

# An innovative methodology for the assessment and maintenance of e-learning courses using the Community of Inquiry model

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**ABSTRACT:** As part of the creation of the series of online, asynchronous learning courses developed for the community of underground ventilation practitioners (Aeolus Modules), the authors have developed an innovative plan for the assessment and maintenance of these courses by leveraging the skills and experience of the existing and active membership of the Underground Ventilation Committee and applying them to the Community of Inquiry model. This process involves the triggering events of the module users (students) to identify weaknesses and deficiencies within the course(s) material, and to guide the development of additional content, while expert users and course developers use the learners' inputs to make necessary revisions and create new and expanded content in the most efficient manner. By working together, and communicating directly through a framework established explicitly for that purpose (i.e., listserves, chatrooms, direct messaging, etc.) the process of content revision and creation can be optimized by letting the end user directly communicate their needs to the developers and become active participants not only in the consumption, but in the creation of their own educational resource(s).

## 1 INTRODUCTION

While it is generally well accepted that engineers have a crucial part to play in society, their function is changing, reflected in roles that are held by practicing engineers and the expectations placed on them by employers, clients and society at large. This places the state of engineering education also in flux, although some might argue that it has always been so. Previous authors have noted that this has been recognized officially by many of the formal agencies and societies responsible for directing, governing and accrediting programs of study in the engineering disciplines, as many have formally sought to change their focus from knowledge-based measures of competency to outcome-based metrics (Walther, et al, 2011).

As long as working professionals continue to need to balance the demands of work, family, and school, they will continue to value online learning. Instructors are challenged to develop vibrant learning communities in their online courses, to provide students with a variety of instructional and assessment strategies to meet their varied learning styles, and to make meaningful and timely feedback an important element of their courses.

Despite the proliferation of online, asynchronous learning courses over the past twenty years, there remains a significant gap in the mining industry between the essential resources that have been identified by mining companies and what can be provided by the existing network of internal (corporate training) and external (technical schools and universities) educational providers. (Hairfield & Wallace, 2006), (SME, 2016) Outside of the university setting, significant obstacles to continuing education remain, including time, cost and accessibility (e.g., language) of available options.

Beyond the simple expansion of available options and accessibility, a further challenge remains; to leverage emergent technologies and even philosophies to provide the end users with true agency and autonomy over their own personal education. A primary question is how to maximize the efficiency of the experience by allowing each individual user to first identify, and then access only the content that is useful to them, while simultaneously winnowing or eliminating any irrelevant information. Ultimately, this is the challenge that inspired the development of the Aeolus educational modules for subsurface ventilation engineers.

## 2 BACKGROUND AND PREVIOUS WORK

It has been well established that the pace of change with regard to information and communication technology (ICT) has accelerated rapidly over the past several decades, providing instructors and students with a greater array of resources than ever before, especially with regard to distance-learning and e-learning course development (Hase, 2009). However, in order to successfully leverage this new technology for building a distance learning course for professional engineers within a specialized field (although the process can be applied to a wide range of technical and vocational education curricula) it will be necessary to consider not only how the course will be designed, facilitated and assessed, but also the underlying methodology of instruction, and how modern students will best respond and interact with asynchronous online educational courses on a fundamental level. All of these considerations were addressed, first individually, and later collectively during the process of designing and deploying the Aeolus Modules for Mine Ventilation Professionals (Stinnette et al, 2017).

In order to fully realize the benefits of e-learning with a student-centered approach, the architecture of any online educational modules or courses must be carefully considered. As we have previously discussed, it is not sufficient to simply copy the successful deployment of traditional educational courses and format them for online consumption. From the beginning the Aeolus modules were considered to be wholly new educational entities, leveraging the most effective strategies for curriculum content and physical delivery designed to be consumed as a series of asynchronous online modules.

Online courses are also notoriously difficult to assess (Gaytan &McEwan, 2007), particularly in cases where the successful completion of the course is measured in real-world, professional outcomes that exist far outside of the confines of the course and may be difficult to recreate. For this reason, assessments should include more than just conventional metrics of memorization and recall. In cases where the courses are specifically for professional development, and not associated with any specific program of study, or accredited system of education, the difficulties of knowledge assessment are even more pronounced. In order to specifically address this issue, the student participation and growth throughout the learning process should be evaluated and included in any rubric for knowledge appraisal, where possible. Noting that participation is key for both students and instructors, some experts have called for e-learning evaluations to focus heavily on activity-linked assessments (Macdonald, 2002).

As of 2016, online courses represent 32% of higher education enrollments, an increase of almost 5% over the previous four years, and trending upwards (Seaman, et al, 2018). Recognizing this trend, study, and analysis of these types of courses has also increased. Many of these studies include the meta-analysis of many courses and interviews with many successful online course instructors and authors. As no set criteria or conceptual framework for all successful online courses exists (nor likely could exist), analyses of these types are helpful in illuminating the various commonalities of courses that have been recognized as superior by instructors and students alike.

One such study of award-winning online courses has identified three critical and sustaining structural components of many effective online courses that were studied; design, assessment & evaluation, and facilitation (Martin, et al, 2019). Noting that while there was no current agreement or compilation of best-practices in course design, many of the best online courses were

based upon established online models such as the “Community of Inquiry” and “Cognitive Load Theory”.

### 3 COMMUNITY OF INQUIRY (COI)

The Community of Inquiry, or COI from henceforth, in particular provides an educational model that is not only proven successfully in the implementation of many online or computer-based courses targeted at the post-secondary/professional level, but also particularly suited to the unique combination of stakeholders and resources represented by the proposed Aeolus modules. At the core of the COI are three fundamental components, first identified by the term’s original authors; cognitive presence, teaching presence and social presence. (Garrison, et.al, 2000) Educational experiences are said to occur at the intersection, or overlap of these elements, as illustrated on Figure 1.

Note that these three essential elements are not exclusively within the provenance of online educational scenarios, and in fact, significant care and attention must be taken when designing effective online educational experiences to ensure that each component is present and functional. Challenges exist in particular, with incorporating a successful social presence and teaching presence, although research shows that when implemented correctly, successful educational outcomes are not only possible, but in many cases, enhanced.

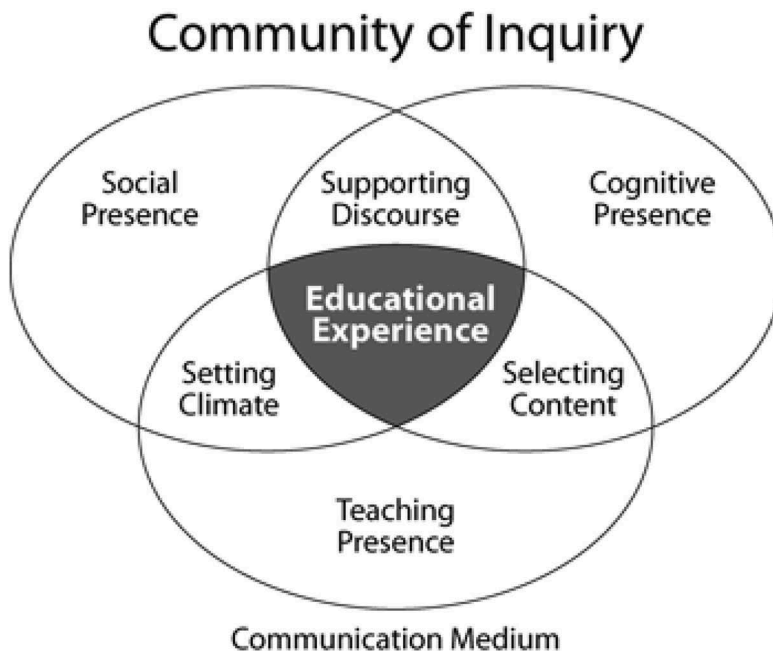


Figure 1. Elements of an Educational Experience as defined by Garrison, et. al., 2000.

### 3.1 *Cognitive presence*

Cognitive Presence is most often considered the most essential component of a higher education experience, here chosen to represent the ability of course participants to produce meaning through continuous communication within the educational environment. Cognitive presence is a vital component of critical thinking, which should be the goal of all higher educational activities.

### 3.2 *Teaching presence*

Social Presence, in the context of the COI represents the ability of the course participants to project their personal characteristics within the educational framework, or architecture of the course, and thus present themselves as individuals, with unique traits, strengths and weaknesses. Social presence, to the extent that the users feel engaged and rewarded personally through their online interactions has been demonstrated to be a significant contributor to successful online courses. (Anderson, et. al., 1999).

### 3.3 *Social presence*

The final essential element of the COI is Teaching Presence; defined by Garrison as the responsibility for course design and facilitation. It should be also be noted that this is a role which can often be shared with great success, particularly in the context of higher education, where the distinctions between teacher and learner may be the slightest and most nebulous.

## 4 ADAPTING THE COI MODEL FOR PROFESSIONAL EDUCATION AND E-LEARNING

Effective online assessments should include a wide variety of clearly explained assignments on a regular basis. Feedback is also a critical component on online assessment. It must be meaningful, timely, and should be supported by a well-designed rubric when possible. The assessment value of e-mail messages, chat room conversations, and discussion board postings should not be ignored as they provide opportunities for the instructor to learn whether the students understand the instruction and are correctly interpreting the assessments. Effective assessment techniques, as perceived by faculty and student respondents, include projects, portfolios, self-assessments, peer evaluations, weekly assignments with immediate feedback, timed tests and quizzes, and asynchronous type of communication using the discussion board. The use of rubrics to aid the assessments and to provide meaningful and quick feedback is valued by instructors and students alike. Other e-learning professionals have also highlighted the importance of developing clearly defined rubrics for student evaluations (Christopher, et al, 2004), and have argued that that rubrics must be carefully prepared to assess learning and promote critical thinking (MacKinnon, 2002).

In order to effectively monitor the communications of active community members, Garrison et al have developed a coding template for evaluating the presence of each of the three pillars of an active COI that have proven useful in assessing the effectiveness of online, text-based environments, and reproduced in Table 1.

These indicators will be utilized by the Aeolus module administrators to “take the pulse” of the Aeolus users and to intervene in an efficient manner if it is discovered that any of the three pillars of the COI are deficient.

One other function of student assessments that is sometimes overlooked by instructors and facilitators of e-learning courses is the ability to guide the internal quality assurance process, whereby deficiencies or weaknesses in the existing course can be identified and corrected. Student assessments in this context, can serve as a compass, guiding further development or correction as necessary to improve the course and make it even more effective at meeting the desired outcomes of students.

Table 1. Community of Inquiry Coding Template (Garrison et. al., 2000).

Elements	Categories	Indicators (examples)
Cognitive Presence	Triggering Event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Applying new ideas
Social Presence	Emotional Expression	Emoticons
	Open Communication	Risk-free expression
	Group Cohesion	Collaboration
Teaching Presence	Instructional Management	Defining & initiating dialog
	Building Understanding	Sharing personal meaning
	Direct Instruction	Focusing discussion

## 5 ADAPTING THE COI MODEL FOR PROFESSIONAL EDUCATION AND E-LEARNING

Based on the COI model, it is the Social Presence and the Teaching Presence that represent the greatest challenges for online, asynchronous content. The twin challenges of how to engage online learners and instructors together to identify, provide and assess the content required to optimize the transfer of knowledge in this case can both be satisfied by the incorporation and reapplication of one of the oldest and most respected sources of knowledge within the industry- the Underground Ventilation Committee of the SME.

The UVC, has for decades served as an aggregator and disseminator of technology and innovation for the community of ventilation engineering professionals around the world, but particularly in North American and Europe, where it is the predominant authority in this field (in comparison to the MVSSA in Africa and the AUSSIM in Australia). Through its bi-annual Mine Ventilation Symposium, the largest and best attended event of its type, the UVC continues to provide a platform for the publication of technical papers and presentations that represent the cutting-edge in underground ventilation engineering. The UVC online community forum, previously a standard email listserve, has also provided a forum through which members can reach out to the community of ventilation practitioners at large and seek advice, or provide new insight to problems faced by the industry, or sometimes, both. Although not as widely utilized as it once was, (SME, 2020) the UVC listserve still represents the most complete and viable current example of social presence in the field of underground ventilation, with over 250 members worldwide.

The demographics of the UVC, is primarily what makes it so particularly well-suited to serve the community in this fashion; its members range in age from university students to retired and emeritus members, in knowledge from novices to experts, and with backgrounds in Academia, Industry, Product Manufacturing, Regulatory bodies and Research. In short, its membership already represents every required role for the successful implementation of a COI model in the deployment or facilitation of an online educational resource. By leveraging the knowledge of the existing community and its existing pathways for communication, it will be possible to provide the required social interaction and teaching presence that is necessary to optimize the learning process for each individual user. Consider the following example:

Subject matter experts within the community identify essential and relevant content for ventilation practitioners and publish interactive online educational content (Aeolus modules). Learners seek out the Aeolus modules relevant to their particular and individual interests (cognitive presence) and complete the relevant courses online. Based on individual needs, learners can request improvements to the course content both directly and indirectly (through pre- and post-course surveys) or by e-mailing the course administrator(s) (cognitive and social presence). Requests can also be made publicly, through email with subject matter experts (teaching presence) or through the listserve or a chatroom set up for that purpose within each module (social presence). The course administrator(s) will have responsibility for identifying

deficiencies in the body of knowledge represented by the courses through the in-course assessments (competency) of the users and through the requests and participation of those engaged in the chatroom or listserv conversations (cognitive, social and teaching presence). Once needs are identified, subject matter experts will be identified and charged with providing additional content, which will then be incorporated into updated modules and content that is posted to the user (social and teaching presence). Once the new content is posted, the entire process will repeat itself.

The identification of a framework for ownership and maintenance ensures that the program is capable of being continuously modified and improved to meet the needs of industry professionals long into the future. This synthesis with the largest community of active ventilation professionals is a key component of the Aeolus implementation strategy, and will allow the existing social presence provided by the Underground Ventilation Committee of the SME to combine with the cognitive presence of the Aeolus users and the teaching presence of the Aeolus administrators to form a competent Community of Inquiry, an essential component of any successful asynchronous online educational platform. The modules are designed to exist as dynamic and evolving entities that are updated as new technology and practices are established in a continuous feedback loop. Course users are expected to identify deficiencies in the content and organization of courses, which is then passed on to the course administrator(s) where it can be corrected with the input of subject-matter experts from within the community of active professionals. The revised course content can then be peer-reviewed within the community before being updated for course users (learners) online. This process is expected to be iterative, and continue as long as the modules are being used. Owing to the nature of the process, and the ease with which individual modules can be updated by the administrators, it will be possible to identify course weaknesses and add or correct content within Aeolus much more rapidly than is possible with traditional textbooks.

## 6 CONCLUSIONS AND RECOMMENDATIONS

The content for the course modules was carefully curated by experienced practicing professionals who utilized their decades of experience in the field in conjunction with strategic partners on six continents to identify core knowledge principles and leading practices to incorporate into the twelve original Aeolus courses. Course architecture was based upon leading theories of online, asynchronous learning, which were incorporated as applicable. Designed to allow competent, adult users to direct their own learning pathways with regard to subject matter and depth as well as time and schedule, the concept for Aeolus was guided heavily by the principles of Heutagogy. Practically, the modules were designed to synthesize the social, cognitive and teaching presence required to form a Community of Inquiry. Competency and knowledge retention by users can be monitored, both internally (by the users themselves) and externally (by the course administrators) through the quizzes that are included at the conclusion of each module. These courses were further refined through a review process that included scrutiny by subject-matter experts as well as neophyte learners, with comments and suggestions from each group utilized to guide revisions to the subject matter and organization of the Aeolus modules.

The outlined strategy for a series of interactive and asynchronous educational modules serving the underground ventilation community provides a workable solution to one of the most prominent and potentially crippling problems currently faced by the mining industry, and specifically the field of underground ventilation. By maintaining high standards in the identification of technical subject matter, pedagogical strategy and content delivery, it is hoped that the modules will be adopted and incorporated by industry professionals across various backgrounds (i.e. academic, regulatory, and industrial/technical) and experience levels from novice to expert. If it is widely incorporated and utilized, it has the potential to be a transformative educational innovation that can provide educational resources to the widest possible range of learners in an under-served and under populated, yet critically important field within the mining industry.

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