. The International Atomic Energy Agency (IAEA) estimates that, worldwide, there are over 10,000 radiotherapy devices used for medical care, over 12,000 industrial sources used for radiography are supplied every year, and approximately 300 industrial irradiator facilities are in operation (IAEA 2002). Multiple discrete sources are used in each of these devices and facilities, giving much larger total numbers of radioactive sources in use around the world. For example, in the United States alone, data collected by the Nuclear Regulatory Commission show that over 80,000 IAEA Category 1 and Category 2 radioactive sources were in use in the United States in 2021, an increase of approximately 30% from 2009 (National Academies 2021).

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Without specific training, a typical local law enforcement officer does not know what devices are in their jurisdiction, where the devices are located, what radioisotopes the devices contain, and how to safely respond if called to report to an in-progress radioactive source theft event, weakening response timeliness and effectiveness. Figure 1 illustrates a hypothetical "race" between an adversary attempting to steal radioactive material and detection, assessment, notification, and arrival of the law enforcement response team in sufficient numbers and equipment to stop the adversary. This race can only be won by the response force if they understand the nature of the threat that radioactive materials can present, prioritize responding appropriately, know where radioactive materials are located, and have a plan for an effective response to contain the adversary at a given site within their jurisdiction.

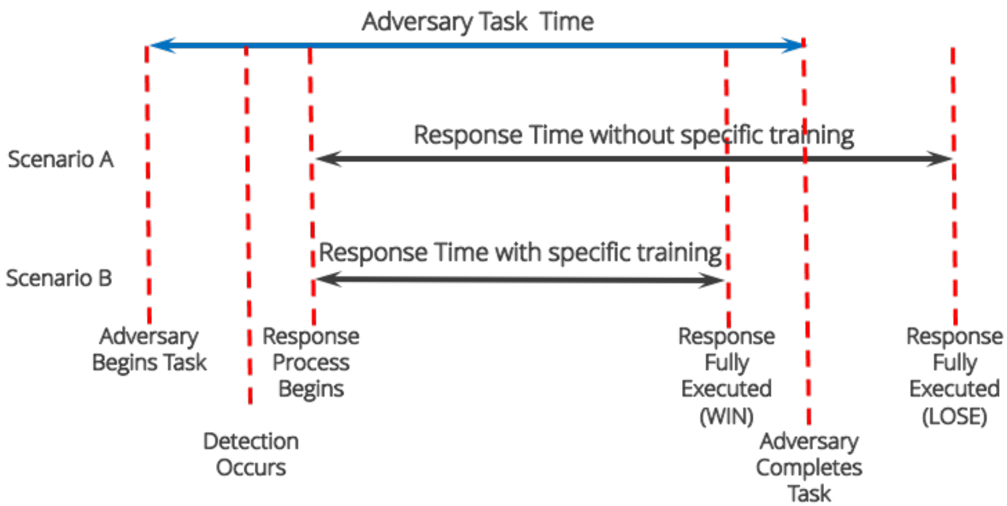

Figure 1. Adversary Task vs Response Force Timelines

Building a self-sustaining capacity for effective law enforcement response to attempted thefts of radioactive materials is vital, and it requires an innovative approach to quickly and inexpensively train large numbers of response personnel to understand the threats associated with illicit use of radioactive materials and to know enough critical information to protect themselves and their communities while preventing loss of control of these materials. The U.S. National Nuclear Security Administration's Office of Radiological Security (ORS) has developed a microlearning approach to present the most essential information that local law enforcement officers need to understand when making an initial response to a potential radioactive material theft event. This microlearning approach has been successfully deployed in numerous United States and international locations directly to local law enforcement officers.

The Case for Microlearning

While the term microlearning has no official definition, all microlearning-based training is short and focused; however, there is no arbitrary time limit assigned to what constitutes microlearning. One report suggested that 13 minutes is about the maximum amount of time to be considered microlearning, with 10 minutes being the ideal length and between 2 and 5 minutes being the most effective length of time for microlearning (ATD n.d.). While video is the most common microlearning content application (*e.g*., YouTube videos), other content types can include text, images, audio, and games.

Some microlearning benefits are that it is faster to deliver, it is more affordable, it is flexible, learners find it more engaging, and it boosts knowledge retention (Andriotis 2018). It is faster than traditional training because there is less material to develop due to short course delivery times. It is more affordable than traditional training because it requires fewer resources and instructors. It is flexible by being easy to change and adapt to new training needs and business practices. Learners find it more engaging since it often uses modern multimedia and targets specific training needs. It boosts knowledge retention since you can review materials easily.

Microlearning supports adult learning theories, or andragogy (the art and science of helping adults learn), where adult learners are assumed to be able to direct their own learning, draw on their life experiences to aid learning, prepare to learn in response to new social or life roles, and implement their new training immediately (TEAL 2011). Since adult learners are independent, self-directed, and need to see the relevancy in learning, andragogy considerations become a significant factor in knowledge retention in a microlearning environment.

A research study was conducted to determine how effectively adults retain information beyond two weeks when knowledge was obtained through a passive microlearning format, specifically by watching a short video (Boring 2020). This study used the Kirkpatrick Model to analyze and evaluate the results. The Kirkpatrick Model can analyze any style of training based on four criteria (Serhat 2016):

- Level 1 Reaction – satisfaction with the training
- Level 2 Learning – increase in knowledge or skills; knowledge retention
- Level 3 Behavior – using what was learned through changes in behavior
- Level 4 Results – measure of positive impact on business or organization

The study found, for Kirkpatrick Level 1, that 94% of the participants felt the training was useful, and 96% were satisfied with the microlearning approach. However, participant feedback included that “microlearning is not for every task,” that they “do find value in both [instructor-led and on-demand training],” and “for subjects that I am particularly interested in or confused by, I like instructor-led ... I like to ask questions and make it as specific as possible to my situation” (Boring 2020).

According to Ebbinghaus’s Forgetting Curve, 70 percent of knowledge obtained from training is lost within 24 hours, and 90 percent is lost within one week without attempts to reinforce learning (Ebbinghaus 1885). Boring (2020) reported, for Kirkpatrick Level 2, that study data showed a statistically higher knowledge retention rate after two weeks than that proposed by Ebbinghaus’s models, with over a 145% higher retention rate at over twice the time period (2 weeks vs 1 week). In support of microlearning for adults, participants over age 35 retained more than younger participants.

Kirkpatrick Level 3 was measured two weeks after the microlearning event to see if participants had changes in behavior because of the training. Behaviors had changed measurably and statistically significantly, showing that microlearning events can impact behaviors (Boring 2020).

Overall, the study showed significant results for learner satisfaction, knowledge retention, and behavior change, or Kirkpatrick's Model Levels 1 – 3, for an adult microlearning event. Kirkpatrick Level 4 was not evaluated in this study.

Microlearning is a powerful capacity building technique because it is fast, affordable, and flexible; it fits well with models of adult learning; and it is satisfying to learners, boosts retention, and can lead to changes in behaviors.

Law Enforcement Response Capacity Building through Microlearning Videos

The United States Department of Energy National Nuclear Security Administration's Office of Radiological Security (ORS) has a mission to enhance U.S. and global security by preventing high-activity radioactive materials from being used in acts of terrorism. ORS works towards fulfillment of this mission through three strategic pillars: Protect, Remove, and Reduce (Figure 2). Law enforcement response is a critical part of the Protect strategic pillar. Successful protection of radioactive materials relies on a timely, well-equipped, and well-trained law enforcement response team to contain an adversary attempting to steal radioactive materials.

Figure 2. ORS Strategic Pillars

Capacity building through training courses, workshops, exercises, technical exchanges, and other engagements are critical elements to fulfilling the overall ORS mission. With a wide and diverse local law enforcement officer base in any given jurisdiction, ORS cannot offer direct, in-person training to all these officers. However, ORS can work with local law enforcement agencies to help them build their capacity to be able to provide the necessary awareness training to all their officers. To reach large numbers of law enforcement personnel across cities, regions, states, or countries, building capacity for effective law enforcement response to attempted thefts of radioactive materials requires an innovative approach to quickly and inexpensively train large numbers of response personnel to know enough critical information to protect themselves and their communities while preventing loss of control of these materials. Traditional training methods, such as classroom lecture, tabletop exercises, and webinars, can train limited numbers of people at one time, can take significant time away from the job, and can be expensive to train a large population over time. If training information is not easily relatable to specific work needs, it can be "shelved" and not implemented in the field. Training for new staff and revisions to training materials will be needed over time.

To address these numerous challenges, ORS has developed and deployed a microlearning approach to present the most essential information that law enforcement officers need to understand when making an initial response to a potential radioactive material theft situation. Learning is delivered by a concise, mobile-capable video, customized to their specific city, and featuring their local officers. Often referred to as "roll-call videos," these videos are short (8-10 minutes in length), viewable across a wide variety of mobile platforms (*e.g*., laptops, tablets, cell phones), and are highly focused on essential topics necessary for local law enforcement to understand when being called to react to an attempted theft of radioactive material. In general, roll-call activities (*e.g*., meetings, information dissemination, videos) are tools local law enforcement agencies in the U.S. use regularly to rapidly disseminate information to officers at the start of their shifts and are mandatory. As a capacity-building tool, these radioactive material security videos allow law enforcement agencies to rapidly deliver information regarding specific radiological response policies; local radioactive materials of concern; response strategy; and personal protection measures to frontline officers, supervisors, and specialized units without the need for pulling officers away from duties to attend in-person classes. Critical information can be delivered across a broad geographic area wherever needed to reach officers.

Typical information the video is designed to convey in 8-10 minutes includes:

- What types of radioactive materials are of concern and what types of facilities these materials are used
- Why radioactive materials present potential security concerns (*e.g*., radiological dispersal devices and radiological exposure devices) and who might be motivated to try to get them
- What certain radioactive materials look like (*e.g*., powder or solid), typical amounts and sizes, and information on radioactivity levels
- What typical devices that use these materials look like, including what to look for to indicate potential tampering
- What health hazards are associated with radiation exposure or radioactive material contamination
- Why it is important for a timely response once notified that detection and assessment indicates a credible threat to radioactive material is in progress
- What to do upon arrival at the scene including who to contact, what information to obtain, and the need to set up an initial containment perimeter
- How to maintain personal safety related to radioactive materials through concepts of time, distance, and shielding

Videos are customized to engage the viewer by including highly relatable interviews and testimonials from local law enforcement staff from the specific city such as commanding officers, peer officers, and representatives from locations within the city that possess radioactive materials. Much of the visual footage is of the local area, including many of the local law enforcement units in action. Videos for international partners are in their native languages.

To reduce costs and decrease video production time associated with creating customized training videos, modules within a video can be reused with no or slight modifications. Examples of the types of information that are applicable to most law enforcement jurisdictions include basic radiation safety and security information; information on radioactive material types of concern; typical devices that use radioactive materials; and detection, assessment, response, and containment narratives.

Results

To date, ORS has provided roll-call videos to 24 police departments in the U.S. and has trained over 13,000 officers. Additionally, ORS has provided 3 international partners with roll-call videos, through which an estimated 9,000 officers have received training. Many more are currently in process or planned for both U.S. and international audiences.

While a formal Kirkpatrick Model levels analysis has not yet been conducted, informal feedback from numerous participants and anecdotal evidence shows that this microlearning capacity building approach is powerful and has significant merit. For Kirkpatrick Level 1, Reaction, participants have found the training to be very useful, interesting, and relevant. They report high levels of satisfaction with the training approach. Much of this satisfaction is due to the video's use of their cities and fellow law enforcement personnel, allowing them to establish an instant connection and rapport with the video content. For Kirkpatrick Level 2, Learning, participants have reported they have gained new knowledge, particularly by learning that there are radioactive materials in their communities, learning about potential adversarial interest and intent associated with these materials, understanding initial steps in responding to achieve containment, and how to maintain personal safety during a response action. For refresher training, the videos can be available on demand, increasing retention. Success in Kirkpatrick Levels 3 and 4, Behavior and Results, remain to be evaluated pending implementation of formal, structured evaluations and analyses.

Summary

Radioactive material response awareness videos, or roll-call videos, provide local law enforcement a short, focused microlearning tool to build the capacity to reach and train hundreds of officers in a short time. These videos include key information on potential threats, vulnerabilities, and layout of a typical radiological site and associated security measures. The videos rapidly deliver information on specific radiological response policies, local radioactive materials of concern, response strategies, and personal protection measures to frontline officers, supervisors, and specialized units. Interviews with first responders, police officers and department leadership create a highly relatable training video that can be quickly distributed through a variety of mobile platforms. Through a microlearning approach, adult learning needs and strengths are maximized. Although each video is customized to the locale and featuring local law enforcement personnel, the modular approach to creating the videos allows reuse of various segments, with little to no modifications, greatly reducing the time and cost to create each video. These types of microlearning videos are not restricted to law enforcement response training, but also have broad potential application for training across a variety of radiological or nuclear safety and security training topics where there is a need to deploy training broadly, quickly, and economically.

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