American Journal of Qualitative Research
2022, Vol. 6 No. 2, pp. 65-92
https://doi.org/10.29333/ajqr/12127

AMERICAN JOURNAL OF QUALITATIVE RESEARCH

ISSN: 2576-2141

Openness in Occupational Hygiene Professional Development

Morgan M. Bliss[1]
University of Maryland Global Campus, USA

ABSTRACT
Continuing professional development is a foundational aspect of professionalism in health-related disciplines. For board-certified industrial/occupational hygiene (IH/OH) professionals, professional development is mandated as part of the code of ethics for practice. However, board certification in IH/OH and occupational health and safety is not required for professional practice in many countries, including the United States. This qualitative study involved a hermeneutic phenomenological approach to the lived experiences of IH/OH professionals who engage in professional development in the United States. This study was conducted to better understand the role of openness in IH/OH professional development, including the use of open educational resources (OERs) and open educational practices (OEPs) and the level of learning desired by IH/OH professionals who complete continuing professional development. Participants (n=11) were IH/OH professionals who engage in professional development and live and work in the United States. A 10-question semi-structured interview was conducted via Zoom regarding IH/OH experiences with professional development. A thematic analysis of interview transcript data was performed. The results provide insights about openness in the IH/OH professional community and how OERs and OEPs might be used for professional development. Findings revealed that IH/OH professionals may be reluctant to embrace the concept of openness, due to the potential financial impact on professional organizations, and indicated that the IH/OH community may not be ready for a public open scholar at this time. The aspect or level of learning desired by IH/OH professionals was also heavily linked to the career stage of the individual. There is a need for research to further explore the continuing professional development needs of early career and mid-career IH/OH professionals. This study provides opportunities for further study about openness in professional development for general occupational health and safety professionals, although this population is difficult to define or set parameters for.

KEYWORDS: Career stage, learning transfer, industrial hygiene, occupational hygiene, professional development.

Industrial/occupational hygiene (IH/OH) professionals are encouraged to engage in continuing professional development to maintain board certifications and participate in lifelong learning (American Industrial Hygiene Association, 2018). There is limited existing research on professional development in IH/OH, and the available literature focuses more on potential new topics for professional development rather than on perceptions or motivations to complete continuing professional development. Openness in the context of this study refers to open content, open educational resources (OERs), open educational practices (OEPs), and other

[1] Corresponding Author: Collegiate Professor, School of Arts & Sciences at University of Maryland Global Campus, USA. E-Mail: morgan.m.bliss@gmail.com

resources provided with an open license (Wiley, 2014). Improved methods of and access to professional development in IH/OH are needed to ensure a sufficient supply of IH/OH professionals are available (Scott et al., 2019).

Continuing professional development is intended to lead to transfer of learning into practice (Curran, 2014; Thalheimer, 2018). Individual learning transfer through professional development can have effects on the learner, their coworkers, the organization, the profession, and society (Chatterjee et al., 2018; Thalheimer, 2018). The Learning Transfer Evaluation Model (LTEM) is intended to be used for workplace learning and development (Thalheimer, 2018). LTEM includes recommendations to evaluate learning for decision-making competence, task competence, transfer of learning, and effects of transfer (Thalheimer, 2018). There is no existing research about evaluating the effectiveness of learning transfer for professional development in IH/OH.

Wiley (2014) developed the 5Rs of openness: the individual rights to retain, revise, remix, reuse, and redistribute learning materials and other content. Researchers in public health and health sciences education have already recognized the value of OERs and OEPs for continuing professional development, especially the potential for supporting a community of practice among practitioners (Hemingway et al., 2011; Windle et al., 2010). A key component of openness is that the work is in the public domain or licensed in a way that anyone can use the resource in the way that best fits their learning needs (Wiley, 2014). Openness supports the goals of open education: to share resources, tools, and practices to improve access to and effectiveness of education for a diverse and collaborative audience (Open Education Consortium, n.d.). Community stakeholders, such as field practitioners or industry professionals, can provide academics with information about OERs that may have been used in practice or professional development (Nguyen-Truong et al., 2019).

A new public open scholar role was recommended to include online curation of OERs and OEPs, especially those developed by professional associations, government, and other organizations, to improve the discoverability and use of available content (Perryman & Coughlan, 2013; Perryman & Coughlan, 2014). OERs and OEPs have been recommended for use by health professionals for continuing professional development to provide access to high-quality resources, but there is a potential concern that the available resources may not be updated frequently enough to reflect changes in practice (Coughlan & Perryman, 2015).

The current study provides the perspective of IH/OH professionals on openness in continuing professional development, benefits and weaknesses of OERs and OEPs, and use of the LTEM framework for evaluating professional development. The study is also an exploration of the application of the public open scholar role to the IH/OH community.

This study aimed to answer the following research questions:

1. What is the role of openness in IH/OH continuing professional development?
2. How can OERs and OEPs be used for IH/OH continuing professional development?
3. What are the perceived benefits and weaknesses of OERs and OEPs in IH/OH continuing professional development?
4. What level of learning is desired by IH/OH professionals engaging in continuing professional development?

Methods

A qualitative study was conducted to address the gap in knowledge about IH/OH professionals' reasons for completing continuing professional development and assess their interest in using OERs and OEPs for professional development. A hermeneutic phenomenological approach was used to explore the experiences of IH/OH professionals. This

study was a necessary preparatory step to identify the IH/OH community's readiness to engage with a public open scholar and with OERs and OEPs for professional development.

Participant inclusion criteria consisted of the individual being an IH/OH professional in the United States who participated in continuing professional development. This target population was selected because the primary certification board for IH/OH professionals, the American Board of Industrial Hygiene, is based out of the United States. Individual participants were recruited via the social media platforms of LinkedIn and Twitter, drawing from IH/OH professionals who were connected to the American Industrial Hygiene Association (AIHA) or American Society of Safety Professionals (ASSP) through the Industrial Hygiene Practice Specialty.

The two instruments used in this study were an online demographic survey (see Appendix A) and semi-structured interviews (see Appendix B) conducted via videoconferencing due to COVID-19 workplace protections. Limited demographic information was collected from participants prior to scheduling the interviews via a Qualtrics (2020) survey.

The sample population was selected using purposeful sampling to ensure that information-rich, narrative data was collected from interview participants, to give an emic perspective about IH/OH professional development. Purposeful sampling ensured the participants were sufficiently knowledgeable with IH/OH professional development and able to provide relevant and reflective responses. After recruitment via social media and the researcher's extensive professional network of IH/OH colleagues, semi-structured individual interviews were scheduled.

Instrumentation used in this study was developed by the researcher and was unique to this study. Interview questions were revised by the researcher based on feedback from subject matter experts. If the participant was uncomfortable with an audiovisual recording, only an audio recording was collected and stored via the videoconferencing platform (Zoom Video Communications Inc., 2020). If a participant did not self-select a pseudonym, the researcher assigned them one from a random name generator.

The interview transcripts were drafted by importing the audio portions for each interview into NVivo for Mac (QSR International Pty Ltd., 2020). Transcripts were confirmed by the researcher by re-listening to the interviews and double-checking the transcript for accuracy. If requested by the interviewees, transcripts of the interviews were provided for review and comment, to ensure the transcript was accurate and reflective of their experience.

Data analysis involved a content analysis approach using themes and coding. The researcher used NVivo for Mac for the initial theme identification, coding, and final analyses. The NVivo for Mac software allowed for both video and audio analysis (with data encryption) and allowed the codebook to be exported (QSR International Pty Ltd., 2020).

After the preliminary analysis of interview transcripts was completed, the researcher contacted two of the interview participants to validate the initial findings for themes and coding as applied to their individual interviews; this action improved the dependability of the study findings. Triangulation of data was accomplished by using the demographic information to confirm whether a respondent was part of the population to be studied, thus increasing the credibility of the study findings.

The researcher also kept a research journal during the data collection, analysis, and interpretation, to explore personal biases and assumptions about the research topic, and to elucidate how categories/coding were determined or decisions were made about the data analysis. Approval was granted from the A.T. Still University – Kirksville College of Medicine Institutional Review Board (IRB) for this exempt research study in May 2020.

Results

Eleven IH/OH professionals were recruited via social media and the researcher's professional network to participate in recorded semi-structured interviews. Demographic information collected was the individual participant's relevant IH/OH certifications, years of IH/OH work experience, industry the participant works in, and their highest education level completed.

A majority (73%) of the interview participants held the Certified Industrial Hygienist (CIH) designation from the Board for Global EHS Credentialing. Many (64%) participants noted that they concurrently held other occupational health and safety (OHS) related certifications, such as the Certified Safety Professional (CSP) from the Board of Certified Safety Professionals. Several (27%) participants held only a safety-related designation, such as the CSP or Graduate Safety Practitioner (GSP) from the Board of Certified Safety Professionals, but regularly performed IH/OH tasks as part of their job.

Participants had a wide range of experience in IH/OH, from 4-33 years of professional experience, with an average of 22 years of experience in IH/OH. A variety of industries were represented by participants, including multiple IH/OH professionals from construction and manufacturing; however, the most common response was Other (46%), which encompasses consultants and retail operations. A majority (73%) of participants had completed a master's degree. All participants had completed at least a bachelor's degree (see Table 1 for details).

Table 1

Demographic Characteristics of Participants in Semi-Structured Interviews

Demographic characteristic	Interview participants	
	n	%
Board certification		
Does not currently hold a board certification in IH/OH	3	27
Certified Industrial Hygienist (CIH)	8	73
Career level		
Early Career Professional	3	27
Professional	8	73
Industry		
Construction	3	27
Education	1	9
Manufacturing	2	18
Other	5	46
Formal education		
Bachelor's degree	2	18
Master's degree	8	73
Doctoral degree	1	9

The AIHA (2018) described five stages of an IH/OH career in the core competencies for IH/OH. The five stages are Student/Intern, Early Career Professional, Professional, Senior Professional, and Emeritus Professional. Delineation between these stages is not well-defined in the core competencies document or AIHA website, except for the Early Career Professional and Professional stages. An Early Career Professional was described as an IH/OH with equal to or less than four years of experience, who had not yet become a CIH. A Professional was described as an IH/OH with more than four years of experience who held the CIH designation (AIHA, 2018). Therefore, only the Early Career Professional and Professional stages were used for assigning descriptive categories in the demographic data collected.

The qualitative data analysis for themes and coding was completed using both inductive and deductive approaches, which are common in qualitative research. The focused conversation method used in structuring the interviews helped participants stay on topic and follow their thoughts to a useable conclusion. Tables with example quotes are provided throughout the results section, with longer quotes from participants in the narrative provided for rich description and illustrative purposes.

Saturation was determined to be achieved when no new themes or codes were identified in the data analysis, after the initial analysis sample and stopping criterion were met. Output extracted for data reporting included the themes and codes, as well as direct quotes from participants to illustrate the nodes/themes in both the narrative and tables for each major theme. Validity and reliability of the qualitative data were supported by inclusion of the number of respondents who shared similar views on the themes and codes, as well as identification of respondents who may have disagreed with the consensus argument.

Research question 1 – What is the role of openness in IH/OH continuing professional development?

Table 2 provides the extracted codes and themes for the first research question with example quotes from participants and a brief narrative explanation after the table.

Table 2

Openness in IH/OH Continuing Professional Development

Themes and codes	Example quote
Identity of IH/OH profession	
Historical divisiveness in the IH/OH profession	"It's a somewhat divisive community. It's a very – at times – judgmental community." (S. Edward Taylor)
Perception of elitist and overly academic group self-awareness	"Usually, those professionals never even leave the college setting. They have never been to, let's say, a foundry, or manufacturing site, or a machine shop. So maybe they're going to talk about book smarts, but they don't have enough realistic experience in what happens." (Nessa)
Growing sense of community because of the online closed social media platforms for members of the IH/OH professional organizations	"[…] those discussions and resources and everything else become a wonderful way to engage with others, or just to lurk and learn, right?" (S. Edward Taylor)
Strong sense of professionalism among IH/OH practitioners	"Let's face it, we're a body of professionals that fear not documenting anything. We're a body of professionals that fear not retaining records for indefinite amounts of time just to prove that we were legitimized in our opinions somewhere." (Felix)
Cohesion in IH/OH profession	
Improved support between colleagues and for early career IH/OH professionals	"[…] we have to leverage the diversity of experience, leverage the diversity of knowledge, in order to grow as a profession." (Dwight)
Improved tolerance for new ideas in IH/OH practice	"There doesn't seem to be a lot of fighting and argument on [the closed social media platforms]. There's a little bit of back and forth, but it usually goes back to the science, and then they agree on it." (Sophie)

Improved cohesion between IH/OH professionals due to the more integrated nature of OHS practice	"[…] cohesion in and of itself means that we're more or less moving in the same direction. We have some sort of a sustainable culture, or a culture that's similar or familiar no matter where you're looking within the profession." (Dwight)
Participation in the IH/OH community	
Membership in professional organizations is one method of participation	"Most professionals are highly engaged in these organizations. Participation is generally sustained over the length of someone's career." (Dwight)
Volunteering in professional organizations is another method of participation	"It's actually helped me a lot with my career, the chance to be involved in the organizations at a number of different levels." (Tanya)
Concern that a focus on openness will affect the revenue of the professional organizations due to decreased sales of resources and consensus standards	"I know from being in the leadership positions that the educational resources, the reference materials, the coursework, the books and textbooks, the guidebooks, that's what keeps the organization financially viable." (NavyRulz)
Communication in the IH/OH community	
IH/OH professionals frequently use scientific and technical communication methods in their daily work	"Safety people are coming in where we don't have these communications degrees, we don't have these law degrees, you know? We might be okay writers, but it's technical writers." (Nessa)
IH/OH professionals have a duty to the public for accurate and open communication about IH/OH concerns	"And I can kind of see that happening with open-source materials, that if you make them free and open, somebody is going to take that thing and now try to add to it and maybe use the AIHA name. As weight for their product where now they've changed it and it's no longer a good or accurate document." (NavyRulz)
IH/OH professional communication is a form of risk and crisis communication, which should be, by nature, open and transparent	"And I think it's important that everybody communicate, 'There are limitations. We just don't know. We're recommending this without it being proven because we think it's the best thing to do. But you have to realize we're doing the best we can.' You have to qualify it." (Tanya)
Openness in the IH/OH profession	
Legalistic nature of IH/OH leads to concerns about sharing requirements for professional practice	"There's a very legalistic nature to the IH community. Safety, because we are so broad, it's so dynamic, that same legalism just cannot apply." (Dwight)
Concern about openness not being an option because of the possibility of inaccurate information if the requirements for professional practice are revised, remixed, or redistributed	"I guess the only concern I would have is if it were revised or remixed in a manner that made it scientifically unsound. I would hope that most people in our community would not do that." (Tanya)
Knowledge hoarding to control information and manage the risk	"I think we should be sharing it among the professional IHs. Where you gotta be careful there is the public, as we know, the public will take things and completely misinterpret them. And so, when you start sharing openly, you've got to somehow limit that to where it's the professionals that are able to get into it and get the information." (Sophie)

Regarding the historical divisiveness in IH/OH, this concern was noted by both early career professionals and more experienced and board-certified professionals, likening it to an identity crisis. Participant Felix, an experienced and certified IH/OH professional, stated:

> *We're facing an identity crisis. And I think a lot of it has to do with the way we've educated people. We've almost made an esoteric science where you have to get to big conferences and listen to academia preach about research that's been conducted with very little input onto what do we do to solve problems.*

This sentiment was echoed by Participant Ruby, an early career professional who was working toward board certification:

> *From what I've viewed, they're very closed off. They want to keep their information. And a lot of the times I've noticed in this there is an age gap between the IHs that I work with and myself. And they're not open to the creativity of figuring out new ways to complete the job. They're like, 'No. This is how we've done it. This is how we're gonna do it.' They're very close minded.*

Multiple participants noted the overly academic nature of IH/OH as compared to the more applied nature of safety (or OHS in general). For example, S. Edward Taylor noted that "[…] there's a certain amount of power and egocentricity to [the idea that] I understand something you don't understand" and this appears to be part of the perceived elitist and overly academic nature of IH/OH. Participant S. Edward Taylor also provided additional context about the elitist nature of IH/OH, specifically the way IH/OH tried to decouple from safety: "We're doing a crappy job of educating the general public, which means they don't understand what we do, which means they can't value what we do, if they can't really understand it." This historical divisiveness and separation led to historical issues with professional cohesion between IH/OH professionals and general OHS professionals.

Participants noted that the IH/OH community had improved professional cohesion, likely due to the growing sense of community from the online closed social media platforms for IH/OH professionals noted in Table 2. These online closed social media platforms may also be a method of providing support for geographically isolated colleagues in IH/OH. Multiple participants noted that there seemed to be improved tolerance for new ideas in IH/OH practice, possibly because these ideas can be shared widely in the IH/OH community via these online closed social media platforms. Participants also noted that the historical divisiveness between IH/OH professionals and other OHS professionals has abated and theorized that this may be due to the more integrated and generalized nature of OHS practice that is expected by employers now.

However, participants still expressed concern with the overly academic nature of IH/OH and the research that is conducted by Education and Research Centers funded by the U.S. National Institute for Occupational Safety and Health. Participant Nessa described this concern and need for more applied research:

> *It's not enough that somebody's giving you a study in controlled settings. Controlled settings where you're controlling the temperature, relative humidity, and who comes in, will not really get you anywhere. It's nice. It's interesting, but what am I taking from that? Okay, so you did a scientific project? Bravo! What can I bring to my boss? Nothing. How is it going to help them? Nothing.*

There was also mention of a need for partnerships between industry, academia, and professional organizations for applied organizational research in IH/OH that could be transferred or translated to other organizations. Interestingly, participants described the best way of participating in the IH/OH community as performing volunteer work through the various professional organizations dedicated to IH/OH and OHS. A common concern from participants was that, if the best practices and consensus standards were provided freely and openly, this would be a substantial loss of revenue for the professional organizations. However, participants also noted that most of the resources and consensus standards are developed by volunteers with very little cost to the professional organizations and seemed supportive of the idea that resources and tools generated by volunteer members of the professional organizations should not be sold to other members of the professional organizations for a profit; instead, these resources and tools should be provided to members freely and openly. There was a strong sense of ownership related to the consensus standards developed by volunteers. Participants noted the costs to develop the resources, tools, or consensus standards could likely be recouped by the sale of such resources to non-members of the professional organizations.

When asked whether the IH/OH community was self-educating in interview question #4, participants were split in their responses. Five participants (45%) believed that the IH/OH community was self-educating, based on the description of the community indicators provided as part of the question. Six participants (55%) disagreed with this assessment, believing that the IH/OH community still had a long way to go in becoming a self-educating community. However, 10 of the participants (91%) agreed that the safety side of the OHS community could be defined as self-educating, with many participants describing the safety side as having better cohesion, participation, identity, and creative capacity than IH/OH. One participant (9%) disagreed with this consensus, believing that both the safety and IH/OH communities were not self-educating and still had significant work to do.

One constant theme identified by multiple participants was the recognition that most IH/OH professional communication is generally a form of scientific and technical communication. Participants also expressed their duty to the public for accurate, open, and transparent communication about risks and hazards. Participant S. Edward Taylor recognized the value of openness in IH/OH practice:

> *But this need for openness, transparency, better outreach, ways of making it widely available both to the community in industrial hygiene, as well as to the greater community of people that have a huge stake in their own environmental health and occupational hygiene, to broaden it, I think would be a huge value.*

IH/OH professionals frequently engage in risk and crisis communication about identified or potential risks and methods to control those risks, and this communication must be open and transparent. Some participants pointed to the free resources provided by the AIHA (2022) for employers relating to re-opening guidelines for the COVID-19 pandemic as an example of this communication.

Specific to interview question #6, which asked participants about the five aspects of openness (retain, revise, remix, reuse, and redistribute), there was an interesting split between the participants that supports this concern about openness as it relates to risk and crisis communication and scientific or technical communication. All 11 participants (100%) supported the retain aspect of openness. Eight participants (73%) had major concerns with the revise and remix aspects of openness, whereas three participants (27%) did not. Ten participants (91%) also supported the reuse and redistribute aspect of openness, as long the free and open materials were peer-reviewed, provided unchanged from the original, or had any changes to the original tracked with justification for the changes. The overall concern was the need to control

the information provided so as not to increase the risk to IH/OH professionals, and by extension, the workers they serve through their employer or clients.

To summarize the general opinion of IH/OH professionals about openness, participants held differing opinions. Approximately half (five participants) expressed positive opinions about best practices and consensus standards being shared openly, whereas the other half (six participants) expressed neutral or negative opinions about openness. The most significant concerns from participants related to copyright infringement, which indicated that participants did not have a firm grasp on the concept of openness. Participants also worried about the legalistic nature of IH/OH practice, specifically the concern that a "bad actor" or inexperienced professional would revise, remix, and redistribute incorrect or inaccurate information, thus resulting in injury or illness to a worker or other damage to an employer. These concerns seem to hearken back to the knowledge hoarding that has been common in IH/OH practice, and the sense of ownership that IH/OH professionals feel towards the voluntary consensus standards.

Research question 2 – How can OERs and OEPs be used for IH/OH continuing professional development?

Table 3 provides the extracted codes and themes for the second research question with example quotes from participants with a brief narrative explanation after the table.

Table 3

OERs and OEPs and Their Use in IH/OH Continuing Professional Development

Themes and codes	Example quote
Preferred method	
In-person continuing professional development is preferred for the ability to learn and build professional network	"I very much prefer in-person stuff. Again, that really comes down to... it's both a networking slash business development slash professional development crux for me. They're not severable. They all happen simultaneously." (NavyRulz)
Online continuing professional development is desired for convenience and affordability	"[…] I have always done the in person. But I am beginning to get more comfortable with the online, and the quality of the online, and the availability makes it very convenient." (Ray)
OERs and OEPs could be used to provide searchable best practice documents	"Yes, I think it would improve our credibility as IHs to have freely shared tools and best practices. The better we can do our job, the more value we provide for our employers and communities. I consider sharing of tools and best practices as a great way to do that." (Tanya)
OERs and OEPs could be developed for specific topics related to certification preparation or complex concerns	"You're looking for one specific process or one specific topic. And you can quickly go through, search for that specific topic, and it pops up with just that information. I think that's a lot easier to navigate than trying to go find it in one of the publications for IH." (Alexis)
Core competencies	
OERs and OEPs could be developed to match the blueprint(s) for IH/OH certification exams	"[…] you're gonna want to make sure they jive with each other, because you're gonna want to ensure that the study materials, and what their expectations are for the certifications, are

	going to keep up with the times and the technology." (Ruby)
OERs and OEPs are needed for specific topics in IH/OH that are covered by the core competencies, but resources are unavailable or difficult to access	"But there's a learning opportunity there because understanding new technologies, what's going on in the world, you know, what's current practice, what are emerging technologies or emerging thoughts coming out with regards to the practice." (Felix)
Gap analysis is needed	
An open wiki-style was recommended as an idea for an OER/OEP that IH/OH professionals could use to reference for continuing professional development	"[…] if I'm faced with a new situation that I don't have specific education or qualifications for, I need to be able to find that. And it'd be helpful to have strong resources, good resources, that I can pull from. Reputable resources that I can pull from, versus just Wikipedia or Google, whatever the search turns up." (Dwight)
There is a lack of interpersonal skills in IH/OH professionals, and OERs or OEPs could be developed for this topic	"Whereas IH, if we're dealing more with things, maybe we don't have to engage with people as much. Trying not to be reductionist, but a lot of us in IH started as what were called - not necessarily fondly - pump jockeys. If you're hanging pumps on people, how much do you really have to engage with them?" (S. Edward Taylor)
There is a need for OERs or OEPs about leadership skills for IH/OH professionals	"I also think these organizations should be looking at developing leadership skills and soft skills, in addition to just technical expertise. I think that's very important." (Dwight)
Application of concepts	
Case studies could be developed as OERs so that IH/OH professionals can learn to apply academic information in their field work and professional practice	"There are a lot of books that come through your education - your bachelors, masters, what have you. They're all more academic and theoretical in nature. They might have case studies, but again, the case studies still just give you one perspective. And in some cases, the case studies are just the author's perspective [...]" (Dwight)
Scenarios could be developed as OERs so that IH/OH professionals can learn to apply academic information in their field work and professional practice	"I would love to learn more about what other companies or other industries are doing, how they're doing it, why they're doing it, and if anyone's willing to share that information, then why not? I don't think it's bad. The data can be changed or used as an example or placed into scenarios where it's not actually giving you the raw data from whoever/whatever they're collecting." (Alexis)
IH/OH professionals are looking for some way to test their decision-making skills in continuing professional development	"[Example from participant] Here's a problem. Not going to tell you the solution. Work through it with a team or cohort. Then let's see how your outcome compares to the outcome that was decided upon. Who got it right, who got it wrong, who could improve and where could you improve? That's where you start the decision-making competencies and decision-making ability." (Felix)

Certification	
OERs and OEPs could be used for certification examination preparation or familiarization with IH/OH topics	"Emerging professionals now are conditioned, systematically, to pursue certificates, degrees, certifications. And the stereotype is that 'Oh, well, they're just trying to beef up their resume. They just want things on paper.'" (Dwight)
OERs and OEPs could be used for IH/OH certification maintenance	"I could understand and see where people are going to want to have [credit for] putting in the work of continuing their education. And they're going to want credit for it. They're going to want to show it being applied to the certifications they potentially have currently." (Ruby)
OERs and OEPs are needed that can count for certification maintenance points or credit from the certification boards	"It's a combination of, okay, what do I need information on right now to do my job, and things that are interesting that I can also get points for." (Tanya)

The preferred method for IH/OH continuing professional development (prior to the COVID-19 pandemic) was in-person events. Participants noted the dual usefulness of in-person events for networking and learning, but also expressed support for online learning activities, due to the flexible and convenient nature of such activities. Multiple participants described the need for searchable, online, topic-based, basic, best practice documents that matched the core competencies or blueprints for certification exams and recommended that a gap analysis be conducted to determine which topics or best practices in IH/OH already have some form of open educational content from the U.S. National Institute for Occupational Safety and Health, other governmental entities, or professional associations. Participant Ruby described how OERs or OEPs could be useful to isolated IH/OH professionals:

> *Having an open education resource can help those who come into a position where the company was one-deep, or in other words, they didn't have backups for this position. So, we were kind of stuck in the water like, what are we doing? So, the open education resource would allow for a more efficient way of learning how to complete jobs or tasks that are within the safety and industrial hygiene careers. Help save heartache for those who are like, 'I don't know what I'm doing. I need help.' Because there's not a whole lot out there.*

Other participants explained that case studies and scenarios would be the most beneficial type of OER or OEP, because these types of resources would help with decision-making competence, leadership skills, and core competencies for the IH/OH profession.

Several participants explored the need for an open wiki-type OER, especially one that was linked to the various core competencies or skills needed for certification preparation and studying. Participants were divided about whether the wiki-type OER should be housed within one of the professional associations or through an academic institution. There were concerns about not getting points or other credit related to certification maintenance for accessing the wiki-type OER for professional development, but all participants stated that they would use an OER or OEP for questions related to their actual practice of IH/OH, even if they did not receive points for it.

Participant NavyRulz recommended that professional associations be part of the solution for developing OERs or OEPs about IH/OH as part of the services provided to members of the association(s):

> *So, I think the professional organizations certainly have an obligation and a role in that, not only to maintain the professional level of the practice in general, but also as a service to their actual members. So, you know, if AIHA didn't offer a conference or didn't offer coursework, I'd be less likely to belong to them because that's one of the reasons I joined, is for that ability and resource to pursue that professional development.*

This idea of professional associations being primarily responsible for continuing professional development for IH/OH professionals was articulated by several participants. To summarize the general opinion of IH/OH professionals about using OERs and OEPs for continuing professional development, participants were supportive of the need for these resources, even if they would not receive certification maintenance points for reviewing the OER or OEP. All participants expressed positive opinions about OERs and OEPs being developed for core competencies in IH/OH, especially to assist with certification preparation and lifelong learning that is not part of certification maintenance. The most significant suggestions from participants were about the OERs and OEPs being searchable, topic-based, and only providing basic information about IH/OH practice. Participants were not in favor of highly technical IH/OH practice information being provided freely and openly, instead, recommending that the OERs and OEPs focus on decision-making skills, application of concepts, leadership, and interpersonal skills, because those aspects are not covered by the technical practice documents and voluntary consensus standards published by the professional associations.

Research question 3 – What are the perceived benefits and weaknesses of OERs and OEPs in IH/OH continuing professional development?

Table 4 provides the extracted codes and themes for the third research question with example quotes from participants. A brief narrative explanation follows the table.

Table 4

Benefits and Weaknesses of OERs and OEPs for IH/OH Continuing Professional Development

Themes and codes	Example quote
Benefits of OERs and OEPs	
Best practice guidelines could be provided as OERs and OEPs, because the core competencies are already provided for free	"There's a difference between a core competency and a best practice. The best practice is really how you implement the competencies. I think we spend far too much time on competencies and not enough on best practice. You know, it's the 'how.'" (S. Edward Taylor)
The free and open nature of OERs and OEPs	"Because it would be there and be free, number one. Two, if it was done in an organized manner, if - loosely using this term - peer reviewed. So, decent stuff. Other than most of the free cookie cutter stuff you find out there that is so generic, it really doesn't help you do much. But if it had value, of course, why wouldn't you use it?" (Fred)
The convenience of fully online and accessible OERs and OEPs	"Who's putting them out? How often are they updated? Who's doing those updates? How accessible are they? I realize just because something's open doesn't mean it's necessarily

	accessible. And then what's the quality? Is it a high-quality document?" (Dwight)
The possibility for just-in-time learning with OERs and OEPs	"[…] I think that's wonderful because it just makes it easier on us higher level folks to be able to train our entry level folks with a common body of knowledge and a common curriculum." (NavyRulz)
Weaknesses of OERs and OEPs	
Identified concern about the perceived quality, accuracy, accessibility, and reliability of learning materials provided for free	"[…] we ascribe value to what we pay [for]. So, there's absolutely that cognitive bias of 'I didn't pay anything for this, so who cares,' right? And that shouldn't be the case. (S. Edward Taylor)
The need for certification maintenance points and verification that an OER or OEP was completed to get credit	"There were some one-hour presentations, no certificate or anything, but I did sign up and listen to those just because I needed the information […] Then other times, some of the universities have had presentations where if you do an evaluation, you get some certificate maintenance points, and a certificate, and I'll do those for the points." (Tanya)
Identified concern about the need for peer review of OERs and OEPs to ensure quality, reliability, accessibility, and reliability	"I want something that's not the media. I want hard, cold facts that have been checked over, and with the peer review, I know that's going to be a better answer." (Ruby)
Mentoring	
Experienced IH/OH professionals recommended that OERs and OEPs could be used for mentoring students/interns and early career professionals	"I think that's really important when you're first starting out. So, you can get that mentoring and that help. As you get on, it's important to keep passing that on and keep the new generation coming up." (Sophie)

Findings related to the third research question seem to support the findings of the second research question. Participants were quick to identify the many benefits of OERs and OEPs for continuing professional development: chiefly the fact that they are free and open, but also the idea that OERs and OEPs could be used for just-in-time learning or on-the-job training and mentoring of early career professionals in IH/OH. The weaknesses of OERs and OEPs noted by participants were mostly related to concerns of quality and a perceived lack of peer review for some open educational materials. The other main weakness of OERs and OEPs was that the open resources may not be able to be used for certification maintenance, but this weakness was bolstered by the overall perception of usefulness for OERs and OEPs in educating the next generation of IH/OH professionals. Participant Sophie, a certified IH/OH professional with many years of experience, described how OERs and OEPs could be used to address the professional development needs of early career professionals, and is consistent with the opinions of most of the study participants, and consistent with the findings from the second research question:

> *I think that industrial hygiene's got a little bit of a problem that they need to appeal more to the younger community, and open resources might help. Because I know that a lot of them, as they're starting out, don't have the backing of companies for the continuing education. So, it makes it a little more difficult. […] Maybe even just make it to where the initial broad general subjects are open, and able to receive without paying, and make more intense, in-depth information payable, because*

> *you're going to have more of your higher, more experienced people using that.*

Regarding the possibility of using OERs and OEPs for mentoring students/interns and early career professionals, Participant Fred explained the ethical considerations of this practice:

> *We have to agree on our subculture. Now the ethical canons, I think could be a good place to start. And I'm on [IH/OH professional association's] ethics committee, but I can't get many other followers to put that in the ethic canon more blatantly. That it's ethically our responsibility not only to share, but to mentor. But we're certainly not doing it enough. If someone just coming into the industry is looking for help, they're likely to find it. It might take a while. And it would take a lot of effort.*

If OERs and OEPs existed for core competencies in IH/OH practice, participants believed this would provide a common core of knowledge that might benefit the field and improve support for students/interns and early career professionals through the mentoring process with more experienced and board-certified IH/OH professionals.

In keeping with the previously identified concerns about openness, participants also engaged in discussions about the importance of OERs and OEPs being peer-reviewed. A peer in IH/OH was generally described by participants as someone who was active in IH/OH practice for more than 10 years, held a board certification in IH/OH, was an active volunteer in professional associations related to IH/OH, and had a publication record of peer-reviewed articles or editorially reviewed submissions. Participant Dwight also noted the peer review selection process needed to consider the individual's ability to take constructive criticism:

> *So, I think that's how I would look at a peer within the profession. Who's got the education, the credentials, the experience, the understanding to be able to evaluate? And, you know, are they someone who is capable of going through the peer review process?*

The general opinion of IH/OH professionals relating to OERs and OEPs for continuing professional development is that the benefits outweigh the weaknesses. If these open materials were available online, for free, aligned with best practices and core competencies in IH/OH, the materials were believed to be beneficial for mentoring and just-in-time learning. The most significant concerns from participants were about the quality and potential for inaccurate or unreliable information from the OERs and OEPs, but participants felt this could be solved by an established peer review process for open materials. Although engagement with these OERs and OEPs could likely not be counted for certification maintenance points for board certifications, participants believed OERs and OEPs would benefit emerging and early career professionals.

Research question 4 – What level of learning is desired by IH/OH professionals engaging in continuing professional development?

Table 5 provides the extracted codes and themes for the fourth research question with example quotes from participants. A brief narrative explanation follows the table.

Table 5

Aspects of Learning in IH/OH Continuing Professional Development

Themes and codes	Example quote
Change management	
The need to stay on top of ever-changing regulations, standards, and technology	"For me, it's keeping up with changes. I mean, things have changed tremendously since I started in the safety slash industrial hygiene field. Instrumentation has changed a lot. Basic approaches have changed." (Tanya)
The need to manage changes associated with professional practice, such as core competencies or industry standard practices	"I would say it's critical because there's changes all the time. Guidelines are updated. Right? So, I get the TLV (Threshold Limit Value) books every year. There's changes to that. […] So how can you truly do industrial hygiene, if you don't know about the new dosimeters that just came out, that everybody wants to use? Or the limitation of a specific method." (Nessa)
Career stages	
Student/intern was identified as a learning-heavy career stage	"Depending on how it's completed or who is leading that education or resource, it could potentially […] help build up the person or the student to understand. To basically allow the students to gain the - not the courage - but to build themselves up so they can feel that they can go out and they can be competent in making those decisions." (Ruby)
Early career professional was identified as a learning-heavy stage	"Well, I can certainly see where newer IHs might be struggling, but I think that's partly, maybe, because we expect too much out of new IHs. […] the junior IHs, which are literally just pump jockeys or sample technicians. We don't want them thinking too much, frankly, about their job. We want them to do what we send them out there to do." (NavyRulz)
IH/OH professionals often hold multiple board certifications in OHS, so there are multiple potential stages of studying for professional certification	"There are four I still do value and still do need to keep up to date. […] I have let some go over the years. […] Most of those were a matter of, I'm just not doing those levels of work, needing those anymore." (S. Edward Taylor)
Certification maintenance was identified as a later stage of an IH/OH professional's career, and an IH/OH professional's learning needs change depending on their career stage	"I guess where I'm coming from on that is, [professional] development is not necessarily a single point in time. It is a process. Therefore, having material out there that's more accessible for the junior [industrial hygienists], I think would get more people into it." (NavyRulz)
Knowledge	
IH/OH professionals are focused on continuous improvement of their knowledge, in keeping with the plan-do-check/study-act cycle of quality management	"[…] if you ever heard of Deming from Total Quality Management, one of his disciples, Crosby […] was espousing that 10 years after you graduate with a bachelor's, half of the information you were taught is dated and obsolete. I give people opinions that quite literally lives depend on it. So, I'm not going to let half of what I know be obsolete." (Fred)

IH/OH professionals felt that baseline competencies in professional practice are covered by this learning tier/level	"We never build on that knowledge or test that knowledge or the skills learned, or the competencies learned. Over the course of that, we just kind of continue to go back and do what we did before." (Felix)
Decision-making competence	
Decision-making competence is needed to integrate theoretical or academic knowledge in IH/OH	"I want the download. I want the information. I need to integrate it somehow, in a practical way, to what I do and what I am doing. And definitely the decision-making competence. I want that level of comfort, a degree of competence that the decisions I'm making are well grounded and understood." (Ray)
Decision-making competence is needed to integrate operational or industry knowledge in IH/OH	"You now are placed in a situation. Not only do you have to sit down with somebody that has no clue about environmental, health, and safety, and you have to convince them about what decision-making needs to happen. And I think that there's not enough training on that." (Nessa)
Task competence	
Technical task competence and management task competence are needed for IH/OH professionals, and depends on the career level of the individual	"Because if you've got somebody who's just starting out, they're going to want the transfer and the task competence. If you have somebody who's starting to be a manager or is mid [career], they're going to be looking more for the decision making." (Sophie)
Transfer of knowledge	
Effective project management is one way that knowledge is transferred from the IH/OH professional to the employer	"But as a consulting IH, I already do this all the time. I collect various pieces of information from various resources and references, and I apply them to my situation and my client project as needed." (NavyRulz)
Transfer of knowledge is an indicator of IH/OH professional competence	"I think there's a lot of resources that could be used for that that are going to help folks understand the application of what they're learning or what they're looking at. […] Because again, we just don't need information for information's sake. We need information so that it can be applied." (Dwight)
Transfer of knowledge was viewed as the ultimate goal of IH/OH practice	"I would use what was learned to perform tasks successfully as the transfer to see how things are actually working in the field. Like you said, it typically stops after you take the class. I know we struggle with that, to see that things are done correctly in the field." (Tanya)

The most significant theme associated with participants' responses to this research question was the idea of change management in IH/OH practice. All participants believed continuing professional development was important to their professional practice, with multiple participants describing it as "critical" to their professional identity. Change management in IH/OH was described as revolving around the updates from regulatory agencies, improved standards of practice, new technology, and organizational process modifications. Participant Dwight explained how continual improvement processes affect continuing professional development needs in the IH/OH field:

> *I think it's critical to our professional practice. We're called through our different management system standards to focus on continual improvement as an organization. And we're called to continually be innovating in safety within our organizations. The only way that we can support and sustain that is if we are also growing as professionals. So, there's a direct link between our organizations growing, and increasing our organizational safety, and becoming better and more knowledgeable professionals on our own.*

For multiple participants, professional development involved but also went beyond the requirements for compliance, due diligence, and certification maintenance. A board-certified IH/OH professional is ethically required to "give priority to EHS [Environmental Health and Safety] interests related to the protection of people, workplaces and the natural environment" (p. 1), with the protection of people, especially workers, as the top priority (Board for Global EHS Credentialing, 2020). Many of the participants described their dedication to this ethical tenet when responding to this research question. Participant Nessa noted that obtaining funding for professional development is a challenge for many IH/OH professionals, despite the obvious need to stay up to date in the field:

> *It is a barrier, because many employers do not understand that when you are working in environment, health and safety, industrial hygiene fields, you constantly have to learn and update, the regulations and what's new, what's changing. So, it is a struggle to convince your boss, your senior management, that is usually not in that same profession, to pay for that. Usually, the company pays it. But it's a lot of, it's a struggle, pretty much with every company I work with.*

Participants did not identify any one specific tier of learning from Thalheimer (2018) as being the most important, instead describing knowledge, decision-making competence, task competence, and transfer of learning as equally important depending on the career stage of an IH/OH professional. This may be due to the prevalence of highly experienced IH/OH professionals who were recruited for this study – the participants tended to answer this question on a macro or global level rather than on a micro or individual level. Only 10 (91%) of the participants agreed that knowledge was important for IH/OH professional development. The one dissenting participant (9%) believed that knowledge should have been covered by the academic preparation to become an IH/OH rather than being a part of continuing professional development. All 11 participants (100%) agreed that decision-making competence and task competence were important for professional development, and several believed these two tiers of learning should be the focus of an early career professional. Most participants (91%) also concurred that transfer of learning was important for professional development, believing this to be the end purpose of continuing professional development and the mark of competence as an IH/OH professional. The one participant (9%) who did not agree about transfer of learning being a necessary part of professional development argued that transfer is not possible to measure or confirm; therefore, it would be a subjective assessment by the person completing the continuing professional development activity. Knowledge, decision-making competence, and task competence were identified as learning-heavy stages for an early career professional, whereas transfer of knowledge was identified as the focus of a board-certified IH/OH professional, especially in management roles. Knowledge was also identified as the primary driver of professional development, especially given the constant changes to IH/OH practice. Knowledge was also acknowledged to be the tier where most IH/OH continuing professional development activities stops. Several participants recommended that OERs and OEPs be

developed around decision-making competence and task competence, such as with case studies or scenarios. Participant Felix offered a helpful suggestion to structure OERs or OEPs in a layered format using the eight tiers of learning from Thalheimer (2018), explaining:

> *I think the best way to do this open education resourcing is to really make it a curriculum rather than a course, right? So, you have a level one, level two, level three, where they build on each other so that you can take the knowledge, the skills, whatever it is that you've learned in the basic course, and you apply that in the next level. And then you demonstrate decision making competence at the next level. That's one way to capture that knowledge transfer.*

This suggestion was unique among the participants and warrants further assessment. In general, the opinion of IH/OH professionals relating to the level/tier of learning needed for continuing professional development is that the level/tier depends on the career stage of the IH/OH professional. Knowledge, decision-making competence, task competence, and transfer of learning were all identified as necessary aspects of learning for all IH/OH professionals engaging in professional development. Participants felt that decision-making competence and task competence should be the focus of OERs and OEPs for IH/OH, as these skills are necessary but likely not assessed in current professional development activities. The primary concern from participants was the need for knowledge to be applied in various organizational and industrial contexts, which is similar to the definition of transfer from Thalheimer (2018).

Discussion

RQ 1: Openness in Continuing Professional Development

This study introduced most participants to the idea of openness. Participants seemed reluctant to embrace the concept of openness, primarily from the legal and risk management concerns of using a modified document or resource, but also from knowledge hoarding and a sense of elitism in the IH/OH field as compared to safety and OHS.

Identity Crisis in IH/OH Field

Although participants described a growing sense of community among IH/OH practitioners, mostly due to the online closed social media platforms hosted by professional organizations such as the ASSP (2020a) and AIHA (2020a), participants also noted the historical divisiveness between IH/OH professionals and generalist OHS professionals. Hudson and Ramsay (2019) described the trend towards a more OHS professional, as evidenced by the recently developed capability framework and international standard for OHS practice by the International Network for Safety and Health Practitioner Organisations (INSHPO). IH/OH is recognized as a specialist profession in the INSHPO (2017) capability framework, which continues this division between IH/OH and general OHS. Hale and Booth (2019) also described this division between OHS generalists and OHS specialists in the United Kingdom. Derman et al. (2020) also seemed to identify IH/OH professionals and the "overall health and safety community" (para 2) as related but separate entities. Therefore, this perceived identity crisis between IH/OH and general OHS professionals still appears to be present.

Role of Professional Organizations

Volunteer work with the various professional organizations, including the ASSP and AIHA, was identified by many participants as one of their primary methods of continuing professional development. This participation in volunteer work could consist of leadership in advisory committees and work groups, development of consensus standards, and networking with other IH/OH professionals to collaborate and share best practices. Participants understood the role of these professional organizations in professional development as a service provider for developing courses around technically challenging topics, certification preparation and maintenance, and other professional development needs relating to leadership and business. The AIHA (2020b) developed AIHA University for IH/OH professionals to earn contact hours as evidence of their continuing professional development for maintenance of board certifications, including eLearning options, face-to-face options, certificate programs, conferences, and a variety of books matching the education options. Similarly, the ASSP (2020b) developed certificate programs, online and in-person courses, certification preparation courses, and conferences for professional development. Both the AIHA (2020b) and ASSP (2020b) offer continuing education units through their accreditation by the International Association for Continuing Education and Training (IACET); these continuing education units from IACET can be used for documentation of lifelong learning that is required for maintenance of designations and/or board certifications. Participants expressed a concern that a focus on openness would potentially affect the revenue streams for these professional organizations, but also noted that membership in these professional organizations should allow for development of OERs as a benefit of membership and a service to the community. It seems that the related professional organizations recognize and are filling this role for developing professional development opportunities in IH/OH and general OHS. However, the effects of the COVID-19 pandemic on the revenue streams of professional organizations (due to not hosting in-person conferences or educational events) may exacerbate the budgetary concerns and lead to less acceptance of openness, because sales of resources and educational materials may become the primary revenue stream to keep the organizations financially stable.

Public Open Scholar Concept

When participants were asked to evaluate the IH/OH community's readiness for a public open scholar's work and assess the IH/OH community as a self-educating community, responses were mixed, indicating that the IH/OH community may not be ready for a public open scholar at this time. Perryman and Coughlan (2014) explained that the first step in the public open scholar's role is to find a community and assess whether the community is a self-educating community and therefore, ready for openness and OERs. The findings from this qualitative study indicate that the IH/OH community does not currently have an interest in a public open scholar's work to gather and curate available OERs in the subject area for continuing professional development, as the IH/OH community is concerned about the quality and usability of such resources. Additionally, participants noted the improved cohesion and creative capacity of the IH/OH community but expressed concerns with the participation in the community and identity or sense of community. This likely relates back to the identity crisis and historical divisiveness, as well as the knowledge hoarding common in IH/OH professionals.

Open Sharing of IH/OH Resources

The primary concern of participants about open sharing of IH/OH resources was the potential for the information to be mis-communicated or inappropriately used, resulting in injury, illness, or death to an employee of an organization. IH/OH professionals frequently

engage in risk communication and technical communication, and therefore may be hesitant or reluctant to use free and open resources unless they were developed by and provided by a known entity with an established reputation. More than half of the participants expressed concern with the potential for misuse if an open resource was remixed, reused, and redistributed, but did not anticipate issues with an individual IH/OH retaining and revising an open resource for their own personal use. Nguyen-Truong et al. (2019) noted a potential concern with quality in free and open resources used in a public health course, but also explained how an academic and community-engaged approach (like the public open scholar role) can identify and evaluate quality open resources for a particular field of study. Similarly, Hemingway et al. (2011) identified the benefits of open resources in supporting a community of practice in public health and recommended the use of peer review by the user communities to address concerns with quality. Although this qualitative study indicates that the IH/OH community is not ready for free and open sharing of IH/OH resources at this time, it also demonstrates the need for further study to assess if this opinion is held by the OHS community at large, as a subset of public health.

RQ 2 and 3: OERs and OEPs in Continuing Professional Development

Free and open learning materials were of interest to participants in this study, but not for continuing professional development that is completed for certification maintenance purposes. Participants felt the benefits of OERs and OEPs outweighed the weaknesses.

Participation in Continuing Professional Development

Participants described the benefits of in-person events for networking and learning in an interactive classroom-type environment, but also noted their preference for online learning, due to the affordability and convenience. This mix of in-person and online professional development options can be matched to the current offerings of both the ASSP (2020b) and AIHA (2020b). However, participants also expressed an interest in using OERs and OEPs for professional development, specifically best practice documents that were searchable, available online, and topic-based, with links to the consensus standards or professional practice documents developed by the AIHA, ASSP, and others.

Suggestions for OERs and OEPs included a wiki-type resource as a baseline of accepted IH/OH practice, a wiki-type resource matched to certification exam blueprints, or a wiki-type resource with case studies and scenarios that could be used and adapted for training and education purposes. Development of these wiki-type OERs could be a goal for a work group or advisory committee within the established volunteer efforts of the ASSP, AIHA, or a similar professional association dedicated to the advancement of OHS professionals. Completion of a wiki-type OER would likely require a gap analysis of available free and open IH/OH resources as compared to the professional core competencies, certification exam blueprints, or other established framework for professional practice. The primary issue with this gap analysis or wiki-type OER is the lack of consensus among OHS professionals about what the profession is, and whether it is a profession at all. Pryor et al. (2019) discussed the state of OHS professional practice and the lack of a comprehensive Body of Knowledge (BoK) for the field. Pryor (2016) previously recommended that the professional development for OHS professionals be focused on capability, rather than competency, and recognized the BoK should be used for gap analysis for continuing professional development of OHS professionals via capability statements, such as those developed by INSHPO. It is unclear whether the two levels of OHS specialist described in the INSHPO framework are a match to how OHS is actually practiced in the field, and whether IH/OH professionals are a separate profession or a specialty within the OHS profession (Pryor et al., 2019). The role of continuing professional development

is abundantly clear in the INSHPO (2017) framework, as it is "not expected that an OHS Professional or OHS Practitioner would gain the knowledge through education alone" (p. 28), but the scope and state of the profession is still being argued in the academic literature. Therefore, development of OERs and OEPs may need to wait until there is consensus on what the state of the OHS profession is, which competencies are needed, and what the standard of OHS practice should be.

Benefits and Weaknesses of OERs and OEPs

Participants were quick to identify the benefits of free, convenient, and online OERs and OEPs, noting that the OERs and OEPs could be used for just-in-time learning and training of new IH/OH professionals. Concerns with quality and inadequate peer review of OERs and OEPs were the primary weaknesses identified, as well as an inability to track or count their participation or completion of an OER or OEP for certification maintenance points or credit. Nguyen-Truong et al. (2019) recommended that OERs be developed as a partnership between academics and practitioners in the field to ensure quality and adherence to professional practice standards. Therefore, one option to address these perceived weaknesses would be to have a public open scholar perform a gap analysis of available OERs and OEPs in IH/OH, identify missing topics, recommend development of additional OERs and OEPs, and engage volunteer IH/OH professionals to peer review the available OERs and OEPs using a descriptive rubric for quality and content. This gap analysis is similar to the public open scholar process developed by Perryman and Coughlan (2013), where the public open scholar listens to the needs of the community and searches for open resources that fit the community's needs. As noted previously, any efforts of a public open scholar, including this gap analysis, cannot occur until there is a consensus on OHS and IH/OH practice. Pryor et al. (2019) noted the OHS framework may need adaptation and development to fit the specific needs of OHS professionals in each country depending on the regulatory requirements. This may complicate development of OERs and OEPs, if the practice requirements between countries are radically different.

RQ 4: Level/Tier of Learning for Continuing Professional Development

Continuing professional development was identified as important to the professional practice of an IH/OH, mostly due to the need for change management and maintenance of board certifications. Participants were hesitant to select any one level/tier of learning as the most important, instead noting that the level/tier of learning was dependent on the career stage of the IH/OH professional.

Participation in Continuing Professional Development

All participants described their continuing professional development as crucial, critical, or important to their professional practice in IH/OH. Most of the participants held a CIH designation or a related board certification in general OHS, and most board certifications in the field have a lifelong learning requirement to maintain certification. Ramsay and Hartz (2017) described how continuing professional development that is matched to continuously updated educational standards is necessary for OHS to be recognized as a profession through occupational closure. Using continuing professional development as part of professional certification will help to "achieve long-term sustainable professional competence" (p. 49) as part of professional practice in accordance with a code of ethics (Ramsay & Hartz, 2017). The Board for Global EHS Credentialing (2020) code of ethics for certificants, which supports the CIH designation, requires certificants to "continually seek to maintain and/or enhance their professional capabilities" (p. 1) through professional development to retain their credentials.

Pryor (2019) described how the lack of a core BoK has limited OHS professional development for the last decade and explained the challenge of developing a core BoK for OHS based on a conceptual framework that is not yet agreed upon by the entire profession. Rae et al. (2020) further evaluated the challenge of professional development in OHS, because "practitioners conduct activities that are disconnected from research, guided more by standards and legislation than by either theory or evidence" (p. 2). In this study, participants were more interested in continuing professional development to stay knowledgeable about changing regulations, technology, and standards of practice; the lifelong learning was viewed as necessary, whether or not the participant held a board certification.

Level/Tier of Learning Desired by IH/OH Professionals

Interestingly, the level or tier of learning desired by participants seemed to be dependent on their career stage. Participants noted the importance of gathering knowledge, decision-making competence, and task competence in the student/intern stage, early career professional stage, and professional stage. Participants were interested in the LTEM by Thalheimer (2018), specifically its focus on continual improvement cycles, as these cycles are common in IH/OH practice. The lower tiers of LTEM (attendance, activity, and learner perceptions) may be necessary for documentation of completion of a learning activity but are not useful for professionals trying to evaluate their own learning. Baseline competencies in any professional practice are covered by the knowledge tier.

Decision-making competence could be assessed through scenarios, case studies, and other methods of integrating theoretical or academic knowledge into professional practice. Thalheimer (2018) also recommended the use of the Situation-Evaluation-Decision-Action (SEDA) model for developing continuing professional development that bridges decision-making competence and task competence using scenarios or case studies. Rae et al. (2020) recommended the use of real-world case studies for advancing the state of OHS knowledge and research. Task competence could be assessed for both technical tasks and management tasks, with the primary goal being transfer of knowledge. Participants noted that transfer of knowledge or learning was an indicator of IH/OH professional competence. Continuing professional development options developed for IH/OH professionals should be assessed using LTEM with a focus on knowledge, decision-making competence, and task competence, with consideration given to the career stage of the IH/OH professional.

Transfer of learning can be demonstrated by the IH/OH professional once they are performing their job but would be difficult for a provider of professional development to assess. Chatterjee et al. (2018) described how the learning transfer from an individual to their organization is affected by the individual's perception of organizational culture and the learning transfer environment, including the supervisor support, peer support, and performance coaching of the individual. Although the effects of transfer would be difficult for a professional development provider to assess, but both transfer and the effects of transfer could be assessed as part of an IH/OH professional's performance review by management.

Conclusions

The findings of this qualitative study provide useful information about openness in the IH/OH professional community and how OERs or OEPs might be used for professional development. Limited research has been conducted on continuing professional development in IH/OH and the general OHS profession. Most of the available research about professionalism in OHS has focused on developing or revising academic curriculum and the need for accreditation of academic programs (Ramsay & Hartz, 2017), the need for certification as a requirement to practice (Hudson & Ramsay, 2019), and ongoing discussions about whether

OHS is still an occupation versus becoming a mature and established profession (Hale et al., 2020).

Continuing professional development is a key element of mature professions and can be used for bridging the gap between inadequate academic education and professional practice, preparing individuals for certification, and helping individuals stay abreast of changes in professional practice throughout their working lifetime (Ramsay & Hartz, 2017; Scott et al., 2019). Findings from this study addressed a gap in the literature about IH/OH professionals' reasons for completing continuing professional development and assessed their interest in using OERs and OEPs for professional development. In this study, the levels of learning desired by IH/OH professionals when completing professional development activities were also evaluated.

Results of the study showed that IH/OH professionals primarily completed continuing professional development as part of the certification maintenance cycle, but participants also acknowledged the need for lifelong learning to keep apprised of changes in professional practice, regardless of whether they held a board certification. There was mixed interest from participants in using OERs and OEPs to complete their professional development, with most citing concerns about quality and peer review of the provided learning materials. The participants noted that an IH/OH professional's level of learning for continuing professional development would differ depending on their career stage, with early career professionals most focused on knowledge and decision-making competence and board-certified professionals most focused on task competence and transfer of learning to their organization or client(s). Additionally, the participants did not believe that the IH/OH community could be described as self-educating, although significant improvements have been noted since the creation of online closed social media platforms hosted by the two primary professional associations. Therefore, the IH/OH community may not be ready for or interested in a public open scholar's work to search for OERs, curate them, and share the information.

There were several limitations of this study. There was potential voluntary response bias that may have resulted in a skewed distribution of experience level, as most of the participants were board-certified and highly experienced, with an average of 31.3 years of experience in IH/OH and at least a master's degree. Potential for researcher bias was also present, but the researcher's professional experience in IH/OH may have helped provide a more nuanced understanding of the participants' responses to interview questions.

Future research on the topic of openness in IH/OH continuing professional development should be focused on early career professionals and mid-career professionals, with recruitment of study participants from both board-certified and non-certified individuals. A better understanding of how employers support continuing professional development needs of IH/OH and general OHS professionals also appears to be needed. If this study was to be repeated or improved upon, an online focus group with written responses from study participants, with the questions provided to participants ahead of time, might lead to improved participation and more useful, focused answers to the interview questions and prompts.

As a result of this study, professional associations in the IH/OH and OHS communities should be the primary drivers of improving the self-educating nature of the community at large, by increasing the participation, cohesion, sense of identity, and creative capability of the community through the online closed social media platforms for their members (Coughlan & Perryman, 2012). However, these professional associations may be disincentivized to embrace openness and the generation of OERs for the community, due to a potential loss in revenue from sales of copyrighted materials required for professional practice. Compounding the problem is the fact that board certification and membership in these professional societies is not required for IH/OH or OHS professionals. Efforts to improve the self-educating nature of the community will leave out those professionals who are not members of a professional society and are not board-certified. These non-member and non-certified professionals would likely benefit most from OERs for professional development. The results of this study can be applied

to other emerging health professions that do not currently have certification and licensure requirements for professional practice, as well as the professional societies that develop continuing professional development courses and learning activities for OHS professionals.

Funding Details

This work was partially supported by a 2020 Research-Doctoral Dissertation Grant from the Board of Certified Safety Professionals Foundation.

Declarations

- Ethics approval and informed consent – This study was approved by the A.T. Still University – Kirksville College of Medicine IRB (May 6, 2020).
- Consent for publication – Participant informed consent included publication of results.
- Availability of data and materials – The qualitative data is not publicly available due to small sample size. Requests to corresponding author for data can be made and may be available subject to IRB approval.
- Competing interests – Author declares no competing interests.

References

American Industrial Hygiene Association. (2018). *Core competencies for the practice of industrial/occupational hygiene*. https://www.aiha.org/publications/core-competencies-for-the-practice-of-industrial-occupational-hygiene

American Industrial Hygiene Association. (2020a). *5 reasons why you should join Catalyst*. https://www.aiha.org/membership/catalyst

American Industrial Hygiene Association. (2020b). *AIHA University*. https://www.aiha.org/education

American Industrial Hygiene Association. (2022). *Healthier workplaces: Back to work safely*. https://www.backtoworksafely.org/

American Society of Safety Professionals. (2020a, January 17). *5 ways the ASSP Community is different than LinkedIn*. https://www.assp.org/news-and-articles/2020/01/17/5-ways-the-assp-community-is-different-than-linkedin

American Society of Safety Professionals. (2020b). *Education*. https://www.assp.org/education

Board for Global EHS Credentialing. (2020). *Code of ethics*. http://www.abih.org/sites/default/files/downloads/BGCEthics2020.pdf

Chatterjee, A., Pereira, A., & Bates, R. (2018). Impact of individual perception of organizational culture on the learning transfer environment. *International Journal of Training and Development*, *22*(1), 15–33. https://doi.org/10.1111/ijtd.12116

Coughlan, T., & Perryman, L. A. (2015). Learning from the innovative open practices of three international health projects: IACAPAP, VCPH, and Physiopedia. *Open Praxis*, *7*(2), 173-189. https://doi.org/10.5944/openpraxis.7.2.188

Coughlan, T., & Perryman, L.-A. (2012). Reaching out with OER: the new role of public-facing open scholar. *eLearning Papers*, *31*, Article 31_1. http://oro.open.ac.uk/35934/1/In-depth_31_1.pdf

Curran, M. K. (2014). Examination of the teaching styles of nursing professional development specialists, Part I: Best practices in adult learning theory, curriculum development, and knowledge transfer. *Journal of Continuing Education in Nursing*, *45*(5), 233–240. https://doi.org/10.3928/00220124-20140417-04

Derman, S., Strode, R., Archibald, D., Ellwood, C., Esswein, E., Knezevich, C., & Welty, S. (2020, May). *COVID-19 and the industrial hygienist: FAQs on practicing IH in a pandemic*. https://synergist.aiha.org/the-synergist-may-2020

Hale, A. R., Hudson, D., & Pryor, P. (2020). The evolution of a global, professional capability framework covering the role, contribution and status of Occupational Health and Safety (OHS) professionals: Editorial, introduction and discussion. *Safety Science*, *122*. https://doi.org/10.1016/j.ssci.2019.104509

Hale, A.R., & Booth, R. (2019). The safety professional in the UK: Development of a key player in occupational health and safety. *Safety Science*, *118*, 76–87. https://doi.org/10.1016/j.ssci.2019.04.015

Hemingway, A., Angell, C., Hartwell, H., & Heller, R. F. (2011). An emerging model for publishing and using open educational resources in public health. *Perspectives in Public Health*, *131*(1), 38–43. https://doi.org/10.1177/1757913910391034

Hudson, D., & Ramsay, J. D. (2019). A roadmap to professionalism: Advancing occupational safety and health practice as a profession in the United States. *Safety Science*, *118*, 168–180. https://doi.org/10.1016/j.ssci.2019.04.018

International Network for Safety and Health Practitioner Organisations. (2017). *The Occupational Health and Safety Professional Capability Framework: A Global Framework for Practice. Park Ridge, Illinois, United States*. https://www.inshpo.org/storage/app/media/docs/INSHPO_2017_Capability_Framework_Final.pdf

Nguyen-Truong, C. K. Y., Graves, J. M., Enslow, E., & Williams-Gilbert, W. (2019). Academic and community-engaged approach to integrating open educational resources in population health course. *Nurse Educator*, *44*(6), 300–303. https://doi.org/10.1097/NNE.0000000000000653

Open Education Consortium. (n.d.). *About the open education consortium*. https://www.oeconsortium.org/about-oec/

Perryman, L. A., & Coughlan, T. (2013). The realities of 'reaching out': Enacting the public facing open scholar role with existing online communities. *Journal of Interactive Media in Education*, *2013*(3), Article 21. https://doi.org/10.5334/2013-21

Perryman, L. A., & Coughlan, T. (2014). When two worlds don't collide: Can social curation address the marginalisation of open educational practices and resources from outside academia? *Journal of Interactive Media in Education*, *2*, 1–12. https://doi.org/10.5334/jime.ab

Pryor, P. (2016). Accredited OHS professional education: A step change for OHS capability. *Safety Science*, *81*, 5–12. https://doi.org/10.1016/j.ssci.2015.04.005

Pryor, P. (2019). Developing the core body of knowledge for the generalist OHS professional. *Safety Science*, *115*, 19–27. https://doi.org/10.1016/j.ssci.2019.01.013

Pryor, P., Hale, A., & Hudson, D. (2019). Development of a global framework for OHS professional practice. *Safety Science*, *117*, 404–416. https://doi.org/10.1016/j.ssci.2019.04.033

QSR International Pty Ltd. (2020). *Student pricing*. https://www.qsrinternational.com/nvivo/products?pm=Student

Qualtrics. (2020). *Research software for students and faculty*. https://www.qualtrics.com/education/student-and-faculty-research/

Rae, A., Provan, D., Aboelssaad, H., & Alexander, R. (2020). A manifesto for reality-based safety science. *Safety Science*, *126*. https://doi.org/10.1016/j.ssci.2020.104654

Ramsay, J. & Hartz, W. (2017). Model curriculum for OSH: Keys to becoming a profession. *Professional Safety*, *62*(3), 40-51.

Scott, J. G., Shore, E., Brown, C., Harris, C., & Rosen, M. A. (2019). Highlights from occupational safety and health continuing education needs assessment. *American Journal of Industrial Medicine, 62*(10), 901–907. https://doi.org/10.1002/ajim.23014

Thalheimer, W. (2018). *The learning-transfer evaluation model: Sending messages to enable learning effectiveness*. https://WorkLearning.com/Catalog

Wiley, D. (2014, March 5). *The access compromise and the 5th R*. https://opencontent.org/blog/archives/3221

Windle, R. J., Wharrad, H., McCormick, D., Laverty, H., & Taylor, M. (2010). Sharing and reuse in OER: Experiences gained from open reusable learning objects in health. *Journal of Interactive Media in Education, 2010*(1), 1–18. https://doi.org/10.5334/2010-4

Zoom Video Communications, Inc. (2020). *Zoom for education*. https://zoom.us/education

Notes on Contributor

Morgan M. Bliss, EdD, CIH, CSP, is a collegiate professor at University of Maryland Global Campus. Dr. Bliss publishes research in environmental and occupational health.

ORCID

Morgan M. Bliss, https://orcid.org/0000-0001-5336-1342

Manuscript received March 4, 2022
Final revision received April 20, 2022
Accepted May 13, 2022

Appendix A

The following limited demographic information was collected via an online survey prior to scheduling interviews.

1. Name
2. Self-selected pseudonym
3. Phone number
4. Email address, either personal or professional
5. Relevant IH/OH certifications held
6. Years of professional IH/OH experience
7. Current industry they work in (e.g., aerospace, agriculture, construction, education, healthcare, manufacturing, mining, oil and gas, public administration or government, research, technology, transportation, utilities, or other)
8. Education level or highest degree completed
9. Confirmation that they live and primarily practice IH/OH in the United States
10. A statement about whether they engage in IH/OH continuing professional development, with options of Yes, No, and Unsure
11. Commitment to participate in an approximately one-hour recorded web conference about IH/OH continuing professional development, scheduled at a mutually convenient time
12. A statement about their interest in participating in the study, with the understanding that their information will be kept confidential, and they can withdraw from the study at any time without penalty

Appendix B

The researcher developed the following semi-structured interview questions for this study about openness in IH/OH continuing professional development. Each question has the related research question indicated at the end in parentheses (for example: R1) and additional prompt questions beneath the original question.

1. How do you participate in continuing professional development? **(R2)**
    - **a.** Do you have any professional certifications related to industrial/occupational hygiene (IH/OH)? Which ones?
    - **b.** Approximately how many hours per year do you spend on continuing professional development? Is it considered to be part of your job?
    - **c.** Who is responsible for paying for your continuing professional development? Is cost a barrier for you?
    - **d.** What is your preferred method of completing continuing professional development (such as conferences, in-person courses, online courses, self-study, or some other method)?
2. Do you think continuing professional development is important to your professional practice? **(R4)**
    - **a.** What do you value about continuing professional development?
    - **b.** What other ways do you learn about new or complex topics in your field?
    - **c.** Why do you complete continuing professional development activities?
3. What is the role of professional organizations, non-governmental organizations, non-profits, and other professional advocacy groups for continuing professional development? **(R1)**

4. This study is an exploration of the *public open scholar* concept, where an academic works with a community to locate open educational content. A community must be *self-educating* in order to benefit from a public open scholar's work (Coughlan & Perryman, 2012; Perryman & Coughlan, 2013). This means that the community has a commitment to share information with new members of the community and meets the following four indicators:
    a. Cohesion (support, tolerance, and responsiveness)
    b. Participation (sustained over time, commitment from a core group of individuals, established roles and hierarchy)
    c. Identity (group self-awareness, shared language and vocabulary, and a sense of community)
    d. Creative capacity (multiple points of view expressed, with creation of knowledge links and patterns)
    e. Do you feel that the IH/OH community meets these four indicators and is a self-educating community? Why or why not? **(R1)**
5. Openness in education has been defined as freely providing resources, tools, and best practices through open sharing to all learners (Open Education Consortium, n.d.). Do you think that IH/OH resources should be shared openly? **(R1)**
    a. Should resources, tools, and best practices be provided freely and openly to anyone interested in IH/OH? Why or why not?
    b. Are there aspects of IH/OH that should not be shared openly? Why?
6. The five aspects of openness are the individual's rights to retain, revise, remix, reuse, and redistribute educational materials with open licenses (Wiley, 2014). Do you have any concerns about IH/OH resources for continuing professional development being provided with the ability to retain, revise, remix, reuse, and redistribute freely? **(R1)**
7. An open educational resource (OER) or open educational practice (OEP) is some form of educational content provided with a free and open license. Do you feel there are benefits to using OERs in your professional development? **(R3)**
    a. What would persuade you to use an OER?
8. Are there weaknesses to using OERs for your professional development? **(R3)**
    a. What would dissuade you from using an OER?
9. Please review the levels (tiers) of learning recommended by Thalheimer (2018). Which of level/tier of learning are you most interested in for your continuing professional development? **(R4)**
    a. Knowledge: Answer questions about facts/terminology
    b. Decision Making Competence: Make decisions given relevant realistic scenarios.
    c. Task Competence: Perform relevant realistic actions and decision making
    d. Transfer: Use what was learned to perform work tasks successfully
    e. Would you benefit more from knowledge, decision-making competence, task competence, or transfer of learning?
    f. Do you think OERs are capable of providing the type of learning you are looking for? Why?
10. How could OERs be created or improved to be used for continuing professional development in IH/OH? **(R2)**