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Expansive Learning Process of Exercise Organizers: The Case of Major Fire Incident Exercises in Underground Mines

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Abstract: A major fire incident in a Swedish underground mine made the personnel from the mining company and the rescue service realize their limited preparedness. It was the beginning of a collaboration project that included the development of a new exercise model for a more effective joint rescue operation practice. The aim of this study was to explore the collaborative learning process of exercise organizers from the rescue service, mining companies, the emergency medical service, a training company, and academia. The analysis was performed through the application of the theory cycle of expansive learning to the material consisting of documents from 16 collaboration meetings and 11 full-scale exercises. The learning process started by the participants questioning the present practice of the rescue operation and analyzing it by creating a flow chart. An essential part of the process was to model new tools in order to increase the potential for collaboration. The tools were examined and tested during collaboration meetings and implemented during full-scale exercises. The exercise organizers reflected that the process led to organizational development and a better understanding of the other organizations' perspectives. Consequently, a tentative model for developing the learning process of exercise organizers was developed.

Keywords: collaboration; cycle of expansive learning; full-scale exercises; major incident; organizational learning; preparedness; underground mine

1. Introduction

Although there is always some probability of an emergency, it is impossible to know when and where they may occur [1]. In 2013, a major fire incident occurred in one of the Swedish underground mines—a specifically challenging environment to establish a rescue operation. A mineworker had to seal himself into the vehicle in which he was working to protect himself from the smoke. Two other mineworkers decided to rescue their missing colleague and entered the smoke but became disoriented and had to enter a rescue chamber [2].

During fires, self-escape and rescue operations in the complex smoke-filled underground mining environment are difficult [3]. To reduce the risk of mortality and morbidity of severely injured mineworkers, they have to be rescued and receive medical care as quickly as possible [4]. However, to reduce the risk of becoming injured themselves, Swedish rescue service personnel in a recent study stated that they only perform life-saving rescue operations underground [5]. The rarity of major fire

emergencies in underground mineral and metalliferous mines makes the experience of performing rescue operations limited [3]. Rescue operations in the underground environment require the use of specific methods and tactics performed by experienced personnel with adequate equipment [6]. While other mining countries utilize specialized mine rescue teams, most mining companies in Sweden are assisted by the local rescue service during rescue operations into the mine [7]. The rescue service personnel are assisted by trained mining company guides during reconnaissance, rescue, and smoke-diving operations [8]. Therefore, the rescue operation relies on effective collaboration between participating organizations. Although the fire in 2013 resulted in a collaboration between the rescue service and mining companies in developing rescue operation plans and training together after the incident, the emergency medical service (EMS) was not included in the collaboration [5]. The EMS personnel are responsible for the care of the injured mineworkers, and not being included led them to feel insecure in their role as responders and becoming passive actors in the rescue operation [9]. Around one half of the Swedish EMS personnel with a mine in their catchment area considered themselves unprepared to respond to underground mine emergencies [10].

The rescue operation during the Swedish mine fire of 2013 was subsequently evaluated by the rescue service, and it was concluded that the rescue service had not been sufficiently prepared to perform a smoke-diving operation into the mine [2]. In order to improve the preparedness of the organizations, development of the rescue operation practice for major underground mine fires was required. A collaboration project with exercise organizers from the rescue service, EMS, mining companies, a training company, and academia was initiated with the overall objective to improve the current rescue operation practice and organizational preparedness by composing learning material for the participating organizations. The participating exercise organizers had to critically study their own organization and their role in the rescue operation in order to develop a new rescue operation practice, which was tested during full-scale exercises. It was deemed relevant to explore the iterative changes both within and between the organizations in a structured way. Thus, the present study had the aim to explore the learning process in the collaboration between the organizers in underground mine exercises. The study retrospectively analyzed the material from the collaboration meetings and full-scale exercises conducted within the collaboration project. The material was deductively analyzed and presented in accordance with the cycle of expansive learning in order to present learning activities following a process-oriented approach.

1.1. Organizational Learning Through Exercises

Emergency exercises are used as preparation and learning for future emergencies [1]. During emergency exercises, the existing response plans, procedures, and skills, as well as the effectiveness and dynamics of the responding organizations, are evaluated [11,12]. Nonetheless, the progress and outcomes of full-scale exercises may be difficult to predict and control [13]. The managers of the emergency organizations, namely the Rescue Service Incident Commander, Ambulance Incident Commander, and Medical Incident Commander [14], need to know what needs to be done and how to effectively work together, thus they have to practice decision making and communication [15–17]. In order to manage the complex emergency situation, they have to be flexible and negotiate [11,13,16]. However, all of the involved emergency organizations have their own objectives and tasks [13], which might lead them to work independently and only sporadically brief each other of the current situation instead of working closely together and taking joint decisions [18]. Full-scale exercises can even be said to be inadequate tools for learning [19,20] and contribute to building intra-organizational skills rather than inter-organizational collaboration [21]. If the organizations lack knowledge about each other's roles, responsibilities, and tactics, this might negatively affect the efficacy and outcome of the rescue operation [22,23]. Still, full-scale exercises may also contribute to organizational learning because the participants build informal relationships with each other and thus learn the other organizations' languages which can be useful for the inter-organizational collaboration during real emergencies [24].

In full-scale exercises, learning can encompass the individual, the group, and the organizational levels simultaneously [13], and both the participants and the exercise organizers engage in the learning process [16]. After an exercise, learning can be facilitated by allowing the participants to constructively reflect on their preparedness, the process, and the lessons learned [11,16]. However, there are few studies that report on continued learning which occurs over time through participation in various activities, e.g., exercises and meetings [25]. Full-scale exercises can even be stated to only reproduce existing knowledge due to using expected scenarios and the utilization of a stable way to make decisions [26]. Full-scale exercises are also too focused on standardization and individual learning within organizations [19]. Thus, the inclusion of more collaborative elements, without finished solutions into the full-scale exercises could contribute to organizational learning [19,27].

Organizational learning also includes learning among the exercise organizers, their learning process including figuring out possible solutions to the scenarios and challenges they create [16]. The exercise organizers also learn by observing the exercise process to be able to modify the scenario and refine the exercise management structure and procedures [13,16].

1.2. Theoretical Framework

The complex nature of incidents in underground mines means none of the exercise organizers can develop exercise models alone. However, the learning process of jointly developing an exercise model can be assumed to be dynamic but challenging due to different prioritizations, concepts, tools, and primary tasks. Therefore, the theory of expansive learning was identified as a relevant framework for the present study. The cycle of expansive learning has been applied in a wide range of contexts, including health care and education contexts [28]. However, to the best of our knowledge, no previous study has applied the cycle of expansive learning to the learning of full-scale exercise organizers. The theory of expansive learning has been developed within the cultural-historical activity theory (CHAT) in which individuals are understood as part of a multi-voiced activity system with its own set of rules, division of labor, community, mediating artifacts, and objects [29]. This means that the exercise organizers have their own organizational culture with diverse ways of understanding potential challenges and solutions.

The focus of expansive learning is on changes in the object of activity, as exemplified by new practices and working methods [28]. Expansive learning occurs when the content being learned is not pre-existent but is created in collaboration among representatives from several organizations. Expansive learning can be described as a cyclical process, as presented in Figure 1, with the following phases: (1) questioning, (2) analysis, (3) modeling the new solution, (4) examining the new model, (5) implementing the new model, (6) reflection on the process, and (7) consolidating the new practice [29]. A collaborative effort is necessary to induce change, which starts when the representatives question the present practice of the activity systems and the common management of the object [29]. The representatives analyze the current practice to find the root cause of the experienced contradiction and to find solutions to the challenges through modeling [29]. Instead of adopting new tools or practices as such, the process of implementation means a continuous re-creation and expansion of the activity [30], which over time can change organizational boundaries [31].

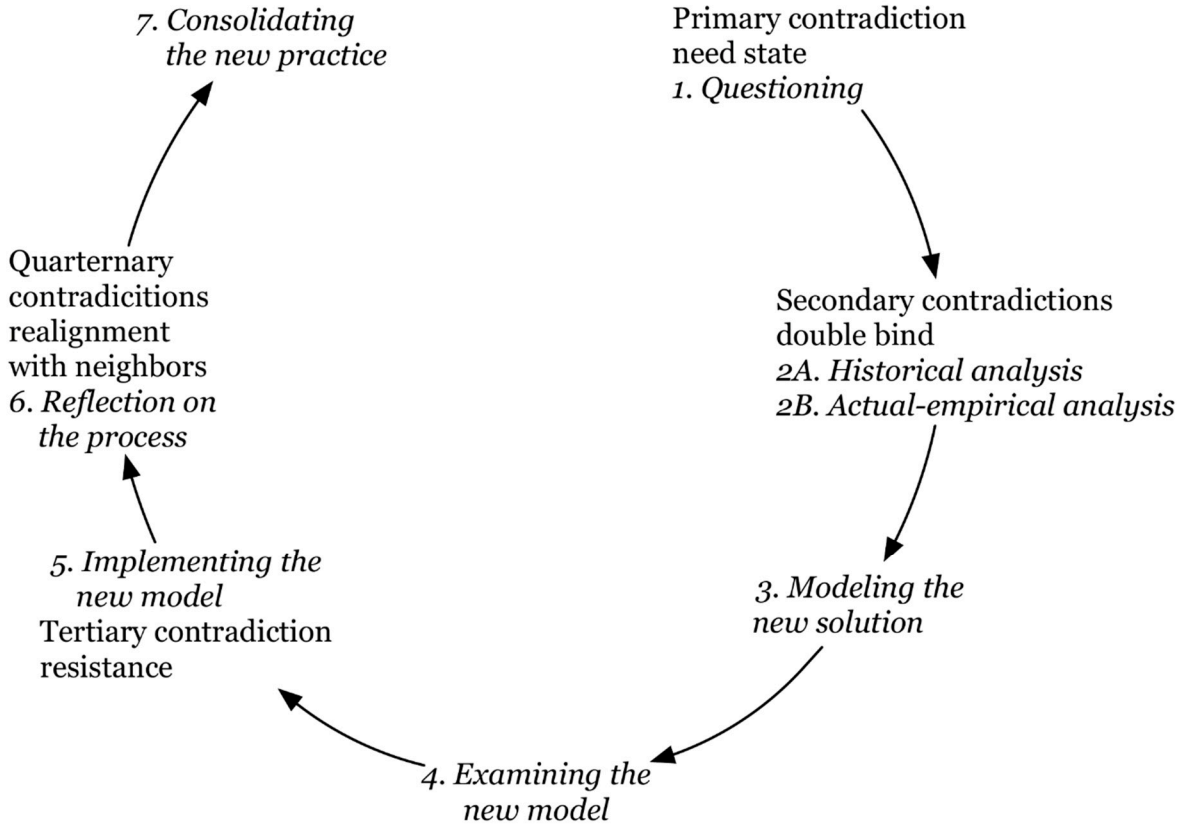

Figure 1. Cycle of expansive learning [29]. Reprinted by permission of the publisher Taylor & Francis Ltd., http://www.tandfonline.com.

2. Materials and Methods

2.1. Setting

A collaborative project was initiated in late 2016 by researchers at Umeå University to improve collaboration during rescue operations in underground mines. Sixteen exercise organizers with relevant experience of full-scale exercises and influence over both exercises and the organizational practices participated, including one rescue service manager, two managers and two operative personnel from the EMS, three managers from two mining companies, one manager and three educators from a company working with training, and three researchers and one teacher from Umeå University. During this project the group of exercise organizers met regularly both for conducting collaboration meetings and for meetings focusing on planning, conducting, and reviewing the full-scale exercises. This made the project adaptable, through the process of planning, acting, observing, and reflecting [32], where new solutions could be developed to respond to the challenges encountered during the exercises.

2.2. Material

The design of this study was a retrospective case study. The material for this study was based on a total of 144 documents from 11 full-scale underground mining exercises as well as documentation from 16 collaboration meetings; Figure 2 shows a timeline of the full-scale exercises and collaboration meetings. The individuals participating in the collaboration meetings were the same individuals planning, executing, and evaluating the exercises. The full-scale exercise participants' perspectives were included within the exercise organizers' evaluations of the full-scale exercises. After each exercise, the exercise participants were asked to reflect on the exercise and to come up with suggestions for further improvements.

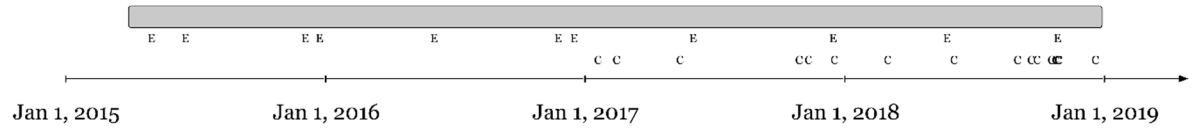

Figure 2. Timeline of collaboration meetings (C) and full-scale exercises (E).

The documentation from the full-scale exercises included a total of 106 documents about planning, logbooks, observation protocols, and evaluations. All of the organizations contributed with material during the full-scale exercises as follows: the rescue service, 30 documents; EMS, 24 documents; the mining companies, 14 documents; the training company, 10 documents; and Umeå University, 28 documents. The full-scale exercises were carried out from April 2015 to October 2018. The collaboration meetings were carried out between January 2017 and December 2018 and resulted in a total of 38 documents. These documents were, for example, documentation of what was discussed during the collaboration meetings.

2.3. Analysis

First, all of the material was read several times in chronological order to get an understanding of the whole material. Then all material relating to the aim was identified. The inclusion criterion was descriptions of collaboration between at least two of the organizations. Excluded text did not relate directly to collaboration, for example, technical aspects of the rescue process. The cycle of expansive learning was operationalized as an analytical tool [29,33,34]. The analysis was performed as an iterative process. At first, the material was sorted in the cycle of expansive learning per exercise/meeting, which resulted in several cycles of expansive learning. For example, steps (3) modeling the new solution, (4) examining the new model, and (5) implementing the new model were revisited several times because the exercise organizers tested a new practice or tool during the exercises and then had to modify the tool or practice or the exercise organizers found a new knowledge gap or limitation that they had to develop a new tool or practice for. To condense the richness of the material, the analysis continued by sorting the material based on the content and message of the text independent of which exercise/meeting the text originally derived from into the cycle of expansive learning. By doing so, the seven phases of the model could be illustrated in a logical way in the manuscript.

2.4. Ethics

All of the exercise organizers who contributed with material granted permission that the material could be used in this study. The study is exempt from the Swedish Act concerning the Ethical Review of Research Involving Humans [35]. The Helsinki Declaration [36] was followed. In the final manuscript, an effort was made to ensure that the identity of the exercise organizers or participants of the exercises could not be discerned.

3. Results

In the result section, the exercise organizers' learning process is illustrated by the seven phases of the cycle of expansive learning, as illustrated in Figure 3.

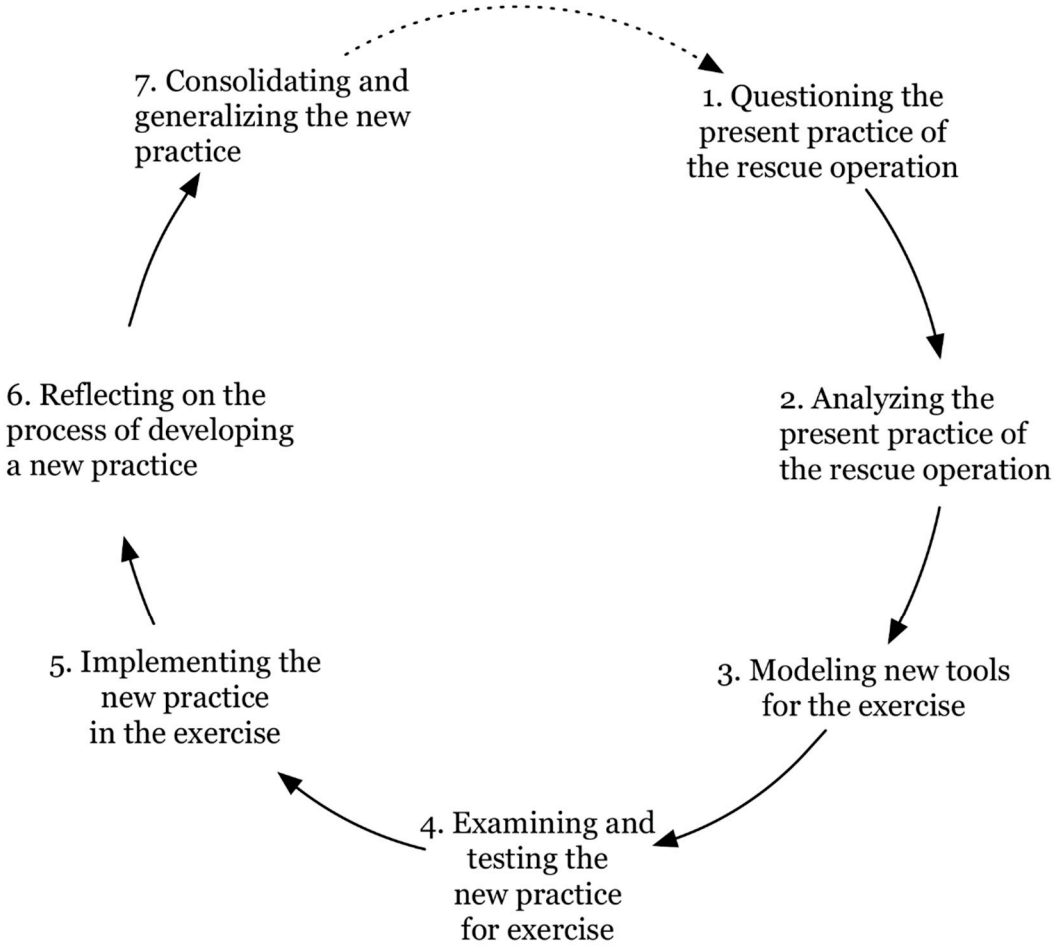

Figure 3. Cycle of expansive learning of exercise organizers as they developed the rescue operation practice as inspired by Engeström [29].

As can be discerned from the results, the learning process of the exercise organizers did not follow the cycle of expansive learning from start to finish, and the cycle was looped in various ways. The primary explanation is that the process was iterative, consisting of different types of activities (e.g., meetings and exercises), and continued over a fairly long time. As time went on, more and more data were produced from the various exercise organizers. During the first six full-scale exercises, the rescue service and mining companies together produced a total of 18 documents, while exercises 7–10 included 41 documents produced by various exercise organizers. The documentation peaked during the last reported exercise of this study; namely, during the 11th exercise, all of the exercise organizers contributed with a total of 47 documents. During the process, there was not only an increase in the number of documents, but their quality and the complexity of information also increased. The first exercise documents mainly consisted of technical reports, but as the learning process continued, the organizations also started to consider organizational and collaboration aspects.

3.1. Questioning the Present Practice of the Rescue Operation

Questioning the present practice of the rescue operation began during and after the aforementioned major fire incident in one of the Swedish underground mines. The evaluation performed by the rescue service indicated that the rescue service lacked knowledge about suitable tactics and methods for rescuing someone in a mining environment. To develop knowledge and tactics to work under these circumstances, a collaboration between the rescue service and mining companies was initiated by, for example, performing full-scale exercises together. However, the EMS was still a missing actor in this

collaborative initiative, which led to EMS personnel being uncertain of how to manage these kinds of incidents. Therefore, the university partners questioned the lack of a comprehensive strategy for managing underground major fires in collaboration including all central actors.

3.2. Analyzing the Present Practice of the Rescue Operation

In order to analyze the present practice of the rescue operation, the exercise organizers created a flow chart together based on their experiences from full-scale exercises and real events. This flow chart visualized each organization's practices and activities from the incident occurring through to the last injured mineworker being transported to the hospital. This flow chart was further used as a tool to analyze collaborative challenges and to find solutions. Identified collaborative challenges included that the rescue service was perceived as having the main responsibility of the rescue operation and that each organization mainly considered their own organizational tasks. How the environment or the task at hand would necessitate modifications of the rescue operation was less discussed, and the mining organizations, for example, considered that their task was to accommodate the needs of the rescue service. Further, the EMS worked according to a pre-hospital management concept that assumes direct access to the injured and therefore were not prepared for rescue operations in which they might not have the possibility to access the injured for several hours.

3.3. Modeling New Tools for the Exercise

During the iterative process of meetings and exercises, the exercise organizers continually tried to find solutions to the identified problems with the rescue operation practice. They gradually created several tools—including a modified first-aid course for the mineworkers, an emergency management template, and an educational video—in order to facilitate the participants' ability to collaborate during the full-scale exercises.

The tool of a modified first-aid course, with a checklist for the systematic examination of an injured peer and guidelines for care and communicating injury information, was developed. The exercise organizers developed the modified first-aid course because they recognized the necessity of the mineworkers to be qualified specifically in how to care for severely injured peers underground until being rescued. The mineworkers had taken a commercial first-aid course, but the environment and their prolonged responsibility for their peers called for the development of the course. The modified first-aid course was also developed due to the exercise organizers realizing that, in order to make the exercise rescue operation of the injured mineworkers more realistic, a medical dimension needed to be added to the rescue service focus. The rescue service focus during the exercises was noticed in the unrealistic acting of the mineworkers. They waited passively until being rescued and were walking even though they were supposed to act as though they had fractures in their lower extremities. Thus, when the mineworkers were educated in the modified first-aid course they became active participants in the exercises. The injured mineworkers were instructed to not only call in the alarm of the incident but also start to act as they would in a real fire emergency. They self-escaped to a rescue chamber and there they would be helped by a peer. This meant that the mineworkers had to give first aid and care for the injured mineworker until being rescued as they would in a real event.

The exercise organizers also developed a tool of a joint emergency management template due to the realization that when the complexity of the scenarios increased, the rescue operation managers had difficulties in creating a shared situational awareness. They observed that this also became obvious to the managers themselves, who drew up a simple table to get an overview of the injured and injuries. Therefore, the exercise organizers gathered and, in several iterations, developed an emergency management template in order to increase transparency and to create common situational awareness among the managers of the rescue operation. The emergency management template tool was also complemented with a course for the managers of the mining organization.

The tool of an e-learning educational video, in order to create a common understanding of each other's structures, terminologies, and tasks during a major fire incident, was also developed by the

exercise organizers. They had observed that the managers of the rescue operation did not collaborate in an optimal way and even made mistakes during the full-scale exercises. For example, during one of the exercises, the EMS managers were directed by the mining managers to the casualty collecting point and therefore were delayed in reaching the emergency operations center where the other organizations' managers were located. The mining managers had limited knowledge about the EMS organization and management structure and did not know that the first arriving EMS unit primarily has a managerial responsibility. The exercise organizers thus realized that the organizations' lack of knowledge about each other's tasks limited their collaboration.

3.4. Examining and Testing the New Practice for Exercise

The exercise organizers constantly evaluated and developed the tools during the progress of the project. For example, they developed the emergency management template when they observed that the rescue operation managers made different interpretations about what they were supposed to write on the template. The introduction of smaller rehearsal exercises focusing on the responsibilities of the managers of the rescue operation also made it possible for the exercise organizers to solve some of the identified challenges prior the full-scale exercise, for example, that there were too many people in the rescue operations center, which led to a noisy environment. The exercise organizers, therefore, instructed the rescue operations managers to start using headsets with their communication devices and also started to consider which managers needed to be in the rescue operations center and who could work in adjacent rooms.

The exercise organizers examined the new solutions for the rescue operation comprehensively and critically. They worked toward reducing the time of the rescue operation in order to make sure the injured mineworkers reached definite care as soon as possible. The exercise organizers also discussed whether the EMS personnel could enter the mine during a fire. This discussion related to the conflict between the safety of the EMS personnel and the medical needs of the injured mineworkers. The exercise organizers solved this by arguing that the managers would have to consider the circumstances of each specific incident. They further argued that if it is impossible for the EMS personnel to enter the mine, they are nevertheless responsible for the injured mineworkers and should be actively involved in the planning of the rescue operation.

3.5. Implementing the New Practice in the Exercise

The full-scale exercises were planned and performed in-between the collaboration meetings, which made it possible for the exercise organizers to test and modify the new tools, practices, and equipment for the rescue operation. The implementation of new tools and practices was an iterative process, where the implementation of one tool or practice led to certain improvements and highlighted new challenges that called for the development of yet another solution. For example, the development and implementation of the modified first-aid course led to more complex injury scenarios, which led to the development of the emergency management template. During the course of the project, the exercise organizers continued their learning process, and the scenarios of the exercises rapidly increased in complexity. The participants of the exercises, being educated in the new tools and practices between exercises, managed the increased difficulty of the scenarios. Initially, the smoke-divers aimed at rescuing confined uninjured mineworkers from one rescue chamber. Later exercises included scenarios with a long-distance smoke-diving operation involving prioritization of two rescue chambers with severely injured mineworkers within them while the Medical Incident Commander communicated with the mineworkers who were helping their injured peers.

3.6. Reflecting on the Process of Developing a New Practice

During the course of the project, the exercise organizers also started to change focus—from primarily prioritizing their own organizational objectives, they started to see how their organizational objectives contributed to the collaborative process necessary during the full-scale mining exercises.

This was evident in the evaluation reports of the exercises. In the beginning, there were few and very technical rescue service evaluation reports of the exercises. In the last of the included exercises in this study, a broad range of evaluation reports from all of the organizations, evaluating both technical, operational, and organizational aspects, were included. One of the most important realizations was that the exercises, while becoming more complex, also directed more of the attention toward the injured/non-injured mineworkers. The exercise organizers started to think, for example, about what to do if there were several injured mineworkers located at different places in the smoke-filled mine. Who should be prioritized and why? The exercise organizers realized the importance that all three organizations shared the discussion on priorities and that the prioritization was done in collaboration. The mining management has to contribute with their knowledge about the mine layout, the rescue service has to combine this knowledge with their practical knowledge about the feasibility of the rescue operation, and the EMS should give their medical prioritization of the injured and be able to explain the medical consequences of the different rescue operation choices.

The prioritization discussion highlights the possibly extensive time it will take until the injured mineworkers are rescued during major fire exercises. The tool of a modified first-aid course was also developed because the exercise organizers realized that the uninjured peers in the same rescue chamber have to be able to take care of the injured mineworkers until being rescued. The uninjured peers are thus a resource for the EMS managers if the mining communication system is operational. The Medical Incident Commander gathers information from and helps the uninjured peer in a structured way but is also able to prioritize between the injured mineworkers. This was an issue during some of the exercises, and the exercise organizers stated that the uninjured mineworkers had to give all the information and the Medical Incident Commander did not ask enough or the right questions. Therefore, the EMS exercise organizers had to modify their protocol of questions to match the modified first-aid education given to the mineworkers. However, the exercise organizers also highlighted the need of the uninjured mineworkers to receive psychological support and information about the progress of the rescue operation from the EMS.

The benefit of performing full-scale exercises was also that the exercise organizers learned the practicalities and logistics of performing a rescue operation in an extreme environment. They had to continually evaluate the necessary equipment and resources. An example of equipment that was developed and refined throughout all of the 11 exercises is a rescue carriage, which could transport both the rescue services' equipment and immobilized injured mineworkers in the smoke-filled tunnels. Another challenging aspect of the rescue operation concerned communication. Because the common emergency organization communication system was not operable in underground mines, they adopted the mining communication system. However, the exercise organizers then observed that this led to operative and collaborative issues during the exercises, e.g., the number of necessary radio frequencies.

3.7. Consolidating and Generalizing the New Practice

During the progress of the project, the exercise organizers adjusted the rescue operation practice for major fires in underground mines. They developed new knowledge and tools regarding what worked during the full-scale exercises and implemented those during the next exercise, or adjusted aspects that they evaluated needed improvement. Therefore, the rescue operation practice for major fires in underground mines was constantly changing and improving, becoming more and more comprehensive. The process also led to organizational development. The exercise organizers from the mining companies had to develop their own emergency command structure, with the preparedness to answer all of the requests from the emergency organizations and at the same time having the overall responsibility for their personnel and the mine. The exercise organizers from the rescue service also had to develop their own practices and to develop plans to conduct the rescue operation as effectively as possible by, for example, utilizing reconnaissance teams from the part-time rescue service arriving first to the mine. The complex rescue operation tended to make the planning process too excessive, which slowed the progress. The exercise organizers from the EMS also had to create new

practices, develop mining rescue operation plans and adapt their management structure to conform to the complexity of the environment, for example, the location of the Medical Incident Commander was evaluated by the exercise organizers. The Medical Incident Commander should be as close to the injured mineworkers as possible but loses touch with the progress of the rescue operation when located in the mine. Therefore, the Medical Incident Commander was located in an adjacent room to the emergency operation center in order to be able to stay in touch with the progress of the rescue operation as well as with the mineworkers helping the injured.

4. Discussion

In this study, the learning process of the exercise organizers of major fire emergencies in underground mines was examined through the use of the cycle of expansive learning [29]. The results in this study presented the process that started with the major underground mine fire incident in 2013 and up to the end of 2018. During this period of time, the exercise organizers not only realized the difficulty of managing major fire incident scenarios but also made progress in improving the rescue operation practice. This was a continuous process and is an example of expansive learning [29] because the methodology of performing exercises in underground mines was not pre-existent in this context.

In this study, analyzing the material according to the cycle of expansive learning, the results showed that collaboration meetings in combination with the full-scale exercises developed the foundation for a new exercise concept. This is in line with other authors' [37] argument that exercises can be positive learning opportunities for organizations. A positive learning opportunity can be facilitated if the involved managers question the current emergency management practices and work toward developing a new and more comprehensive approach [37].

The results showed that the exercise organizers were influenced to identify collaboration challenges within the current response during the collaboration meetings. In line with what other authors [22] report, the exercise organizers in the present study had to be interested in understanding the other organizations' tasks and responsibilities during rescue operations. The collaboration meetings improved the participants' understanding of the complex situation, allowing them to discuss challenges and find solutions as also described by others [1,22]. Thus, including collaboration meetings between the full-scale exercises can motivate the exercise organizers to consider full-scale exercises from the other organizations' perspectives.

The results also indicated that the collaboration meetings in combination with the full-scale exercises also were helpful for the exercise organizers to practically examine the tools and practices they had developed. This can be compared with the implementation of collaborative elements into exercises, such as the reflection seminars, to facilitate learning as recommended by other authors [22]. In this study, the combination of collaboration meetings and practical exercises influenced the exercise organizers to identify needs and challenges of various activities, as well as possibilities to develop and test new tools to support collaboration and the development of new knowledge of how to conduct rescue operations in underground mines. Thus, a productive approach for sustainable organizational learning, as in our study, is the combination of the collaboration meetings where the tools are modeled and examined and thereafter implemented in full-scale exercises. The tools evolve as they are implemented [30], which was also the case in our study. The exercise organizers evaluated and modified the implemented tools iteratively during the following collaboration meetings and full-scale exercises. Thus, even though significant time and resources were spent on this iterative process, this process may still induce a sustainable organizational learning process.

The results of this study showed that the increased realism and complexity of the full-scale exercises resulted in the exercise organizers realizing that there was a need for the development of new solutions for the rescue operation. The exercise organizers did not have a finished instruction for how the participants ought to respond in order to rescue the injured mineworkers, except for following the practices of their respective organizations. This meant that the exercise organizers had the opportunity to observe the participants as they responded to the presented challenges. The exercise organizers

could thereafter further develop the ideas of the participants and develop tools to facilitate the rescue response. Furthermore, the participants were educated in the new tools and practices between exercises, which also helped the participants manage the increasing difficulty of the scenarios. This is in contrast to the results of other authors [19] who mentioned that, in general, participants who attended several exercises considered that they did not learn anything new during the exercises. However, the participants of the exercises in this study also had great power to influence the development process, and the exercise organizers did not just observe the participants, but they also asked the participants to evaluate the exercises and to reflect on identified issues. This is supported by other authors [19] who recommend that exercise organizers focus on collaborative learning during exercises, where the participants are forced to improvise when they encounter variations of the scenario and the unforeseen.

4.1. Learning the Importance of Including the Mining Organization as an Equal Responder in the Rescue Operation

As a result of the learning process of the exercise organizers, the mining organization became an active participant of the exercise rescue operation practice. The exercise organizers realized that the mining organization has an important responsibility in the exercise rescue operation because fire incidents are located within a complex industrial context that the emergency organizations are not accustomed to. This complexity might necessitate collaboration [18,38]. However, in our study, the exercise organizers also recognized that the mining personnel were not as accustomed to managing emergencies as the rescue service and EMS personnel were. Thus, all of the developed collaboration tools can support the workers and managers within the mining organization. The modified first-aid course prepares the mineworkers for helping severely injured peers and for keeping the EMS managers informed during major incidents. The emergency management template aids the mining managers as active participants during the rescue response, and the educational video informs the mineworkers of the organizational structure and responsibilities of the rescue service and EMS. This can be compared to another exercise study [39], which showed that the organizations involved in a rescue operation at an elderly care center had different understandings of the emergency situation and that the rescue operation experiences of the police and rescue service personnel were complemented by the contextual experience of the elderly care personnel. However, the management of the rescue operation was, in general, handed over to the emergency organizations [39]. In our study, this was exemplified in the analysis of the present practice of the rescue operation by the mining personnel thinking that their main objective was to accommodate the needs of the rescue service and thus handed over most of the responsibility to the emergency organizations.

In the study mentioned above [39], the rescue operation was analyzed to have been more efficient if the emergency organizations had collaborated more with the elderly care personnel and had adapted their practices to the situation. The findings in our study showed similar outcomes. In the beginning, the mining organization mainly considered their responsibility to be to accommodate the rescue service's needs, but in the new consolidated practice for rescue operations, the mining organization had their own management structure and equal responsibility for the rescue operation. This is supported by other authors [21] who state that giving each organization specific meaningful tasks can increase organizational involvement in full-scale exercises. The increased participation of the mining organization perhaps also led to one of the most important realizations of this study. The exercise organizers reflected on the change of focus of the exercises, from the perspective of the rescue service in just carrying out a rescue operation to taking the perspective of the injured into consideration.

4.2. Methodological Considerations

This study had several benefits and limitations. The most important benefit of the study was the illustration that the learning process of the exercise organizers led to sustainable organizational change. Other benefits of the study included the comprehensive material gathered from all of the exercise organizers and from several consecutive exercises and collaboration meetings. This is an

example of triangulation of the gathered material that increases the credibility of the study [40,41]. The specified inclusion and exclusion criteria, i.e., collaboration and the application of the theory in the analysis, accounted for the confirmability of the study [40,41]. Using the theory of expansive learning as a theoretical framework for the study helped to visualize and organize the learning process of the exercise organizers. The application of the cycle of expansive learning has not previously been used to analyze the iterative learning of exercise organizers, and this study can thus be seen as a contribution to the research field. By using the theory of expansive learning, it is also possible that the transferability and dependability of the study were increased [40–42].

The limitations of the study included the risk of confirmation bias [42], meaning only including information that is in accordance with the theory. To minimize the risk for this, the research team thoroughly discussed the application of the theory on the comprehensive available material for this study. When the material was analyzed in chronological order the cycle of expansive learning can be argued to loop several times in various ways, for example, when a new tool was implemented during a full-scale exercise and later consolidated while at the same time new challenges were identified. Nevertheless, this process would have been too tedious to report and the material was therefore divided based on the content and meaning of the text and on the learning of the participants. Although this approach was used, progress can still be discerned when reading the results section.

5. Conclusions

In this study, a tentative model for the development of a learning process of the organizations' exercise organizers during a set of collaboration meetings and full-scale exercises was developed, which was illustrated through the cycle of expansive learning. Through a combination of collaboration meetings and full-scale exercises, the exercise organizers were able to iteratively question and analyze the current practice of the rescue operation; to develop, test, and implement new practices and tools; to reflect on the process; and to consolidate the new practice. During the learning process, several of the steps of the cycle of expansive learning were revisited. Thus, the iterative combination of collaboration meetings and full-scale exercises led to sustainable organizational change. The strength of the combination of collaboration meetings and full-scale exercises was that the exercise organizers learned to visualize and take the other organizations' perspectives. The iterative process in which the lessons learned from one full-scale exercise were implemented during the next also meant that the exercise organizers did not have to start from the beginning each time they planned a new full-scale exercise, which in itself reduces the costs and time of full-scale exercise planning. Thus, the use of a combination of collaboration meetings and full-scale exercises with the steps of the cycle of expansive learning in mind could well be utilized in the learning process of exercise organizers as they develop their rescue operation practice. More research is needed to determine if this is an efficient way of developing the learning of exercise organizers in order to develop both the full-scale exercise practice and their organizational preparedness.

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