GIVING SCIENCE A SEAT AT THE TABLE

A Science-Based Training on Avian Influenza Targeting Poultry Industry Executive Teams

A Thesis

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DEDICATION

To my wonderful husband:

For always being my greatest supporter and the love of my life

To my son:

My greatest joy

ABSTRACT

Avian influenza (AI) is a disease that has become a serious animal and human health risk throughout the years. An avian influenza outbreak can cause bird losses that can impact food security and the economy, which the US poultry industry has experienced during several highly pathogenic outbreaks. The Eurasian A/Goose/Guangdong/1/1996 (Gs/GD) lineage of avian influenza viruses has been unusual in its global spread, number of species infected, and decades-long persistence. As the poultry industry has grown and changed, Gs/Gd threats have emerged that are more deadly and complex. There has been an increasing number of AI outbreaks, numbers of birds lost, and disruptions to the poultry industry forcing the industry to look for better ways to guard their flocks and organizations against AI. The poultry industry needs to be prepared for AI outbreaks and how these can impact all aspects of their operations. Although preparation is not usually a priority, training employees about AI during an outbreak is not practical due to their additional workload and stress. Employees need to be trained about and plans need to be developed for AI prior to an outbreak. This preparation requires the leaders of poultry organizations to know and understand how AI will impact their business. If the leaders know prior to an outbreak what AI is, how it spreads, impacts employee workload and mental health, financial impacts, and how to make decisions and communicate during an

outbreak, their decision making will be more effective and this can help stop and prevent future AI outbreaks.

To prepare organizations for the impacts of an AI outbreak and allow science a seat at the decision making table, a pilot course was created for top executives to take during low-risk periods to prepare their teams for AI. When creating the course, adult learning techniques were considered so the viewer could engage with and reflect on the material presented. It was important that this course included all sections of a poultry organization during the learning period since all aspects of poultry production and processing are impacted when an AI outbreak occurs. Having all departments present and engaged during the course not only helps with creating an organization's preparation plan but helps everyone in the organization understand the mental and physical loads employees may experience during an AI outbreak. This course also includes training on how poultry employees may react during an AI outbreak and how team leaders can support their employee's overall health.

This course was piloted by two different poultry organizations in 2022. One organization was a mixed poultry business in one region of the US, and the other was a layer organization with farms across the United States. The teams that underwent training were given a survey to evaluate the effectiveness of the course and provide feedback. Results from the survey showed that the course was beneficial in preparing teams for an AI outbreak. Attendees indicated that they

felt prepared to communicate and create messaging for their teams regarding AI decisions and understood what their team's concerns might be. The survey also indicated that the pilot group understood who among their team was responsible for making decisions organizationally and departmentally, and who was responsible for relaying that information to all employees. Piloting this course to the different companies showed that more information on biosecurity should be included, and that specific online format for how attendees would improve delivery. As of July of 2024 the two companies that completed the course have not been or have been minimally impacted by HPAI.

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LITERATURE REVIEW – ADULT LEARNING IN CRISIS CONDITIONS

Introduction

Teaching approaches for adults should be different than those used for teaching children since adults learn differently and face different challenges.[1] The styles, concepts, and formats of materials used to teach adults need to be catered to how they learn best, and not the traditional styles used in teaching children. The main difference between child- and adult-instruction, is that adults have a lifetime of experiences that they want to connect to the subject matter. This concept can be encapsulated by saying that the adult learner wants to know "What is in it for me?"[2] When an adult goes through a course or learning experience, they want to be able to connect what is being taught immediately with how it can be incorporated into their lives. Addressing this is imperative to assure success when it comes to professional and workplace-related learnings. When an organization is setting up a training program, information needs to be presented so trainees can connect the benefits of what is being discussed to their field and needs within the first five minutes of the course.[1]

Another hurdle to consider is that adults lose information at a quicker rate than children and adolescents. Adults, on average, after twenty minutes of being

taught new information will have forgotten around 40% of the material, and after two days will only remember around 25%. [3] [4] Building connections between what is being taught and how to incorporate material immediately into their day-to-day lives is critical for adults to retain the concepts that are taught.[5]

Theories/Models of Adult Learning

Eduard C. Lindeman constructed a classification of adult learning theories in 1926 in *The Meaning of Adult Education*. His classification of theories is shown in Figure 1[6] and he acknowledges that it is important to remember that each theory individually is not complete on its own. It takes multiple theories combined to build a cohesive and successful learning plan for adults.[1] [7,8,9,10,11,12,13,14]

The instrumental steps in adult learning focus on harnessing an individual's own experience in learning content.[3,4] Humanistic approaches are important for adult learning because they place responsibility on the individual to complete the course. These approaches present a self-paced style of learning that gives the adult the ability to plan, conduct, and evaluate their own learning experience in a way that works in their individual setting.[9] Transformative steps use critical self-reflection to help the learner apply lessons to personal experience.[15] When using transformative theories in adult-learning, the reflection

process should be oriented around the meaning, structure, context, process, and premise of the learning.[11] The social theories of learning focus on combining the context of the learning and creating a community for individuals to learn together.[13] The adult learner's community will influence their viewpoints on the material being discussed. For the social theory to be incorporated into adult learning, training is best done as a social activity with a learner's peers and colleagues. When training is a social activity, not only are stronger bonds within a group of individuals established but also broader perspectives are applied to a concept that may not be captured when an adult learns independently.[16] The motivational model theorizes that adult education should incorporate motivation and reflection.[17] Motivation is needed to encourage action on whatever topic is being taught. The higher the level of perceived urgency or actual urgency, hope, or expectation surrounding the lesson, the more time and effort adults will apply to training and engagement in the process.[18] Lastly, the reflection model uses active hands-on practice to develop knowledge and skills that were introduced in the training.[19]

Self-reflection is a useful tool when creating training for adults and if done correctly can combine transformative and self-reflective theories to create a critical and hands-on reflection. When an adult reflects, which is one of the main differences between children and adult learning, it spurs further motivation to

learn.[18] Knowles identified several key topics that adults think through when going through a training (Figure 2).[20] Reflection can occur on two different spectrums, reflection in action and reflection on action. Reflection in action occurs when a person hears something new, such as when attending a lecture or discussing a problem with someone who brings a new point of view. For a person to reflect in action, they are going to take the new information they are given, and compare it to what they already know, and reflecting on the differences between what they know and what they have learned.[20] Reflecting in action is usually done during the learning process, while a person is formulating a new idea or method. Reflection on action occurs when a person is thinking through a process or decision.[17] Reflecting on action is a crucial part of learning because it allows learners to think through a process or discussion to determine if it was correct or it is an appropriate use of the material.[16] A self-reflection on action could look like a person thinking about a new process used to get results and the steps, or materials, that would be required to implement the process in their workplace. A reflection on action, using this example, may yield an outcome that the new process is not feasible or that it can be optimized with a few changes.

To build a training that incorporates both reflection in action and reflection on action, educators may utilize Kolb's Scheme to help create concrete experiences for their trainees to reflect upon.[21] The Kolb's Scheme utilizes both

reflection in action and reflection on action to help formulate and learn new concepts. Kolb's scheme uses an adult learner's experience and gives the individual time to reflect on that experience. The cycle that Kolb proposes consists of four main parts: feeling, watching, thinking, and doing (Figure 3).[21] During the feeling portion of the cycle a learner encounters a concrete experience. This experience might be brand new or a reinterpretation of an experience in light of new concepts.[22] During the watching portion of the cycle, a learner reflects on the new experience and compares it to their existing knowledge. This section of the cycle is where a person utilizes reflection in action. The thinking portion of the cycle is also known as abstract conceptualization. This space allows for learners to use what they reflected on during the watching phase and start to think of new ideas or modify a current concept.[22] The last phase of the cycle is also known as active experimentation. During active experimentation, the learner uses their newly cultivated ideas and experiments with them. This step utilizes the reflection on action concept to see how the newly created ideas or experiment might work in the learner's own setting.[22] The Kolb cycle uses this approach to form a new experience for reflection, and the cycle continues until the team/individual is satisfied that they can perform the new action or take a new direction as smoothly as possible.

When leading group-based learning, educators might pair the Kolb's scheme with the Johari window. The Johari window (Figure 4) makes two points crucially clear.[23] First, when a group of people learn a new concept together, the discussion between the attendees will increase the amount of collective practical knowledge. This is a result of individual contributions of experiences and ideas, which the group may use for reflection and learning. Secondly, the Johari window points out that sometimes it will take a new individual joining a team to solve the problem as a result of that individual's unique knowledge and understanding.[20]

The Kolb Scheme and Johari window are effective methods to utilize when there is a group of adults who are at the same level of knowledge or understanding, but many times, especially in a corporate setting, there may be a wide range of knowledge and experiences among individuals all working towards a common goal. A novice may require more surface level learning to feel comfortable with a topic whereas a veteran will want deeper and more complex information to expand on their already laid foundation of the topic. The whole goal of learning something new is to make the student comfortable enough with the material presented that they can make use of it in their daily lives, not just for acquiring information during a training and never coming back to it. When teaching a person a new topic, they may not know what to expect, what to be looking for, and may not even understand the vocabulary. This lack of

background experience can leave novices without a guide on how to interact, resulting in them not feeling empowered to ask questions. Most new learners require some background information on targeted topics before they can move forward, and especially before participating in a group setting.[14, 24, 25] In these scenarios when a teacher can help create and unite learners to get every individual to a position of understanding, they can become valued members of the community and are able to contribute and practice what is taught.[26]

There are many different theories when it comes to adult education and putting them all together can be a challenge, but Taylor and Hamdy proposed an outline that encapsulates various theories to build a cohesive learning plan for adults in the context of medical education (Figure 5).[27] Taylor and Hamdy's theory can be used in a multitude of learning environments: one-to-one, small group work, seminars, and large lectures, and is better equipped for teaching adults with different educational backgrounds. They proposed that there are five different stages that an individual must go through to learn a new concept: dissonance, refinement, organization, feedback, and consolidation.[23] The dissonance phase is when a learner sees that their current base of information is lacking or incomplete. They will then complete a challenge which ends with the adult reflecting on what they want to accomplish by learning more.[23] The next phase, refinement, seeks out solutions or ways of solving the problem.[23] The

refinement phase can encourage learners to seek out new information through completing tasks, research, reflection, or discussion with others.[23] The organization phase, allows learners to test and retest new information to better make sense of it. The feedback phase gives the learner the space to verbalize what they have learned and compare it to their peers and teachers.[23] The feedback phase is crucial because it gives space to reinforce a person's newly obtained knowledge, and to check if their understanding of the knowledge is in alignment with others in the group. If the group is not in alignment, they have the opportunity to stop and review the concepts before moving on to the consolidation phase. The consolidation phase gives the individual the space to reflect on the process, the material they just learned to identify, what they learned in regards to the group, themselves, and the learning process.[23]

Taylor and Hamdy's theory is based on the Constructivist Learning theory. Constructivism is a term that refers to the idea that learners actively construct knowledge and make meaning, based on their experiences, individually, or socially.[28] This theory assumes that knowledge must be constructed by an individual and it can't be transmitted to a person. The two main points of constructivism theory is that prior knowledge will influence new knowledge and that learning is an active process.[28] It is important to understand how Taylor and Hamdy's theory uses Constructivism because it identifies the fact that adult

learners are not blank slates; each individual is bringing their own experience into a learning situation that will impact the way they interpret the information being presented. So, even though each person going through a training may be hearing the same information, they might leave a training session with different takeaways because their individual experiences are going to impact how they go through the different stages.

Targeting "Unused Time"

For children it may be beneficial for them to congregate in a room and learn content together; but adults prefer flexibility and autonomy in how they learn.[29] [11] Adult learners often want to choose the time and speed of how they go through course content. This need to have freedom to choose when, where, and how quickly to go through material is driven by many factors such as work load, family, and other adult obligations that children do not have to deal with on a day-to-day basis.[30] Since learning pace is unique for each individual going through a course, it is important that information builds off itself to allow for content refreshers before moving into new materials. These are many reasons why online learning has become a regular tool in adult learning.

Online learning allows an adult the freedom and flexibility of completing their training at a time that works best for their schedule.[31] In a work environment,

a person might choose to go through required learning before they start work in the morning, or after business hours. A different person might choose to do their training over a lunch break, whereas someone else might choose to do it while they are waiting for their child in the pickup line at school. This freedom to choose when and where to complete the learning allows the learner to pick the time that they are going to be able to focus on the information being taught.[31] Online learning also allows learners to move through the content at their own speed. If a person is struggling with a specific concept, they can repeat and review the information before moving ahead.[32] Whereas someone else might have readily absorbed that same lesson and is ready to move ahead. The ability to customize learning plans to best fit the educational needs of the person going through the content ensures learners flexibility in time usage to optimally learn content. A person going through an online training is going to be able to choose how quickly they prefer to go through the material. If a person is familiar with topics being discussed they can go through a training quicker. If a person is unfamiliar with the topic they can stop, pause, and repeat sections of the training to ensure they fully understand and grasp the new concepts.[24] [33]

Whole Team versus Individual learning

Using an online platform to teach adults in a corporate setting has its pros and cons. Currently the most common form of online learning in a work environment uses mobile devices such as a laptop computer and course modules range between 5 and 20 minutes long.[34] Online learning has several benefits for organizations: it is time efficient, can be done anywhere, there is reduced cost of travel and time to access the training.[35] [36] [37] However, there are also some disadvantages to online training, which can be particularly problematic for agriculture companies because of their rural locations. Technological issues such as Wifi access, device issues, or being unfamiliar with training software can make completing training frustrating or unachievable.[36] When learning is done completely online, many participants can start to feel isolated from their team and peers.[33] Learners may miss out on new ideas that would be introduced through peer discussion, peer relationships and the practice of incorporating new ideas into the workplace. Self-paced learning can be an advantage for a learner to go through the content on his or her own time and speed, but it also has the disadvantage of being removed from the teacher or facilitator. If questions arise when a person is going through the content, they might go unanswered due to inability to ask them.[33] Or a person might not be held accountable to finish the

training in the first place, leaving a section of the workforce untrained in a particular topic.[38,37]

Learning in-person is the traditional style of teaching. Bringing all members of a team or organization together to learn the same materials and concepts helps build connectivity and allows people to socialize face-to-face with new and old team members.[39] Bringing employees together who have different levels of experience and expertise can help spark interesting discussions to bring new ideas to a concept. Bringing a team together in person can be beneficial when working through a scenario or case study and gives the participants a chance to read each other's body language and facial expressions that might be lacking if the exercise was done virtually.[40,41,42,43,44] Unfortunately, in-person learning also has some drawbacks. In-person learning requires people to take more time out of their busy lives, and can be costly depending on travel time and length of the training.[37,39]

With both online and in-person training having advantages and disadvantages, educators are always looking to find ways to unite the two forms of learning to create a more optimal learning environment for adults. One method - is called flipped learning.[45] For a flipped course, students review the required information prior to coming together in a group setting to expand on that knowledge using in-person group activities.[45,46] Just like any teaching method,

flipped learning has its pros and cons. Flipped learning is beneficial in that people have the freedom to do the online learning at their own pace, when they have time, speed through materials if they are familiar, or slow down if they are becoming confused.[47,48] For some people though, especially for a person who is completely naive to a topic, this isolation can make it very difficult to learn a new concept or theory especially if the learner has no background in the topic being discussed. The other main portion of flipped learning is the in-person group activity.[48–50] This group activity is a great way for learners to engage with their peers, build relationships, and promote collaboration. The in-person session also has its drawbacks. Not all people are outgoing or feel comfortable speaking up in a group situation. Or, if a person did not have time or understanding of the online materials, they might feel unprepared, confused, and feel unworthy of interacting with the group.[48–50] If a person is not comfortable interacting with their group, they could start to become isolated from the team and will not be heard and/or valued. This has the potential to create more confusion around the topic being discussed.[51–53]

Flipped learning has many positives and negatives and should be used on a case-by-case basis. Some situations and groups may thrive using flipped learning whereas others might seriously struggle. It is up to the educator to decide if flipped learning is going to be the best option for their group. If the group has

some basic understanding of the topic and everyone is comfortable speaking up and interacting in a group setting, then flipped learning could be a very great option for them. If the group is heavily divided with highly experienced and new learners, and there are some very shy individuals, flipped learning might not be the best route. A good educator will be able to understand if flipped learning is the correct learning style for a group of adults.

Trauma and Learning

Teaching and learning are always going to be impacted by the environment in which they are conducted. Creating a safe space, both physically and psychologically, is extremely important for adults to optimize their learning experiences.[54] When a person is learning in a safe environment, they are going to be more comfortable with being vulnerable. Learning something new requires vulnerability, risk taking, willingness to make mistakes, and the need to ask questions in order to critically reflect.[55,56,57] Another reason adults learn best in a safe learning environment is the fear of being exposed as an "imposter" in the group.[58] If a group of people are not comfortable being vulnerable with each other, individuals might not ask questions in fear of others thinking that they do not belong in that session. A threatening learning environment can cause a person's brain to: lose its ability to correctly interpret learning clues, lose the

ability to perceive relationships and patterns, lose long-term memory capacity, and overreact to stimuli, etc.[59] A person might feel like they are learning in an unsafe environment if they are going through a traumatic experience.

Trauma refers to extreme stress that overwhelms a person's ability to cope.[60] When someone is going through a traumatic experience it is often accompanied by overwhelming stress and a sense of chaos. During a traumatic event, people will often have thoughts of "what if" or "if only" about the decisions or events leading up to, during, and after the traumatic experience.[61] Trauma can cause people to react subtly, aggressively, or even destructively to a situation. Responses to trauma are varied and unpredictable and when the trauma occurs in a person's workplace or in their personal life, it can impact individuals, teams, and ultimately the organization. When trauma initially takes place, some common reactions are exhaustion, confusion, sadness, anxiety, agitation, numbness, dissociation, and confusion.[62,63] If a person is experiencing a delayed reaction to trauma they might present some of the following signs: fatigue, sleep disorders, nightmares, fear or recurrence, anxiety, depression, and an overall avoidance of emotions.[64] Workplace and personal trauma can become overwhelming and debilitating enough to push people out of an organization.

When a person is going through a traumatic experience, their brain struggles to maintain attention and regulate emotions that can impact their

decision making ability.[65] Sound decision making for executive leaders in an organization is critical for the growth and survival of that organization. The area of the brain that is responsible for making decisions is the prefrontal cortex. The prefrontal cortex is responsible for holding attention and analyzing a problem, having a working memory, ability to maintain the flow of information, manage emotions, and think through the steps needed to execute a decision.[66] When a person is experiencing trauma in their work or personal life, the prefrontal cortex is not able to function at its highest capacity, which can make it difficult for the affected individual to make sound decisions.[64,67,68] Decision makers dealing with trauma might struggle to fully analyze a problem because they are thinking emotionally versus logically.[69,70] A decision maker might also make unsound decisions when experiencing trauma because they can have difficulty regulating their emotions.[70] A person might experience feelings of anger, sadness, anxiety, shame, or dullness that can cloud their decision making ability to think through an entire decision.[71,72] In some people, the brain will mark the traumatic experience permanently as a life-threatening experience making anything that triggers a person move to a thinking place of danger instead of thinking logically.[73]

When a person starts to feel threatened, physically or emotionally, their body and mind will act in a way to "neutralize" the threat. The perceived threat could be a response to an active or previous traumatic experience. When the body

thinks it is under attack the alarm response is activated; this is called the “flight-or-fight" response.[74] When a person’s flight-or-fight response is activated , they move out of a homeostatic balance.[75] Once a person has identified a threat, external or internal, the brain will trigger a response called the alarm reaction that will result in a complex total-body response.[76] Some of the physical responses will be increased blood flow to skeletal muscles, release of glucose from the liver, reduced blood flow to the skin and digestive system, as well as other responses.[77] This flight-or-fight response and alarm reaction will further be classified as the “primitive brain”. While a person is operating in their primitive brain, the way they process feelings, thinking, and behaviors may change. The more time a person spends responding in a primitive brain state, the less open that person is to learning, and understanding materials, and thinking critically.[78]

Employees who are experiencing trauma in their personal or work lives will behave differently than employees who are not experiencing trauma. A person who is traumatized is less capable of concentration, more anxious, more attentive to non-verbal cues, and more likely to misinterpret these non-verbal cues. These symptoms can present themselves in a working environment as absenteeism, poor individual performances, avoiding tasks, conflicts with other employees, physical accidents, isolation, and loss of motivation.[79] If the trauma has been experienced at the workplace it might trigger people to the point of being

overwhelmed by the thought of coming to their workplace.[79] If an organization does not address a person presenting trauma-related symptoms, the disruptions can compromise the organization by resulting in missed deadlines, reduced work quality, or the loss of an employee.[79] When the trauma-related symptoms are in the executive team, then the results can be decisions that will harm the company. Organizations can help their employees prepare for high-stress situations by providing role-playing activities. Teams can prepare for unfamiliar or difficult situations ahead of time to better understand how they and others will feel during that situation.[80] By acting scenarios out, people are able to work through approaches that might help them solve the problem, work through emotions they might encounter, and understand how they fit and can rely on their team members.[80] The more time people practice a scenario the more comfortable and self-confident teams become with handling the situation in real life.[54 81] Organizations can use techniques used in a crisis management scenario when formatting their role playing and other preparedness activities.

Crisis Management and Learning

When reviewing the literature on some of the most common practices in crisis management, there are many that could be applied to a highly pathogenic avian influenza (HPAI) outbreak. Sarah Kovoor-Misra writes about the

prescription to crisis management that an organization can use to prepare for a crisis. She summarized that for any organization preparing for a crisis it is important for it to proactively address the underlying systemic causes of potential crises, institute signal detection mechanisms, and continue to learn and unlearn on a regular basis.[82] Due to susceptibility of poultry to HPAI, and the overall disruptions the disease causes to poultry companies, organizations can address their systemic causes of potential crises by maintaining open communication channels so that bad news can be received, or to ensure that appropriate assumptions and beliefs are present in their culture.[67 68] For example early detection is key to help stop a crisis from becoming a full-blown crisis and some examples could include: audits, surveys, hotlines, and issue management committees.[83 84–87] For an HPAI outbreak, early detection in an organization could come from mechanisms such as biosecurity audits, surveillance testing, or systematic review of the USDA's database (https://www.aphis.usda.gov/livestock-poultry-disease/avian/avian-influenza/hpai-detections) to understand new and emerging risks.

The last point that Sarah Kovoor-Misra addresses is the ability for organizations to practice learning and unlearning. Fink, Shrivastava, and Mitroff recommend organizations practice "no fault" and "near miss" investigations and evaluations.[84–86] These practices can be used when preparing for an HPAI

outbreak by reviewing biosecurity practices annually or after each outbreak, or when an employee leaves the organization. For organizations to practice unlearning, Nystrom and Starbuck suggest that leaders within an organization align their practices with reality by "listening to dissent, adopting experimental frames of reference, and converting event into opportunities.[88] For a poultry company this practice of unlearning during an AI outbreak might look like executives going to a farm and walking through their biosecurity measures and practices to brainstorm how to improve. The practice of unlearning is all about individuals being vulnerable about their policies, procedures, practices, and management styles and being open to criticism and being incorrect.

Crisis containment is a process that is developed by an organization to manage a crisis that is actively occurring. Many authors note that an organization should develop plans and teams that align with different crises.[83,85,89–91] Mitroff makes note that an organization should prepare for a range of different crisis scenarios.[85] This concept can be carried over to poultry organizations and used to prepare for different types of avian influenza outbreaks, a product recall, or a welfare issue, etc. Using the avian influenza example, some outbreaks might be low pathogenicity, and some might be highly pathogenic, which will have very different involvement of the poultry company, regulatory agencies, and different outcomes. Poultry leaders need to be prepared for all forms of avian influenza

outbreaks because in all cases, many people and stakeholders are going to be impacted. Many authors suggest that an organization's crisis response teams should include stakeholders that are going to be impacted short- and long-term, and rely on scientific, tangible information to build their action plan and/or prevention plans.[92] In an avian influenza outbreak scenario this might include people from live production sectors alongside employees from marketing or transport sections in a poultry company. Each of these departments is going to be impacted; it just a matter of when in the course of a response that will happen.

The other important thing to note when trying to contain a crisis is creating a way for people to cope with the stress and helping prevent the loss of meaning which can occur during a traumatic time.[89,93–97] One way organizations can provide this safe space for coping is through cross-functional crisis management teams.[83–86,90,91,98] These cross-functional teams can utilize techniques such as role-playing, behavior modification, and "what if" scenarios.[83,,85,98,99]. This type of training can be very helpful for team members to develop "virtual role systems," where each team member can understand their own role and the roles of others during a crisis.[69]

After a crisis, recovery helps employees within an organization to overcome the trauma that occurs during the crisis. A lot of focus is placed on preparing and containing a crisis, but little attention and research has been placed

on how to recover the human resource. Some of the research that is available focuses on the psychological trauma that can occur after a crisis. An employee experiencing psychological trauma might experience anger, anxiety, depression, difficulty concentrating, nervousness, and withdrawal.[100–103] Organizations that can provide support for the psychological trauma experience less turnover, higher morale, and a quicker recovery than organizations that do not.[103] Wolf wrote that organizations that do not provide timely and adequate emotional support, risk further traumatization of their employees.[100] An avian influenza outbreak can cause psychological trauma to employees working in the poultry industry. Organizations need to understand the emotional toll of a crisis on their employees and be prepared to support them before, during, and after an outbreak.[100,103]

Conclusion

There are many different theories on how best to teach adults. Having a clear path to understand how to teach an adult is important when trying to teach or handle traumatic and stressful situations. When an organization is working through a traumatic scenario many decisions need to be made very quickly. For a group of adults to make these decisions successfully every member of the team needs to have a full understanding of the situation, which may require some

individuals to learn new concepts. Trying to teach these team members everything they need to know in the midst of the traumatic experience will impact how quickly and well they will learn. To minimize the impact of a traumatic experience, organizations can prepare their teams by teaching them the ins- and outs- of stressful situations. Organizations can use crisis management tools and techniques to prepare, learn, unlearn, contain and recover from a traumatic situation.

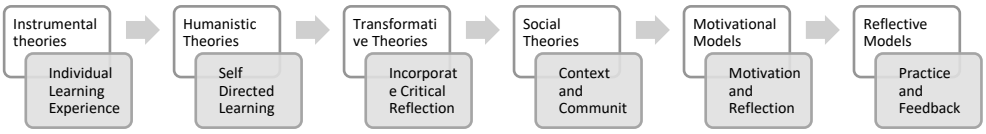

Figure 1: Adapted by the Different Adult Learning Theories and Models

[3,4,9,11,13,15-19] Figure 1 shows how multiple educational theories are needed when building a cohesive learning plan for adults.

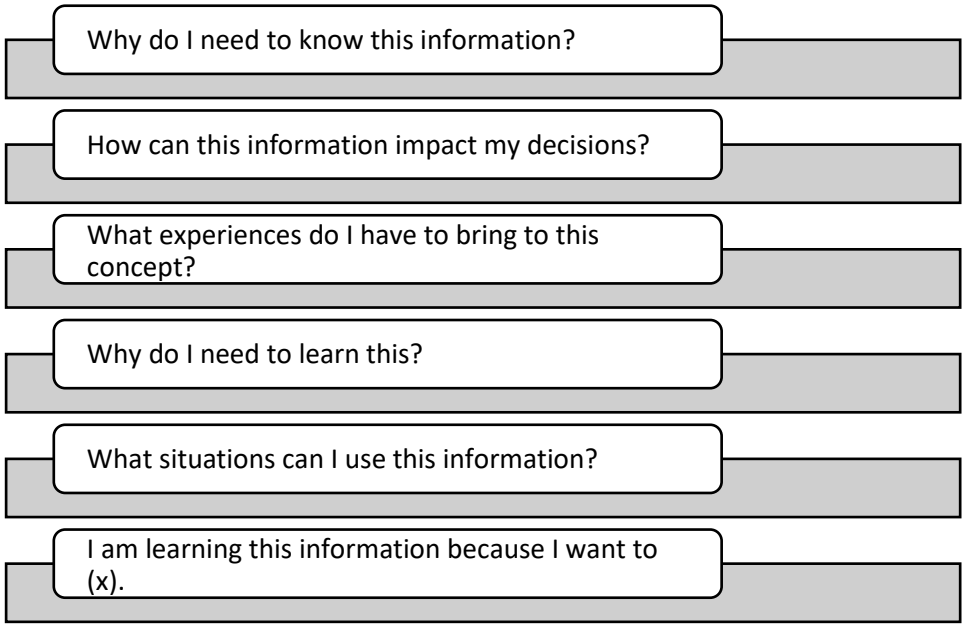

Figure 2: Adapted by Knowles' Six Topics for Adult Learning.[20] Knowles identified these six topics for adults to think through and reflect on when they are going through a training. Reflection is important for adult learning because it helps connect why the learning is important and how it can be implemented immediately into their day-to-day lives.

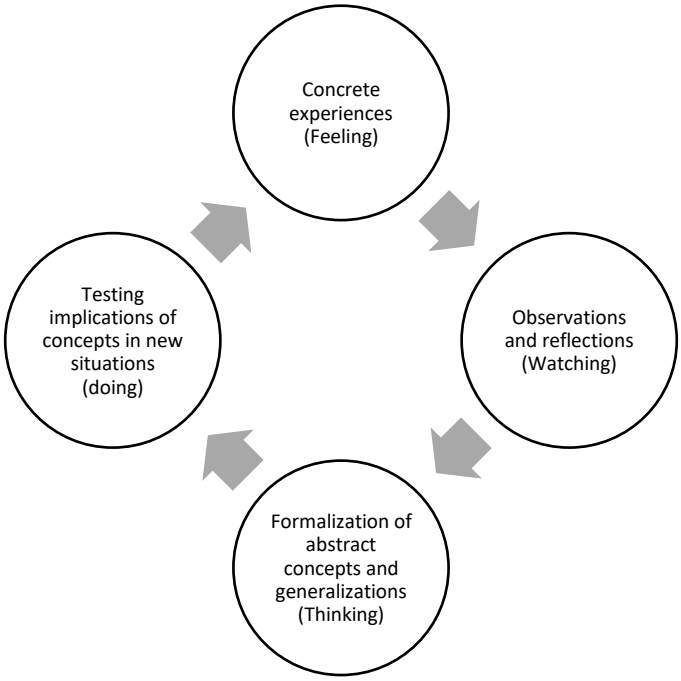

Figure 3: Adapted from The Kolb Cycle.[21] The Kolb cycle is another tool an educator can use to help adult learners reflect on the new information they are learning. The goal of the Kolb cycle is to use the adult learner's experience and give space for them to reflect on that experience using these four main parts.

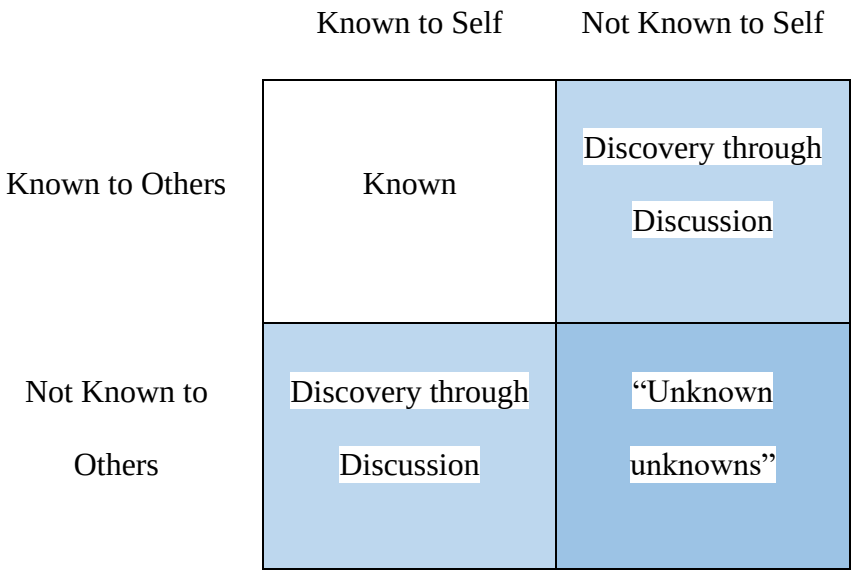

Figure 4: Adapted by The Johari Window, Luft, and Ingham (1995).[23] The Johari window is a tool educators can use when working with a group of adults. The Johari window creates space for a new individual to bring their own ideas and experience to a group and create new thoughts based on the discussion and reflection.

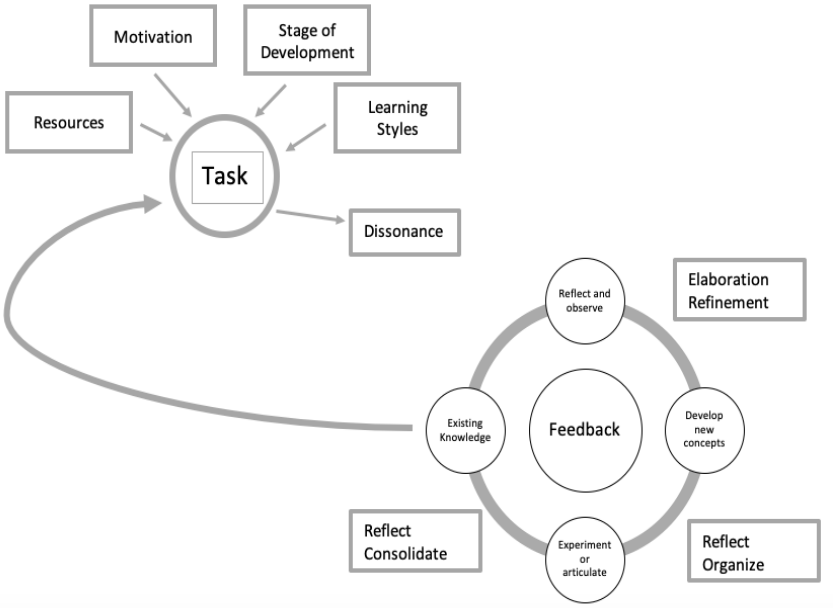

Figure 5: Adapted by Taylor and Hamdy's Adult Learning Model.[27] This model is a great example of multiple adult learning theory and models coming together to create a more cohesive learning plan. This model is a great model to use when the group has mixed levels of educational background. Taylor and Hamdy's model understands that adult learners actively construct knowledge and make meaning, based on their experiences, individually, and/or socially.[28]

CHAPTER 2

LITERATURE REVIEW – AVIAN INFLUENZA AND IMPACT ON POULTRY AND PEOPLE

Introduction

Many executives in the poultry industry are not trained in scientific and technical information about potential crises such as disease outbreak, food safety tracebacks, and even natural disasters. Executives understand that these scenarios can be devastating and have tremendous impacts to their organizations but lack the need-to-know specific information on how to prevent, control, or prepare for these crises. This scenario emerged in recent HPAI outbreaks especially since HPAI had not been detected prior to 2015 in Minnesota. Many poultry production companies were overwhelmed with impacted farms and reacted with bare bones plans and outdated information because they had nothing else immediately available. The resulting reactions were not based on the most recent findings on HPAI and could have caused disastrous situations when companies failed or made choices that would lead to unintended consequences. Allowing science to have a seat at the table where decisions are made, will help provide up-to date information and allow all executives to understand and make better choices. This

concept of bringing up-to-date science into decision making could help with the responses to other diseases or challenges.

Avian Influenza

Avian influenza (AI) as listed by the World Organization for Animal Health (WOAH), has become a disease of great importance for animal and human health.[104] Avian influenza is a disease with a broad potential for pathogenicity from low to high. Some avian influenza outbreaks have been minor in bird and economic losses, but other outbreaks, such as the outbreaks caused by the Eurasian A/Goose/Guangdong/1/1996 (Gs/Gd) lineage viruses have been devastating. The number of domesticated birds across the world impacted by AI outbreaks has increased, from 23 million from 1959 through 1998 (39 year span) to over 200 million from 1999 through 2005 (6 year span)[105], and over 150 million from 2014 through 2024 (10 year span)[106,107,108] mostly as a result of the spread of the Gs/Gd -lineage viruses.

Influenza viruses, from the *Orthomyxoviridae* family are negative-sense, single-stranded and segmented RNA genome viruses that have four different types, A, B, C, and D.[109] Avian Influenza is caused by type A influenza viruses.[109] The influenza A viruses contains eight gene segments and has at least ten proteins: polymerase basic 1 (PB_1) and 2 (PB_2), polymerase acid (PA),

hemagglutinin (HA), nucleoprotein (NP), neuraminidase (NA), matrix 1 (M_1) and 2 (M2), nonstructural 1 (NS_1), and 2 (N_2).[110,111] The HA component of the virus is important in virus attachment to the host cell, and is the main target of the humoral immune response (antibody based immunity). There are sixteen HA types and nine NA types that make up different subtypes of avian influenza viruses that have been isolated from wild waterfowl. The different combinations of HA and NA determine viral subtype and encode many of the characteristics the virus will have, such as its virulence. In poultry, the virus is further divided into pathotypes based on the type of HA, making the virus either a highly pathogenic or a low pathogenicity avian influenza virus.[112] As of this writing in July 2024 only viruses of H5 and H7 subtypes have been shown to cause highly pathogenic avian influenza (HPAI), but not all H5 and H7 viruses are highly virulent; some are of low pathogenicity.[104,113,114,115] All other HA's cause low pathogenicity avian influenza (LPAI) in susceptible poultry.[112,116,117]

Avian influenza viruses are considered to be the ancestors of the influenza A viruses (IAV) of mammals and birds.[110,118–130] All known genetic subtypes of influenza A viruses circulate and spread through wild aquatic birds such as ducks and geese.[110,127,131–133] Aquatic birds spread and carry IAV, passing them to their offspring during breeding and other birds when migrating.[134,135] The migration of wild birds results in the exposure of naïve hosts as the birds gather, commonly

hatch-year birds, who will replicate the virus in large amounts. The large amount of virus is deposited into the environment where new hosts may be exposed. When the AV virus spills over into domestically-raised birds such as turkeys, the disease caused is often more pronounced than it was in the wild aquatic bird reservoir hosts.

Although all avian influenza outbreaks are a concern, producers are constantly surveilling their flocks for AI viruses because of the host's susceptibility to the AI viruses, especially highly pathogenic avian influenza (HPAI) virus. The most common sign of HPAI is a rapid increase in mortality.[136] A flock with HPAI can experience mortality that increases from tens, to hundreds, to thousands in a span of one or over a few days.[137] Other signs a poultry grower might see prior to the rapid increase in mortality is a decrease in water consumption, respiratory issues such as gasping, and digestive issues like diarrhea.[138] In breeders or laying hens there might be a reduction in egg production or hens may lay soft-shelled or misshapen eggs.[139] A turkey grower might also see nervous signs such as tremors, twisted necks, paralyzed wings, and birds laying down and pedaling with their legs.[140] In an untreated naïve chicken, HPAI will cause multiple organ failure in individual birds leading to mortality of 90 to 100% of the flock within 48 hours in the fastest spreading strain although

near total mortality of a flock may take much longer with slower spreading HPAI viruses.[141]

In recent years, the number of mammals being impacted by AI has increased. As migratory birds continue to migrate and circulate, they continue to spread viruses of the Gs/Gd lineage into environments, and other hosts at increased rates. In the 2022/3/4 outbreak, the result is the detection of Gs/GD H5 viruses in many different species of wild birds and mammals.[142,143] In 2024, more domesticated animals have also been infected including goats, cats, and cattle.[144,145,146] In early 2024, the dairy industry started to see confusing health challenges such as decreased milk production, low appetite, and abnormal colostrum-like milk.[147,148] After extensive diagnostic work, the dairy cows were confirmed positive for Gs/GD H5 influenza virus. This spillover of H5 influenza virus into dairy cows has caused a situation where so much virus is shed, that mammals that have never been infected with H5 influenza virus are now becoming infected. An example of this was seen in the recent infection of alpacas.[149,150] As of this writing in July 2024, the ecology of the Gs/GD HPAI viral lineage in North America is emerging and changing. Because the clinical signs of disease or viral shedding patterns are known in all infected species, critical processes like transmission cannot be fully understood. This shift of H5 influenza into mammals creates many questions that researchers and scientists are

going to have to answer and understand to give the agricultural industry and backyard producers tools on how to stop and control the spread of HPAI. It remains rare for humans to become infected with H5 influenza, but as of this writing in July 2024 four cases related to dairy H5 infections have been identified in recent months.[147,151,152]

Globally, from January 2003 to October 3rd, 2023 there have been 878 confirmed cases of human infection with avian influenza A (H5N1, Gs/GD lineage) reported from 23 different countries.[153] From these 878 cases, 458 of them have been fatal, making a case fatality rate of 52%.[153,154] Avian influenza is a zoonotic disease and people who are in close proximity to a source of virus are at greatest risk of infection.[155,156] A person infected with an H5 influenza virus will most likely present symptoms similar to any other influenza-like illness, such as fever, dry cough, body aches, and nausea.[157–162] A more severe presentation of H5 might have a person experiencing inflammation of the lower respiratory tract leading to respiratory distress, multiple organ dysfunction or death.[157,158,163] The incubation period for H5Nx is estimated to be three to five days, all the way up to nine days in humans.[157,158] The average time it will take a person to start experiencing symptoms to death is commonly eight to twelve days.[155] The more extensive or prolonged exposure a person has with poultry or other animal infected with AIV, the greater their chance of becoming infected. The lack of

receptors for AIV in the upper respiratory tract make it difficult for a person to become infected with an AIV, but once the virus is present in the system, the presence of AIV-susceptible cells in the lower respiratory tracks make it so a person can become very sick.[164,165] A human pandemic with avian influenza could become a catastrophic situation if the virus adapts to effective at human-to-human transfer.[166]

History of Highly Pathogenic Avian Influenza

The United States has had a long history with avian influenza including several HPAI outbreaks (timing and length of those outbreaks is shown in Figure 6). One of the first major outbreaks in the United States was in 1983 in Pennsylvania and lasted for 6 months. More than 17 million birds and 356 sites were impacted costing over 312 million dollars.[167,168] The Pennsylvania outbreak first started as an LPAI outbreak that was circulating through chickens, but through mutations in the virus, became highly pathogenic and caused devastation.[169] Because of improvements in surveillance and intensive, industry-wide biosecurity procedures, HPAI did not occur in the United States for the next 21 years. In 2004 there was a singular case in Texas of an infection from a virus that met the molecular definition of HPAIV but was clinically LPAIV. That virus did not spread and the outbreak was limited to one farm.[170] The case in Texas

contained only one 6,600 broiler complex in Gonzales County, Texas.[171] It took another thirteen years before the United States saw HPAI again. In 2014-2015 H5 HPAI of the Gs/GD lineage emerged in the US and impacted over 211 commercial operations across 21 states leading to the depopulation of over 7.4 million turkeys and 43 million egg-layers/pullet chickens, as well as various other backyard operations resulting in an economic loss of over 3 billion dollars.[106,172,173]

The Gs/GD H5 lineage of viruses has continued to evolve and in October 2021, a distinctive H5Nx 2.3.4.4b virus was detected in wild birds in the Netherlands.[174] Since then, many European countries reported seeing 2.3.4.4b H5Nx detections in their wild bird populations prior and up to December 2021.[175] [176] The 2.3.4.4b virus continued to circulate around Europe using the Eurasian flyways until the 2.3.4.4b clade was detected in Canada indicating that transatlantic spread had occurred.[177,178] It did not take long before the H5Nx 2.3.4.4b viruses were detected in North Carolina at the end of December 2021 through hunter-harvested duck surveillance.[174,177] After the introduction of H5Nx clade 2.3.4.4b the US was impacted with a more widespread HPAI outbreak than it had ever experienced before.

HPAI outbreaks are becoming more and more common. Since the 2000s, the US has experienced eleven years where there has been an occurrence of

outbreak events for HPAI in wild and captive birds as reported to WOAH.[179] The speed at which outbreaks are impacting the US, is making it harder for people to view them as infrequent events. As HPAI continues to circulate and re-appear, it is becoming clear that the poultry industry might have to operate in an environment that always holds the threat of HPAI.

Each HPAI outbreak carries its own set of challenges and obstacles, but as more HPAI outbreaks impact the US, they are becoming more complex and difficult to eradicate. Looking back on previous outbreaks we can see how the complexity of HPAI outbreaks has increased over time. The Pennsylvania outbreak in 1983 began as an LPAI outbreak. Impacted flocks experienced mortality from zero to 15% that might be isolated to a single barn or floor of chicken house.[168,169] At the start of the 1983 outbreak only five to seven new cases were reported during the June through September months, but by late September through October multiple new cases were reported everyday.[168,169] By late September the causative LPAIV strain had mutated to become highly pathogenic. Biosecurity concepts in 1983 were not fully developed and very little was known about the shift in pathogenicity through viral mutation that could occur. This allowed time for the virus to circulate and accumulate mutations resulting in the emergence of HPAIV and spread to new farms.

The next known outbreak in 2004 in Texas started as an HPAI outbreak. The 2004 outbreak was limited to only one farm site and two live-bird markets in the Houston Texas area.[170] [171] This short outbreak showed that HPAI could infect farms without having an LPAI precursor circulating in the area prior to the appearance of an HPAIV. The 2016 and 2017 LPAI outbreaks came from viruses that arose from North America and can be used to emphasize that the virus is an always present threat. These two outbreaks were limited to a few sites and had minimal distributions to the poultry industry as a whole, but still caused individual organizational work flow disruptions and stress for those employees impacted by those positive sites.

As the poultry industry grew, expanded, and became more connected, it created opportunities for Avian Influenza Virus (IAV) to evolve. Every avian influenza outbreak acts and spreads differently due to the virus' promiscuous nature and the many possible hosts.[110,,114–117,127,132] As an example, the 2015 and the 2022/3/4 HPAI outbreaks had similarities but were also very different from each other. The 2015 outbreak of HPAI was the first introduction of the Eurasian lineage of IAV arising from Gs/GD to North America.[180] This lineage of viruses has spread across the globe through the movements of wild birds.[181] In the United States, the result was a large and expansive outbreak mostly spread from farm to farm. This outbreak began in Washington state at the end of 2014 and lasted

through June 1st 2015 with the majority of the impacted farms located in the upper Midwest.[182] By the end of the outbreak, the virus had been detected in 21 states, 232 poultry farms, over 49.6 million birds were depopulated, and it required $879 million dollars to stop the spread.[106,108,183] After the outbreak ran through the states, wild bird testing continued and found that no wild birds were carrying HPAI. The USDA samples over 45,000 wild birds and there were zero positive HPAI cases.[184]

The 2015 outbreak shed light on how easily this virus can be transferred laterally from site to site. In the second North American introduction of a Gs/GD lineage HPAI virus, the result was equally devastating. At the time of this writing July 2024, the 2022/3/4 HPAI outbreak has 1,164 confirmed cases in 48 states in the US and has impacted more than 99.10 million birds.[185] The 2022/3/4 outbreak, had numerous more cases of positive backyard flocks as compared to the 2015 outbreak. In 2015 there were twenty-one detections in backyard flocks, and as of July 2024 there have been 661 HPAI detections in backyard flocks, and continual wild bird detections.[186] The result has been a poultry production environment saturated with HPAI virus that was difficult to exclude with biosecurity.

Need for Speedy Decision Making to Control an Outbreak

Avian influenza is a crisis that is currently impacting the poultry, employees, and stakeholders within the poultry production and processing industries and was why it was the topic chosen for this project. When an organization navigates an AI outbreak, executives have to make many decisions that will have critical outcomes in how the company weathers the crisis. Their knowledge base and preparedness may significantly impact their likelihood of being successful.

In Figures 7a and b we can see that during the 2015 and 2022 HPAI outbreaks there were a significant number of cases in the US starting near the end of March and continuing through June.[104,105] When cases are occurring rapidly, as happened in these outbreaks, many decisions need to be made just as rapidly and when leaders are not prepared, it can result in viral spread and expansion of the outbreak.[112,166,187] The stress placed on executives to make decisions at the start of an outbreak can become very emotionally taxing, but using science can provide evidence for those decisions and practice can help alleviate some of the stress of decision making.

Working in the Poultry Industry During a HPAI Outbreak

Working in the poultry industry during HPAI outbreaks requires people to make many weighty decisions that creates a very stressful work and life environment.[188] Industry personnel are left with a lot of "What If" questions: "What if my birds get sick?" "What if I lose my job?" "What if I am the one that brought in the virus?" "What if my company goes under?"[189] These are some of the questions felt by people working in the field and can lead to devastating effects on their mental health and well-being. Professor Jeff Bender at the University of Minnesota summarized what it was like for a grower to depopulate their birds. He discussed the physical and mental anguish of watching his birds get depopulated, and worrying about how he would dispose of them.[190,191] Being a farmer who has had a case of HPAI in their birds comes with a stigma not only within the industry but from the community that can push people into isolation.[191] The stigma around having a flock with HPAI can make a person feel like they have no one safe to talk to who understands , which can further isolate an employee, increase their stress, and contribute to a person leaving the poultry industry.[192]

The poultry industry has a high turn-over rate among employees, at around 65% annually based on a survey conducted in 2018.[193] Considering the infrequency of HPAI outbreaks in a specific location, when an outbreak occurs, a

poultry company could have had nearly a complete change in employees since the last outbreak. While not all of these employees are high-level executives, many high-level employees frequently change jobs. A recent study conducted by Forbes showed that almost 70% of executives are considering a change in career at any given time.[194] In addition to the already high rate of turnover, these high-level employees might feel frustrated with the demands put on them to operate the company during an HPAI outbreak. People in high-level managerial roles will experience an increased burden on them during HPAI due to uncertainty and lack of consistency in the policies with which they need to comply causing executives to have increased responsibility, decreased resources, and an exhausting schedule for months on end.[22] These factors can lead an individual to stop practicing self-care and turn to unhealthy coping tactics or burnout.

Conclusion

Avian influenza viruses circulate in wild waterfowl usually not causing disease. When they spill into domestic poultry, they can cause highly pathogenic or low pathogenicity avian influenza outbreaks. Influenza A viruses originate from waterfowl but have also established infections in mammals including humans. Some strains of avian influenza, particularly those of the Gs/GD lineage, are zoonotic and can directly infect humans and other mammals. Outbreaks with

Gs/GD lineage H5 HPAI viruses have occurred globally including in the US. It is important that outbreaks are prevented or contained as quickly as possible because an outbreak can cause trade and business disruptions, mortality in birds and wildlife, and mental strain on people working with or around the outbreak. Working in a poultry company at any level during an avian influenza outbreak can be very stressful and traumatic. There is an increased work and emotional load placed on employees and leaders needing to understand how an outbreak will impact their business and employees to help prevent and contain outbreaks. It is important that poultry executives and leaders understand the science on how the AI virus is spread, how flocks and employees are going to be impacted, and what steps they, as a team, can take to help stop and prevent future outbreaks. All of these topics need to be discussed through the lens of current science surrounding AI. If executives are able to use science to help steer and guide their decision making, their organization and employees are going to be able to weather an AI outbreak better.

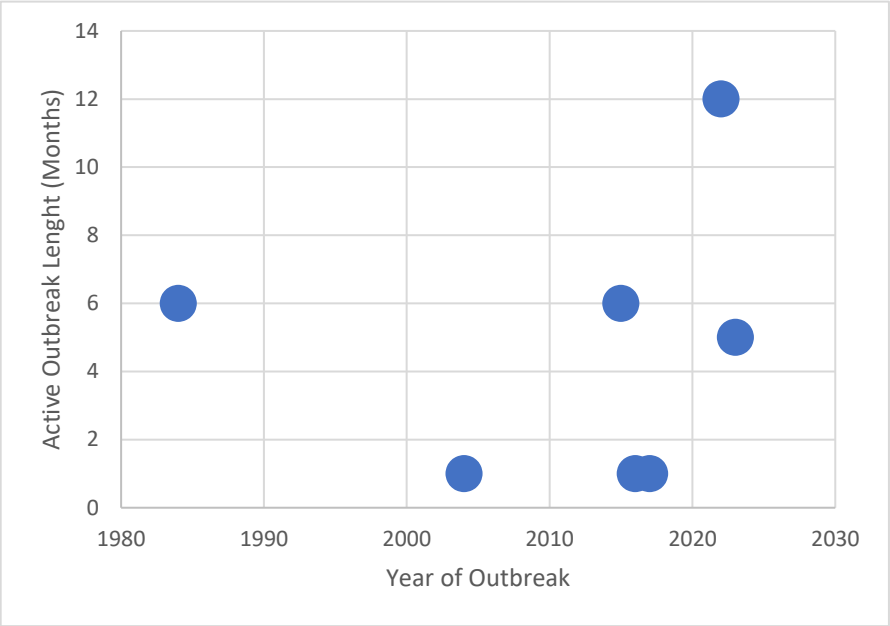

Figure 6: Adapted by Timeline of Avian Influenza Outbreaks in the United States.[185] The timeline of avian influenza outbreaks shows that the United States has had a long history with avian influenza, but in recent years outbreaks are reoccurring at a faster pace than in the past.

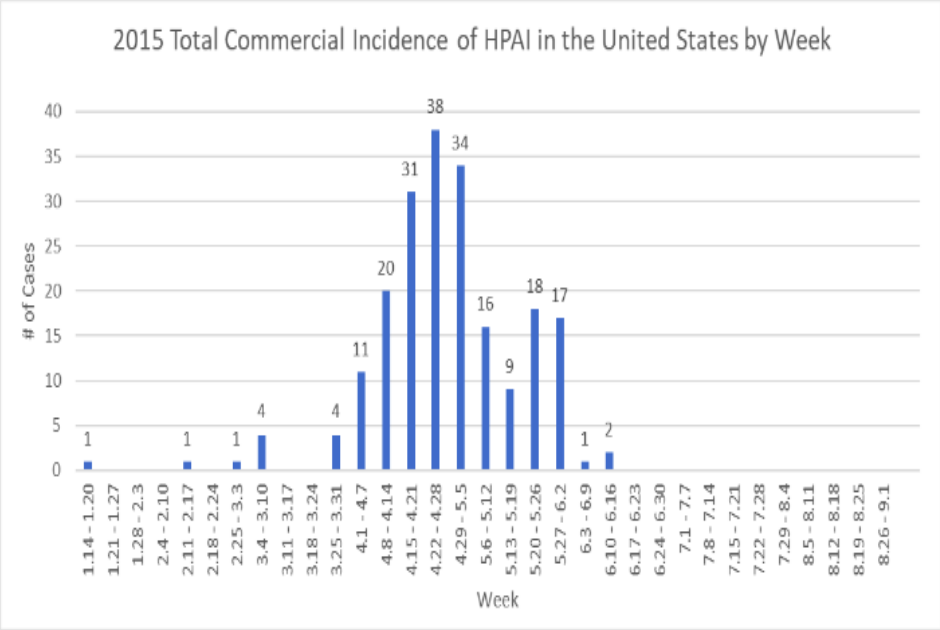

Figure 7a: 2015 Incidence of HPAI in Commercial Poultry in the United States by Week.[104] The 2015 HPAI outbreak in the United States had the majority of their cases during March through June. The peak occurred in April with 38 cases detected in one week.

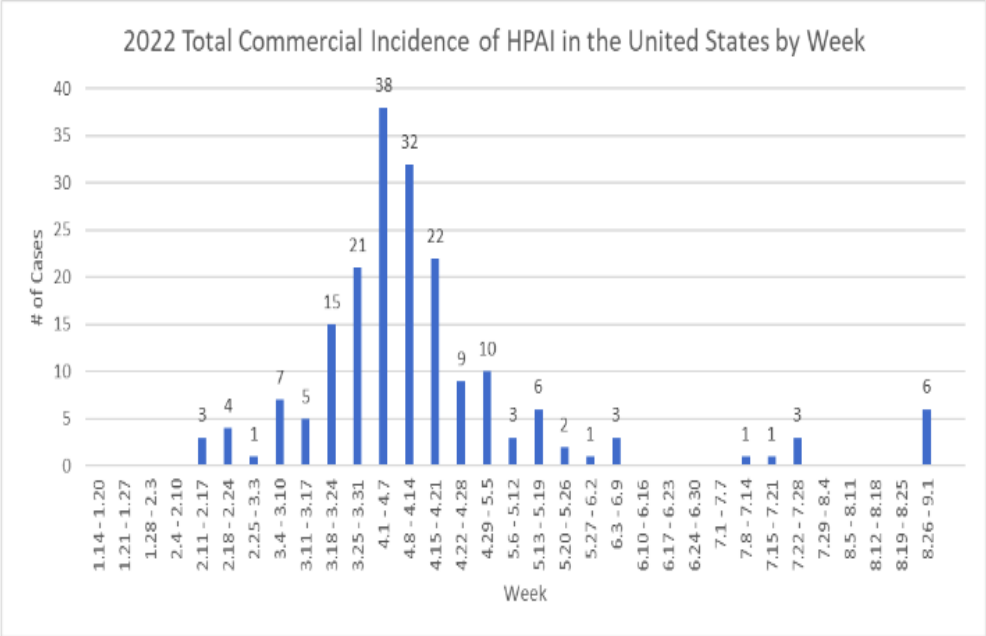

Figure 7b: 2022 Incidence of HPAI in Commercial Poultry in the United States by Week.[105] The 2022 HPAI outbreak still had the majority of cases break during the spring months, but the United States saw cases in the fall/winter during this outbreak which was abnormal. The peak occurred during April with 38 cases detected during one week, which was similar to what occurred in the 2015 outbreak.

CHAPTER 3

CURRICULUM DEVELOPMENT CONSIDERING TARGET AUDIENCE AND NEEDED COURSES

Need for AI Specific Training

As HPAI outbreaks increase in frequency, the poultry industry needs to learn how to operate during and through them. When HPAI virus is circulating in the environment, it requires a team of organizations that work together to help keep commercial and backyard flocks free of infection and eliminate positive cases. This team of organizations is built from public and private sectors and aims to help give the poultry industry the best chance of success in controlling the outbreak. When each player of the poultry industry is trained on what their role is during an outbreak they are going to be able to act swiftly and effectively to perform their tasks. For example, a private grower needs to understand the signs and symptoms of HPAI in their flocks and who to contact to start testing their birds. Or a publicly run lab that is processing samples needs to understand how their hours of operations might have to change to be more available for sample runs during an outbreak. They need to prepare their labor for increased workloads. Organizations need to start training their employees and preparing their

organization for HPAI outbreaks routinely because HPAI outbreaks are becoming a routine occurrence in the United States.

The 2015 HPAI outbreak taught those who experienced it that quick and timely responses are required to limit the spread of virus between farms. The difficulty is that both bird owners and regulatory agencies need to be engaged in response to achieve success. Large privately-owned organizations are important to engage because they control large populations of poultry. These privately-owned organizations can take proactive steps to increase day-to-day biosecurity and surveillance to help stop the initial introduction/spread of the virus and greatly impact outbreak outcomes. Regulatory agencies are involved when HPAI emerges and have authority to implement big changes, like quarantines and other restrictions. Public-private partnerships are crucial to make sure information is shared in a way that it can be used and implemented immediately at all levels across the public-private spectrum.[195] For example, poultry growers are crucial in stopping and preventing outbreaks because they are the people watching and monitoring their birds on a daily basis and can participate in detection of HPAI if their birds are showing clinical signs. The speed at which birds are confirmed as positive, can increase the speed of depopulation, reducing the amount of virus that is produced and shed into the environment. To start this process of detection,

however, it takes a grower who knows and is trained on what to look for and who to call if they see it.

Training organizations and employees about HPAI is crucial for outbreak prevention and virus elimination. If an organization's leaders understand what the HPAI virus is and how it operates, they will have a better understanding on why specific tasks and regulations are in place. Understanding the virus and the disease will also help organizations understand what biosecurity measures to implement, better preparing their farms and employees for an increased or at least different workload during high risk times.[196] Training the leaders on the impacts of HPAI will also help prepare these leaders for how their employees might react and what support they may need to endure the stressful times ahead. HPAI training will help determine responsibilities, align tasks, and help provide a sense of preparedness for a very unpredictable time.

Providing initial training for a HPAI outbreak is important, but retraining is just as important. The HPAI virus is constantly evolving, changing, and acting and presenting itself differently so industry players need to understand how these changes are going to impact their everyday jobs. After the 2015 HPAI outbreak, one of the main lessons learned was the risk associated with rendering and garbage trucks coming near barns.[197,198] During the 2015 outbreak, 70% of the HPAI cases were attributed to lateral spread (between farms), whereas in the

2022/3/4 outbreak only 15% of the introductions have been attributed to lateral spread.[199,200,201] This decrease in lateral spread from 2015 to the 2022 outbreak shows how the lessons learned from 2015 have helped in 2022/3/4 but also new lessons continue to present themselves. In the 2022/3/4 outbreak wild bird introductions continue to pose a big disease risk and are a main point of introduction.[200] These wild bird introductions show how important of a role biosecurity plays in limiting the impact of wild birds at farms and facilities.[202 203] Each HPAI outbreak is going to come with its own unique challenges and lessons forcing poultry industry personnel to constantly adapt and change their approaches to make sure they are protecting birds and their organizations for the current virus. The poultry industry needs an avian influenza course that provides information on the basics, allows organizations to think critically on how their team is going to operate and change during an outbreak, and how these policies and practices might change with future outbreaks.

When a company is taking an avian influenza course, they want to ensure that the material they are receiving is specific to their industry and that it addresses the risks that their commodity faces in an outbreak. In learning to adapt approaches needed for disease control, a company needs to address industry-specific issues such as how production and placement will be impacted by restricted movements. When movements get stopped or altered there will be a

domino effect that leaders will need to be prepared for and the costs associated with them. These movements could look like delaying a placement, reducing hatching egg sets, or moving market schedules around. Each of these movements can improve an organization's biosecurity but have negative impacts to the normal movements and a company's bottom line. Having a course that an organization can take to run through different business decisions to determine the pros and cons of each strategic decision during times when there is not an outbreak, will speed up the decision process during an outbreak because the cost and benefits of various scenarios have already been considered.

Target Audience

It is important that a course can be altered to present information that is tailored to the specific organization enrolling in the course. Each organization is going to have a different corporate structure. For example, a larger organization might have a singular vice president overseeing one department, whereas a smaller operation might have one person overseeing very different departments (Figures 8 and 9).[204,205] Corporate structure will impact the specialization of executive team members. An organization that has a large group of executives will have leaders that are very knowledgeable in their specific areas but might not have a great understanding on how different departments work. In contrast, a

smaller organization might have upper management members oversee many different departments and understand how they work together, but they might not be able to bring as much depth of knowledge for the individual department.[206]

Targeting the executive team for training is critical to help stop the spread of avian influenza because these are the individuals who make decisions that can drastically change outbreak outcomes. If everyone at the executive level understands the basics of avian influenza, what business decisions are needed in an outbreak, and how it is going to impact their employees and organization, the better the outbreak outcome will be. Figures 10 and 11 are examples of who might be a part of the executive team taking this course and some of the industry specific information they can bring to the conversation.[208]

In a corporate structure like that shown in Figure 8 the company president will be responsible for bringing the decisions made back to a board of directors and the company owner as shown in Figure 10.[209,210,211] It is important that these decisions are thoroughly thought through and correct to help stop the spread of avian influenza and ensure the longevity of the organization. In the best case scenario, a company president relies on a team of vice presidents to use their expertise to lead the decision making for their departments, and rely on each other to help make decisions for the organization.[211] This model assumes a highly functional executive team with the ability to trust each other and communicate

well. It is also possible that the VPs might not understand deeply how other departments operate and how they will be impacted by an avian influenza outbreak. When this is the case, one department's input and voice can be amplified or silenced leading to a lopsided response.

In an alternative corporate structure, such as shown in Figure 11, the company owner is tasked with final decisions based on the support of their team. The VP of products brings their knowledge of sales and marketing but might choose to recruit their HR lead to provide deeper knowledge to employees. The VP of operations will be deeply impacted by an AI outbreak and might choose to have the manager of live production and their manager of operations be a part of an AI team to help bring a deeper level of expertise and a different perspective to the team. A technical service team member might also be sought out to be a part of the team to bring subject matter support. It is important that whatever corporate structure there is, an avian influenza response team will include the relevant expertise coordinated so that each member's opinion and expertise is heard, regardless of their level within the organization.

An organization's executive team is the team that determines the course of action, prevention, preparation, and response for an avian influenza outbreak. But policies and decisions are interpreted and implemented at the farm level. It is thus important that executive team members have the background to understand day-

to-day operations and to hear about impacts changes will have especially when dealing with an animal disease emergency like an avian influenza outbreak. As shown in Figure 12, employees who are further up the corporate structure move further away from the on-farm activities of the operation.[210]

An avian influenza course needs to be able to overcome this type of separation to ensure that communication freely flows upwards and downwards through an organization. Since there are members of the decision-making team who are not going to understand farm operations, it is crucial that feedback from the individuals having the most interaction with the birds are heard. Having an avian influenza course that is targeted for the executive team, but shows how important free-flowing communication is will give decision makers some tools to understand how their decisions are working and help stop and prevent future avian influenza outbreaks.

Each poultry organization is structured slightly differently. These differences are what makes each organization unique and will make their strategy towards an avian influenza outbreak unique. For an avian influenza course to be successful across the broad spectrum of corporate structures, it needs to be able to adapt to different business structures. Targeting the executive team of each organization helps ensure that all departments of a company understand the impacts an avian influenza outbreak will have, build a sense of camaraderie

among the team, and streamline communication throughout the organization. When leaders are united and working together to prevent and control an avian influenza outbreak they will be a lot more successful than an executive team that isn't fully prepared for the impacts an outbreak will cause.

Replacing Bias with Scientific Approaches

Every person comes into a situation with their own set of experiences and history that shape the way they respond to a scenario; this includes the people working within the poultry industry. Each HPAI outbreak that a person experiences is going to influence the way a person views an upcoming or current outbreak. Having people in an organization who have gone through an avian influenza outbreak previously can bring valuable knowledge and expertise that can bring tremendous benefits and struggles.

When an organization is working through an avian influenza outbreak there are many decisions that need to happen quickly and correctly to prevent viral spread and further economic loss for that organization. Having people in the decision-making process who have had experience with these types of decisions can help speed up the process while also mentoring the rest of the team on how the process works using examples and lessons learned from past outbreaks. As previously discussed, adults need to understand how information being taught to

them is relevant and how it can be immediately put into action for best learning. Having a person confidently speak how the information being presented has been utilized by them during an outbreak helps build connections and retention for the whole group.

The social theory explains how people will learn best when interacting with others; individuals in the group can also influence a person's viewpoints on the materials being discussed.[13] An individual with experience in avian influenza outbreaks can help support important topics such as biosecurity, the need for proper carcass disposal, and timely depopulation that can help prepare an organization for an outbreak. Having team members with avian influenza experience brings many benefits but organizations need to be aware that the same person may have biases towards specific activities or lessons learned during their outbreak due to its traumatic and emotional nature.

Avian influenza outbreaks are very emotional experiences, and people who have been through an outbreak are going to have memories about that outbreak and how they felt during it. When a person is making a decision, large or small, they are basing it off a predicted emotion.[212] When a person is trying to decide something, they are trying to predict how the future outcomes will make them feel so they can pursue the option that will make them feel the best.[213] These predictions are based on the memories of how they felt in similar situations in the

past, which can cause a person to overlook their overall emotional response.[214,215] When a person starts reliving a past emotional experience they will often focus on the most noticeable or important part of the event and fail to consider all the details that occurred during that event.[216,217,218,219] A person may use the weight of their own and others' past emotions and experiences to make judgements and decisions, and if that is the only input, it can lead to bias and poor decisions.[220] A good example of bias in an avian influenza response is the focus only on preventing lateral spread, as that was a main cause of viral spread in the 2015 outbreak, and not focusing on the initial point of wild bird introduction, which has been the major concern in subsequent outbreaks.[119-201]

Having biases influence decision making can lead to poor outcomes, and poor outcomes during an avian influenza can lead to further viral spread. It can be tempting for organizations to rely solely on the individuals who have experienced an avian influenza to create a game plan and set the status-quo for how a current or upcoming outbreak is going to be managed. Staying within the status-quo is easy and comfortable; changing or going against the status-quo requires action, responsibility, and opening oneself up to criticism and potentially regret.[214, 215] Having an avian influenza course grounded in science can help an individual with prior experience step up and lead using their experience to help the decision-making process but allows for the rest of the team time and space to critically

think and understand the process and feel comfortable speaking up when biases might be impacting a decision.

Tailored Course Considerations

Providing information based on the type of bird the viewer is working with is important to make it worth the organization's time to take the course. An executive working primarily with turkeys is not going to want to spend time learning about how HPAI impacts the broiler industry. Likewise, an organization that is spread widely across the country is going to have different needs than a smaller scale local organization. Providing specific information on how the scale, location, and bird type matches with the organization will ensure that the time spent by participants taking this course is worthwhile.

Poultry organizations sometimes have farms and locations in different states, which often have different rules and requirements during an outbreak. As organizations are preparing for an outbreak, leaders and managers need to learn how to navigate all the requirements of federal and state regulatory agencies to stay in business. If an organization does not have a full understanding of their states' requirements it could delay movements, slow down the release of control zones, and increase virus spread during an outbreak. An example of how different states operate is Minnesota and Wisconsin surrounding Initial Virus Elimination

(IVE) dates. As of this writing in June 2024, a Minnesota veterinarian can complete the paperwork required and set the IVE date, whereas in Wisconsin the state-designated case worker is the only person allowed to set an IVE date. The IVE date is critical in getting control zones released, and if an organization is not aware of who is allowed to set an IVE date, it could delay control zone release, which will impact placements and ultimately increase losses from the outbreak.

The state where a farm is located has a critical role because state regulators are the first point of contact for a poultry company with avian influenza. It is important that relationships are built with state officials, board of animal health personnel, and other producers prior to an outbreak because tensions can quickly build during an outbreak resulting in confusion, tension, and mistrust, which can lead to further virus spread. Having an avian influenza course that encourages proactive relationship building, tools and resources on how to create long-lasting relationships and provide names and titles of people who should be contacted will make that course a unique asset to the poultry industry. An example on how building strong working relationships prior to an outbreak can be beneficial would be in a lab setting. If poultry Company X wants to perform surveillance testing on all of their farms during high risk times, it will cause a dramatic increase in lab samples being sent to the lab. If Company X just started sending all of their new samples to the lab without communicating what

they were doing, and the lab did not have the resources to handle this increase in samples, the lab staff might build up animosity towards Company X and be less willing to operate outside dedicated business hours if an emergency sample needs to be run. If Company X had communicated with the lab management and worked together on a successful plan for surveillance sampling that fit the needs of Company X and was manageable from the lab's standpoint, the lab staff would be much more willing to accommodate Company X's emergency needs in the future. Tensions are always going to arise during an outbreak due to stress and increased workloads, so it is important that an avian influenza course encourages building successful working relationships across all aspects of the poultry industry because AI outbreaks are going to continue to occur and evolve.

The variability in outbreaks makes it difficult for poultry organizations to set a fixed plan to handle their prevention and response protocols. Poultry companies can create a base plan to help guide during a time of an avian influenza outbreak, but some things can be handled only during an outbreak. Poultry organizations need to respond to each outbreak individually, very quickly, and they may need help to fully understand how an active outbreak impacts their system. In order for the poultry industry to be prepared for outbreaks, they need to have reliable and relevant information in a format that is easily viewed and can be applied immediately. Organizations not only need information, but they need

tools to help build communication plans and business strategies for future business disruptions.

Building the Course

Previous HPAI outbreaks have identified gaps in outbreak response, preparation, and prevention related to the poultry industry.[221] In this project, it was assumed that when decision makers have basic knowledge, they can better predict impacts in their own operations during an outbreak and can better prepare their teams and departments. This course was created around the challenges of avian influenza, to help organizations prepare for major decisions related to outbreaks. The objective for this course is to help poultry industry decision makers gain basic avian influenza, communication, and outbreak procedural knowledge in short time frames to prepare, control, and recover from avian influenza outbreaks.

To reach top tier executives in the poultry industry, information has to be accessible and packaged in a way that fits into hectic schedules. Since this course is targeted for top tier decision makers and their available time is limited, this course condensed the content into 20 minute modules.[222] There are five modules, with four of them to be completed individually and at the learner's own speed, and the last module is a group case scenario that is done in person. The first four

modules are pre-recorded. A person can view these videos during their lunch break, in-between meetings, or quickly before or after work.[223] The goals of the first four modules are to present pertinent information as quickly as possible so that learners can then contemplate how their expertise fits into the content. The last module is an in-person group activity that runs through a case-scenario on HPAI. The last session is an in-person activity that allows teams and organizations to work through whole processes and procedures that are likely to come up during an AI outbreak.[224] The last session takes most of a day (4-6 hours) and can include as many or as few people as an organization wants.

At the end of each module, participants have the option to review and complete additional materials. These materials were created to promote self-reflection, which will improve retention and application of the materials.[225–228]. These additional materials are designed to help individuals think through what they will need during an outbreak,what their departments in the organization may be tasked to do and the resources they will need. Balancing topics and reflections between individual and departmental needs is meant to prepare an organization for the decisions that need to be made at the top level and understand how they will impact departments and individuals. When an organization is proactive in allocating additional outbreak roles and realistic in time expectations, their employees will feel more supported and be less likely to suffer burnout.[229–232]

Experts/Source of Material/Content

Before content was identified and created, Dr. Carol Cardona, Michelle Kromm, and practicing poultry veterinarians were asked to provide guidance on poultry industry training and information needs relative to avian influenza. What we heard is that organizations needed a way to provide information quickly and effectively to top level employees while simultaneously allowing them to act on the information provided. The course needed to provide fundamental knowledge on the disease impacting the organization, information on how the organization might be disrupted, and how to support their teams from within during crises. Since the target audience was identified to be the top leaders in an organization, the course needed to be short and flexible. Organizations need the opportunity to practice how the information provided in a course could be applied, while uniting teams and the organization as a whole. Using this background, "Targeted Learning Modules for the Poultry Industry on Highly Pathogenic Avian Influenza" was created.

With the goal and key concepts of the course identified, the breakdown of modules was done. While creating each individual module, experts were identified to provide relevant, and trustworthy information. The need for an avian influenza course was needed as quickly as possible due to the threat of the 2022 HPAI outbreak in the United States. The course was created referencing scientific

materials, and industry and avian influenza researchers who were available. An expert in the Secure Poultry Plan (Dr. Carol Cardona) was contacted to provide insight on how permitting is accomplished and what requires a permit. A highly accomplished adult teaching expert was brought in to provide insight on how to format modules, and take-home materials. An expert in survey software (Dr. Abby Schuft), helped build and distribute the end-of-course survey. Each module also utilizes information found in online publications. Materials used to construct the course are cited in the reference section. Online information is supplied from reliable and relevant sources to give the most updated and current information possible. This unique course brings experts and online resources from many different industries and backgrounds that touch base on a wide range of topics to provide a cohesive and unique course on HPAI for the poultry industry.

Building the Modules

This course focuses on five major topics, introducing avian influenza basics, understanding outbreak logistics, mental health, preparing for an outbreak, and communication. These topics were chosen to provide foundational knowledge that organizations need in order to implement outbreak preparedness and response plans for their specific operations. This course is built differently from other AI courses, because the focus is not only on the science of avian influenza as a

disease but also on its regulation, and its potential impact on employees. When creating this course, the focus was on how to prepare business decision makers to play their organizational roles during an outbreak.

The first module in the course is a basic introduction to what avian influenza is, its cause, the pathotypes (low and high pathogenicity), and disease transmission. Building off this knowledge of different types of AI, we introduce how a flock is likely to be exposed to AI and also how they might expose other flocks by looking at the things that flow into and out of a farm. Executives have a wide range of knowledge in their departments that help an operation run effectively, but not all will understand how many inputs and outputs to a farm there are, and the risk that can be assigned to them related to a disease. It is crucial that all decision makers understand how AI can be introduced into their farms to appreciate the decisions that are made at the farm level and their impacts. The first module also introduces how rapidly influenza viruses change, to help participants realize that if they have experienced one AI outbreak, they might not be able to exactly replicate what they have done in the past and be successful. Organizations need to evolve alongside the virus. The last main topic in the first module is understanding when regulatory oversight is required based on the type of influenza outbreak. Organizations that understand what decisions they can and should make themselves, and which ones will require guidance from outside

entities will be better able to delegate and form bridges before outbreaks begin to make control operations go more smoothly.[233]

The second module focuses on the logistics of an outbreak. Organizations are exposed to the Secure Poultry Plan (https://securepoultrysupply.umn.edu) and permitted movements. There is a brief walk through on how to permit along with some movements that will require a permit. We also discuss the allocation and distribution of workload in an outbreak. Permitting can be very time consuming and might require a team of individuals to complete. Organizations can support these individuals by proactively delegating current tasks and responsibilities to others in order to allow time for permitting. Module two also introduces regulatory premises designations and the risks and requirements that come with the different control area designations. Lastly, module two will discuss some common business disruptions that an organization may experience during a HPAI outbreak and ways an organization can prepare and respond.

The third module shifts away from delivering scientific information and focuses more on leadership relationships to employee response to an outbreak. Module three focuses on mental health, describes action bias, and tasks learners with creating a cohesive communication plan. This module introduces some common signs and symptoms of stress and trauma, and how an individual can become emotionally overwhelmed, through triggers such as depopulation and

disposal of positive HPAI flocks. The third module introduces the concept of action bias and how during high stress situations, such as an HPAI outbreak, people may want to feel that they are contributing to solving the problem. If leaders do not provide a productive way for people to contribute to outbreak response, more harm can come than good from people reacting emotionally. Lastly, we discuss how relationships, when possible, should be built proactively as part of outbreak preparedness. Building work relationships during high stress periods can be difficult due to heightened emotional states.[234] Building and maintaining key relationship before can lead to better working relationships and lower stress during an outbreak.[235]

The final virtual and independent module focuses on using a team and organization's unique characteristics to advantage. This module discusses finding reliable information sources. People going through this module will be exposed to concepts of what makes an information source reliable and how to find them. Each organization that goes through this course is unique. The fourth module explores how an organization can use employees' individual experiences and expertise to problem solve and build an HPAI response plan. The last major topic addressed in module four is how to create and build messages for an organization. As an outbreak progresses, communication needs to seamlessly flow upwards, downwards, outwards, and inwards. Top leaders need to be able to communicate

down to the farm employees, and the farm staff needs to be able to voice their needs and concerns up to top leaders. This module will walk learners through how to identify audiences, the needs and wants from that group, any communication barriers, and best practices on message delivery. Examples will be provided on how messages should differ based on the audience it is geared for and how internal expertise can be used to create these messages.

The final session for this course is an in-person group activity. The activity consists of a tabletop exercise for teams to practice problem solving, communication, and delegation of tasks during an HPAI outbreak. This session unites teams within an organization by providing space and time to logically think through decisions, understand, and practice how those decisions will impact the overall organization.[80] Teams are able to work through how their departmental roles and skills can impact the course of an outbreak, or provide relief to others in the organization. During the in-person session, emphasis is focused on how decisions are communicated through the company, and the impacts it has on employees. Allowing space and time for leaders to proactively think about how their employees might respond to HPAI outbreaks and the decisions that need to be made, will identify if and when supplemental support is required for employee physical and mental health and safety. here are the gaps that can threaten the

sustainability of the organization? A breakdown of modules and learning objectives can be found in Table 1.

Building Take Home Materials

After each module has been viewed, there is supplemental material to help the learner review and practice content. The goal of the take-home materials is for individuals to think through how the information provided in the module can be applied in their individual and departmental roles in the organization during an HPAI outbreak. These materials allow viewers to blend personal and professional expertise with new information provided in the modules, to practice reflection in action and reflection on action.[19] Viewers are guided to use supplemental material to think through how that information will affect their work environment (reflection on action). Attendees at the tabletop scenario on the last day use the supplemental material to analyze processes in place in the organization, what might be changed, materials that are needed, or employees who should be trained for changing policies or roles (reflection in action). When building the supplemental materials, Knowles theories were utilized to create questions that resonate with adult learners and foster engagement with the information provided during the modules.[236]

Different forms of supplemental materials are provided to engage people with different learning styles: visual, auditory, reading/writing, and kinesthetic approaches are used.[237] For visual learners, who learn best by viewing graphics, each module contains pictures, graphs, and diagrams to help them connect and understand the information being provided.[238,239] Auditory learners are those who learn best by listening to information provided to them.[240] All online modules have been pre-recorded with someone presenting the entire module. The last in-person session is designed to have a direct leader providing instruction and information who will foster communication and participation. For read/write learners who learn best by reading through information, each module contains a copy of the slides to viewers to read before, during or after the module.[239] Lastly, for kinesthetic learners who learn best by doing, at the end of each module, supplemental material is provided for individual practice with hands on activities to better understand the information provided in the modules.[241]

We wanted to create a course that fosters a sense of community and teamwork for the organizations.[242] Collaboration and team building are crucial components in the modules because organizations that can unite and empower employees will be the most successful in an outbreak. To create a spot for collaboration and problem solving, each module has an online platform that attendees can access and ask questions. This online platform was also created for

attendees to have access to an online support system to freely ask questions without judgment or fear of criticism.[243] Creating a space for communication to flow between attendees and leaders can help learners feel supported and engaged with the course.[244]

Conclusion

This course provides scientific information to the top decision makers in an organization through online, take home, and group activities to help prepare, respond, and prevent an avian influenza outbreak. The course is flexible to adapt to different bird species, corporate organization, and location to bring a catered experience to whatever organization wants to participate in the course. This flexibility and adaptability will help encourage collaboration between public and private poultry organizations.

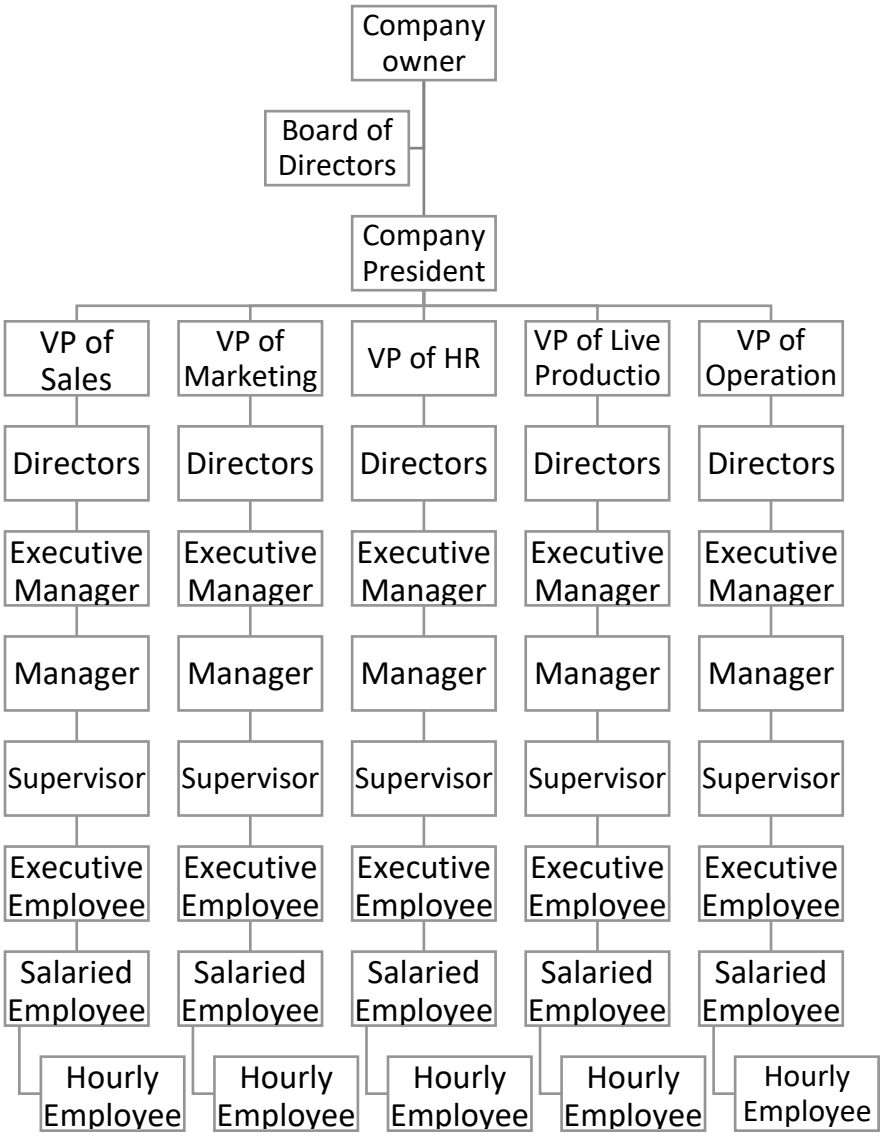

Figure 8: Example of a Large Organization's Corporate Structure.[207] Large corporations are going to have a larger executive team that oversees a singular department. This type of corporate structure is going to have executive members that are experts in their department but might only have introductory knowledge about the other departments.

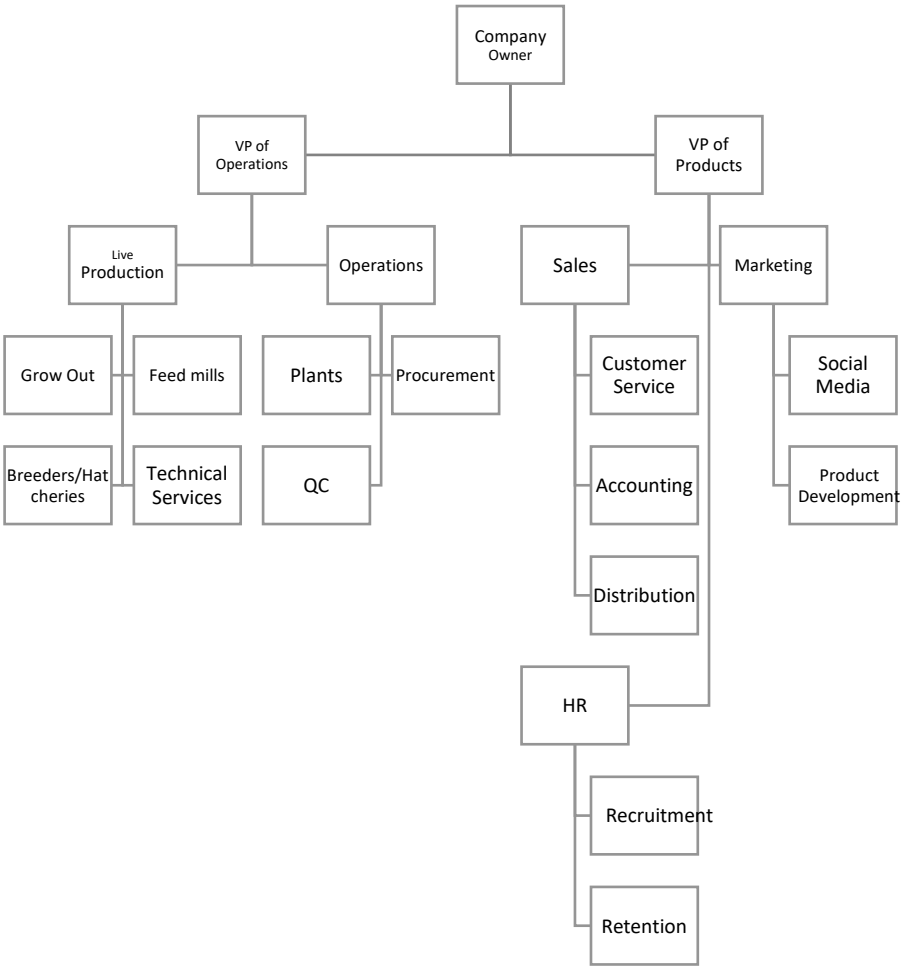

Figure 9: Example of a Smaller Organizations Corporate Structure. [206]

Smaller organizations are going to have a smaller executive team that oversees many different departments. This type of structure is going to have executive members that might not be experts in their departments, due to the wide range of departments they oversee, but they will have a deeper understanding of multiple departments and how they interact with one another.[206]

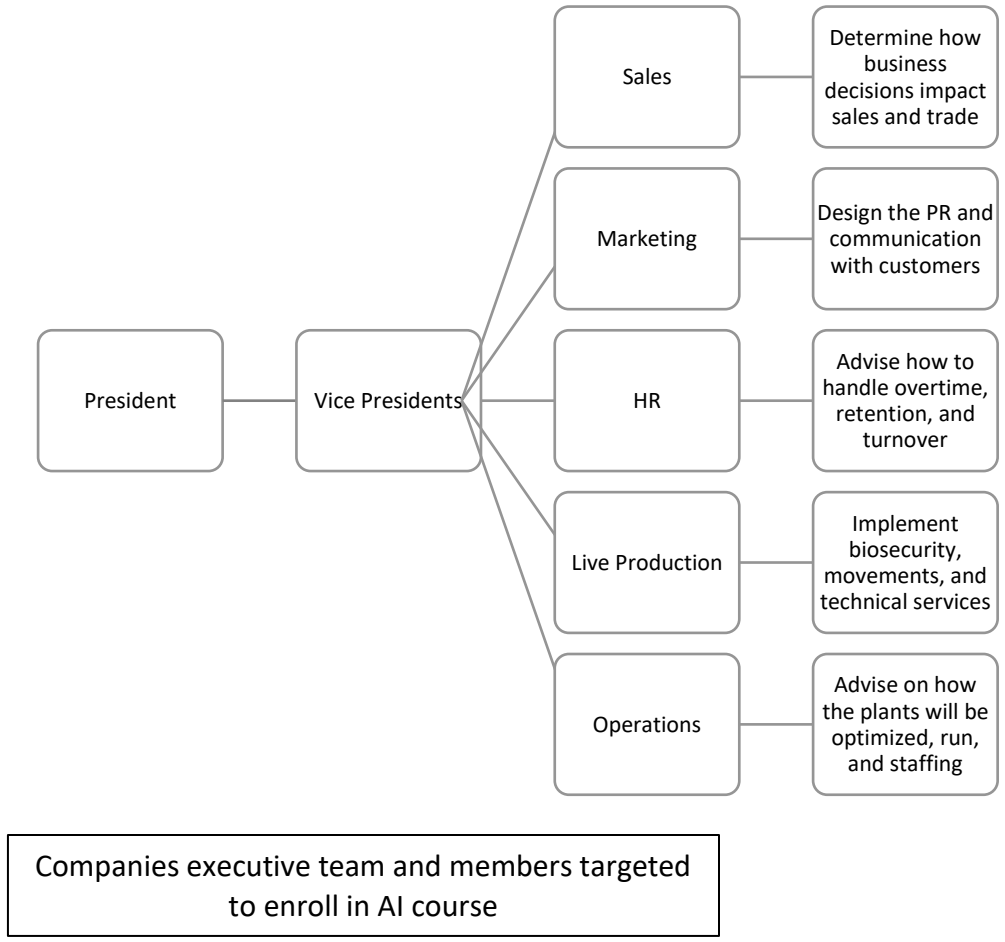

Figure 10: Example of a Larger Organizations Decision Making Structure – Target Audience. [208] In larger organizations where there is a large executive team. This team has the knowledge and expertise in their individual departments to help make decisions surrounding an IAV.

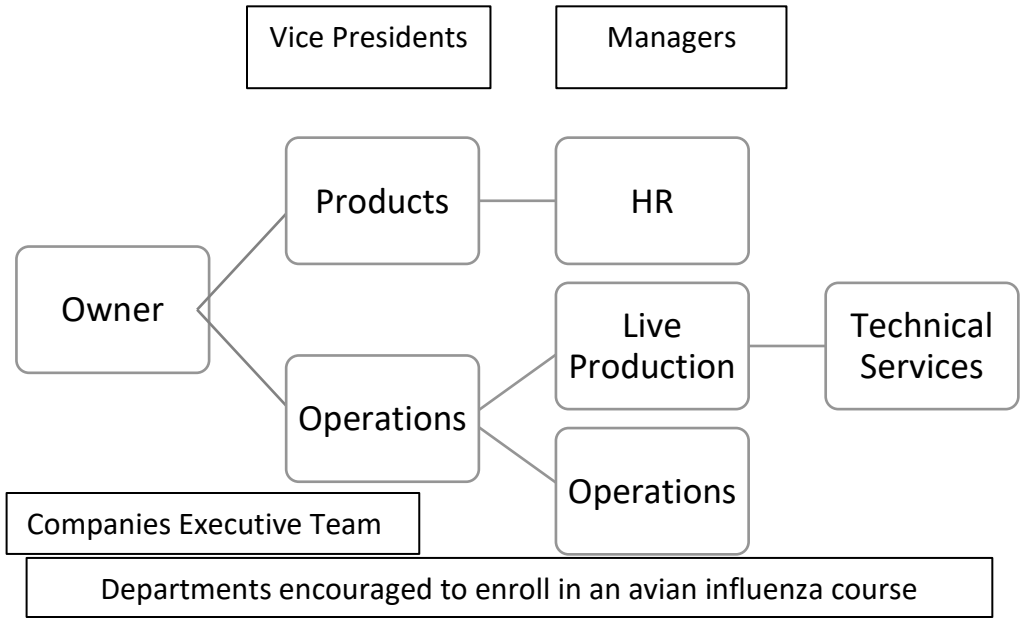

Figure 11: Example of a Smaller Organizations Decision Making Structure – Target Audience.[206] Smaller organizations might not have enough Vice Presidents in individual departments to bring in the level of expertise needed to answer IAV questions during an outbreak. In these situations it might be necessary to bring individuals from different levels of the organizations to provide their specific expertise or even bring in a person from outside the organization.

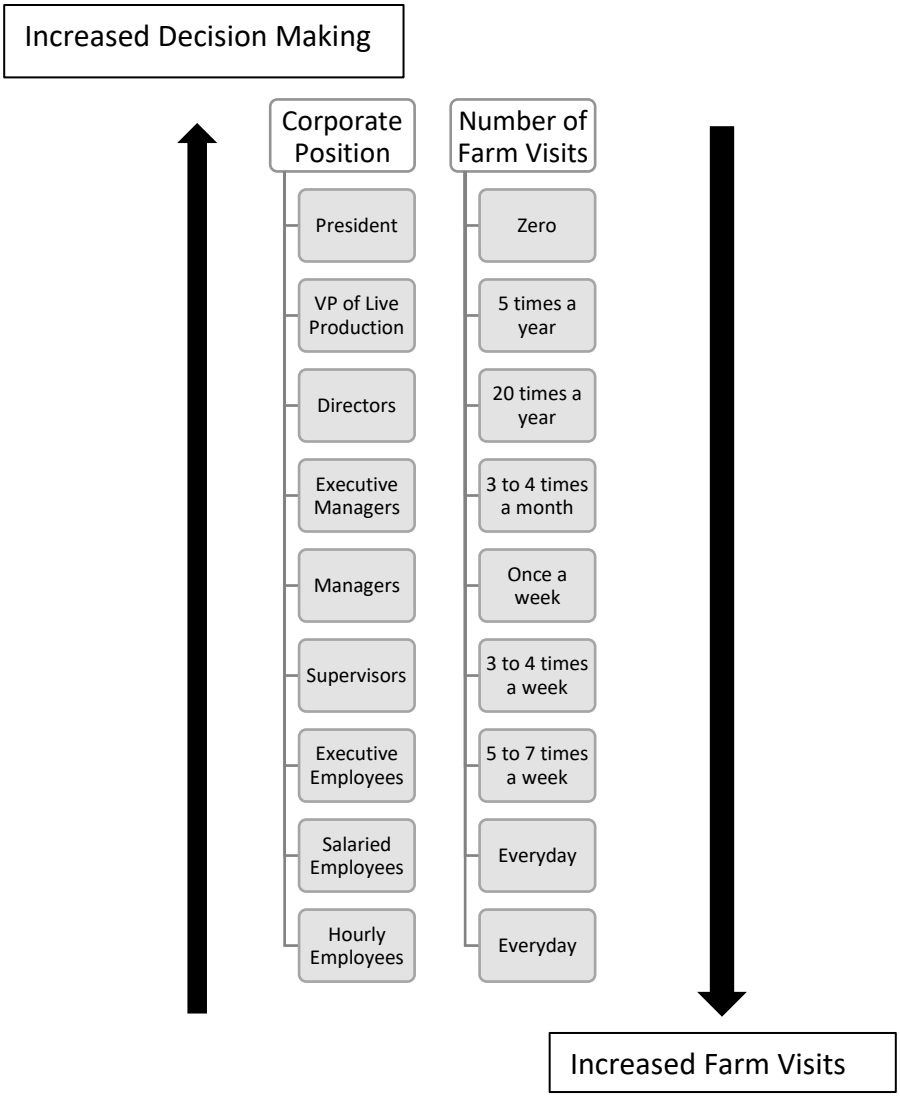

Figure 12: Example of the Inverse Relationship Between Decision Making Ability and Farm Visits. This figure shows that as a person increases within the organization their ability to make organizational level decisions increases but their ability to be on farms decreases. This level of separation between decision making and on farm activities can impact how decisions are executed during an avian influenza outbreak.

Table 1: Course Module Breakdown

Module Title and Number	Module Objectives:
Avian Influenza Basics - Module #1	How AI viruses infect a flock LPAI vs HPAI How influenza viruses change Evaluating the risk of infection to a poultry flock and to other species When regulatory oversight is requires
Logistics in an Outbreak Setting - Module #2	Secure Poultry Plan Defining premise designations Movements during an outbreak What disruptions might you experience
Coordinating the Chaos - Module #3	Understanding employee's emotional loads Action Bias Building a communication plan Identifying information needs Building relationships
Preparing for an Outbreak - Module #4	Identifying trustworthy sources Bringing your expertise to the table Message building Start building a crisis team Identifying information flow
In Person Session - Module #5	Practice using communication plan Build message Run through mock HPAI case scenarios

CHAPTER 4

PILOT GROUP EVALUATION OF THE COURSE

Course delivery

Once the course content was created and organized, poultry companies were recruited to test and provide feedback. Two companies, one chicken egg layer and one multi-sector (layer, commercial turkey and turkey breeder) company, were enrolled to participate in the pilot test. A third broiler company, and large commercial turkey company were interested in the course but had to drop out due to breaking with their own HPAI cases. We wanted organizations that specialized in different bird production types to evaluate the relevance of the materials. We also wanted to test this course with companies located in different states to assess state-specific information. While both companies are located in the Midwest, they are in different states. Each of the companies that participated, used different viewing servers, such as Teams or YouTube, to distribute the information internally, which allowed us to evaluate our viewing platform. Once an organization completed the course, a survey was sent to participants to collect feedback.

Evaluation

The survey used to collect feedback included questions on demographics such as what industry, department, years of employment in that industry, and prior outbreak experience a person had, although personal identifiers were avoided. This survey was reviewed by and given exempt status by the institutional review board in June of 2022. The main objectives of the survey were to solicit feedback on the course itself such as its layout and organization, learning pace, and how well the individual understood the content presented. The survey, in its entirety, is included in Appendix A.

Results

The survey was sent to two different and independent poultry organizations that were enrolled in pilot testing. As mentioned above one organization was an egg production company and the other was a mixed poultry organization. We received fourteen survey responses, but we were not able to determine how many people received the survey. The survey was given to the point contact person we were working with and they distributed the survey to training participants.

To gather basic demographic information about the participants who were a part of the pilot test group, we asked three questions: 1) What type of industry

do you work in? 2) What department do you work in? 3) How long have you worked in your current industry? Responses are presented graphically in Figures 13 - 15. Most of the respondents, 86% (Table 2, Figure 13), worked in the layer industry. Among corporate departments, most responses came from the operations group (Figure 14).

We had a wide range of departments taking the course, with most working in operations followed by live animals and sales (Fig. 14, Table 3). The department with the largest representation was operations followed by 'other'. For other, we had one participant who worked in animal health, and three participants who worked in areas not covered in the survey, transportation and quality control. We did not have any representation of the finance and marketing departments with a response of 0%.

The poultry industry has employees with a wide range of experience, just like any other industry. There will be employees with many years of service working alongside people with little or no experience. Question three asked how many years of experience the participants had in their current industry. There were a total of 14 responses for this question. The participants who had over fifteen years of experience were the largest group at 50% and the smallest group was the one participant with zero to five years of experience (Fig 15, Table 4).

We wanted to know how much prior outbreak experience participants had. Since this course is specific to avian influenza, we wanted to understand if people had previous experience with either low or high pathogenicity avian influenza outbreaks. Poultry companies in the US are likely to have a mix of experienced and inexperienced workers. The majority of our participants in the pilot group had worked with avian influenza previously, some with high and some with low pathogenicity outbreaks (91.67%). (Fig 16, Table 5).

Another aspect in the pilot test was to understand if the entire course was well organized, and if information was presented clearly and respectfully by both presenters. The pilot group was asked to respond with Likert scale ranking questions that evaluated the presenters and their clarity in presenting the content, course organization, and overall respectfulness of tone. The results are shown in Figure 17 and Table 6.

The course layout is crucial in making sure the concepts are easy to follow and participants feel comfortable and confident navigating the course. Participants were asked to rate various statements from somewhat agree to strongly disagree regarding the course layout and the results are shown in Figure 18 and Table 7. Participants responded well to the accessibility and length of the course but responded neutrally to the homework statements.

The communication plan was introduced to participants during the third and fourth modules and was a key concept in this course. In module four we introduced an approach to building messages so that they contain pertinent information and that are delivered in a format that has the audience in mind. Module four also introduces the idea of finding reliable sources for relevant information. To evaluate the effectiveness of the communication planning materials, the pilot participants were asked to score the statements listed in Table 8 on a 5-point Likert scale. Responses are shown in Figure 19 and Table 8. Many of the responses from the pilot testing group scored the statements as either strongly agree or somewhat agree. Participants also indicated that they strongly felt they could find reliable information sources with that statement having the highest amount of "strongly agree" responses. Two participants indicated that they somewhat disagreed that the communication plan was helpful and that they were better prepared to create messages for the concerns of their teams. These comments could have been due to the individuals thinking there wasn't anything wrong with the way they have been creating messaging, or that they already knew this material. This could have been better identified had a pre-survey been administered. This feedback is helpful in re-evaluating the take home materials around these topics to make sure they can be applicable to all individuals taking the course. The total number of responses for this question was fourteen.

A major component of this course was to assist organizations in creating their own avian influenza crisis management team. Creating a team that identifies the person or people responsible for tasks in a response based on their roles in the company can help prepare organizations and individuals on how the decision-making process will flow in an emergency. To help capture how well this process was understood by course participants questions were asked in the survey. The questions were formatted in a way that individuals ranked statements from definitely yes to definitely not, as seen in Figure 20. These questions received very good feedback with only one participant stating they feel neutrally and probably yes on who they are supposed to be receiving information from, with the remaining twelve stating they definitely know where to get information. Full results are shown in Figure 20 and Table 9.

This training was targeted for senior leaders in the company who oversee decisions regarding large sections of their organization during an avian influenza outbreak. To understand if these individuals feel comfortable making those decisions, a question was asked in the survey ranking how comfortable the participants were in making business decisions that would be impacted by avian influenza (Figure 21, Table 10). The question had participants rank how comfortable they were from extremely uncomfortable to extremely comfortable. This question received a wide range of responses. Nobody answered that they felt

extremely uncomfortable making business decisions in an outbreak but three people identified that they would be somewhat uncomfortable. This could change if we had representation from individuals in the finance or marketing departments. Results did show that four people stated that they were somewhat comfortable and five people scored that they are extremely comfortable making business decisions that will be impacted by avian influenza.

The last section of the survey provided a place for the pilot test participants to list other comments or concerns regarding this course. There were two main themes that jumped out of the responses, the format of the fifth module and regarding biosecurity content. The comments regarding the fifth module were that it did not need the pre-recorded sections that were created for that module, and that in-person moderators were preferred to facilitate conversations and encourage participation. The comments regarding biosecurity were to include what has or has not worked in previous outbreaks, and to include a condensed module that focuses on biosecurity and that could be used to help train team members (specific comments are listed in Table 11). These comments and questions could have been skewed due to the majority of the participants in the pilot group coming from an operations background and potentially all having the same specific needs.

Conclusion

The two poultry companies that piloted this course provided vital feedback. This feedback was used to evaluate the effectiveness, ease, and usefulness of the course. Based on the information provided in the post-course survey, areas of opportunities have been identified, and adjustments have been made to the course and survey to make it more beneficial for the poultry industry.

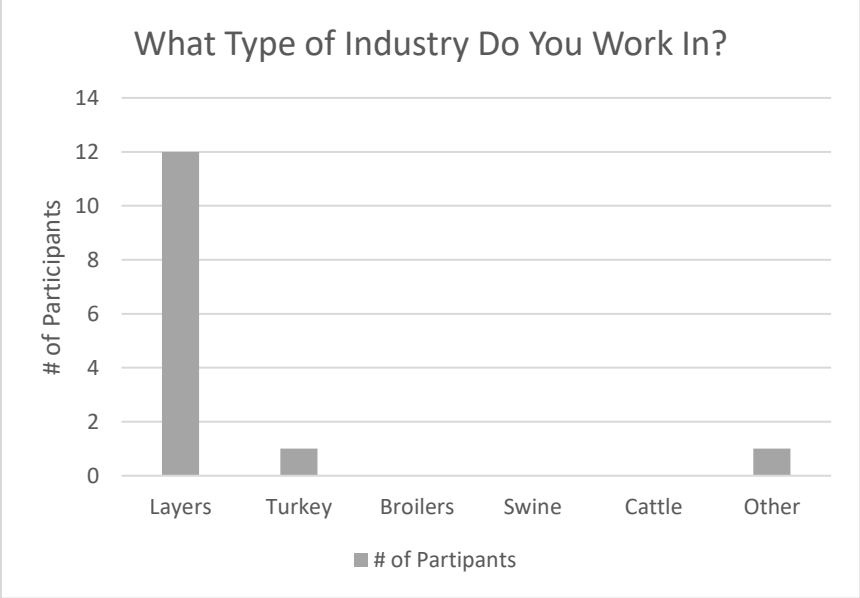

Figure 13: Demographic Responses from Pilot Training Group – Current Industry

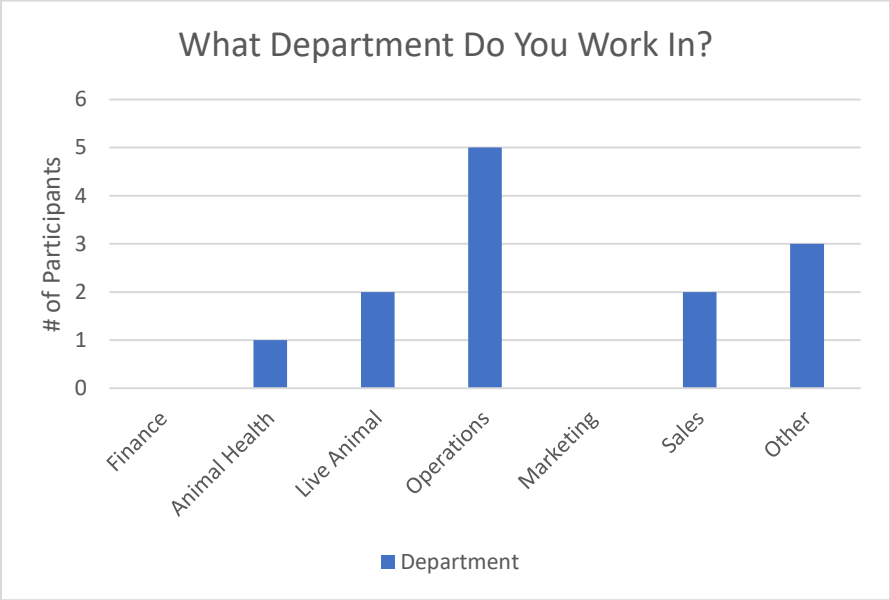

Figure 14: Demographic Responses from Pilot Training Group – Department

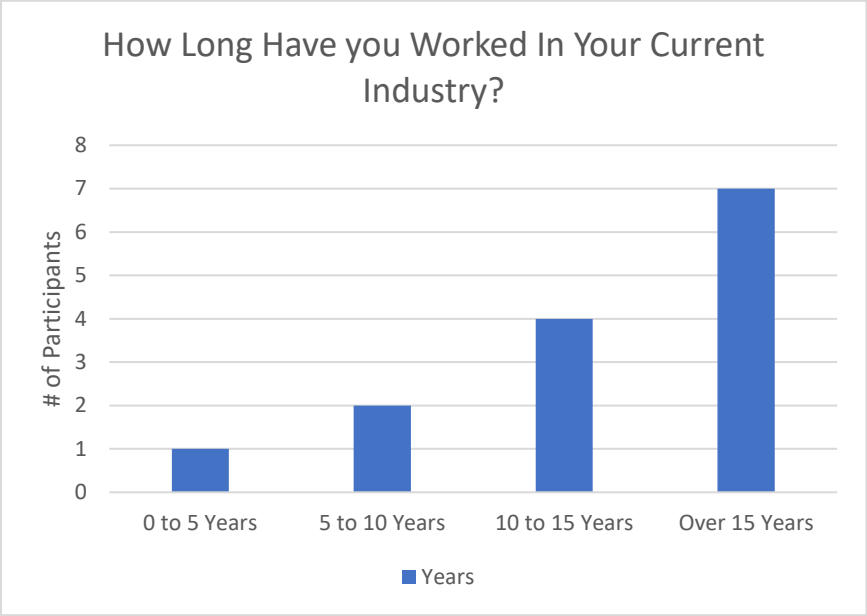

Figure 15: Demographic responses from pilot training group – Length of Employment

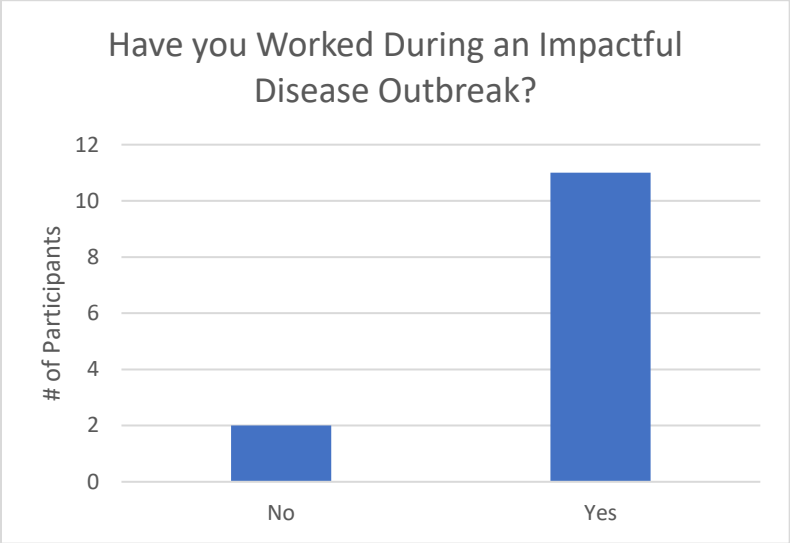

Figure 16: Demographic responses from pilot training group – Outbreak Experience

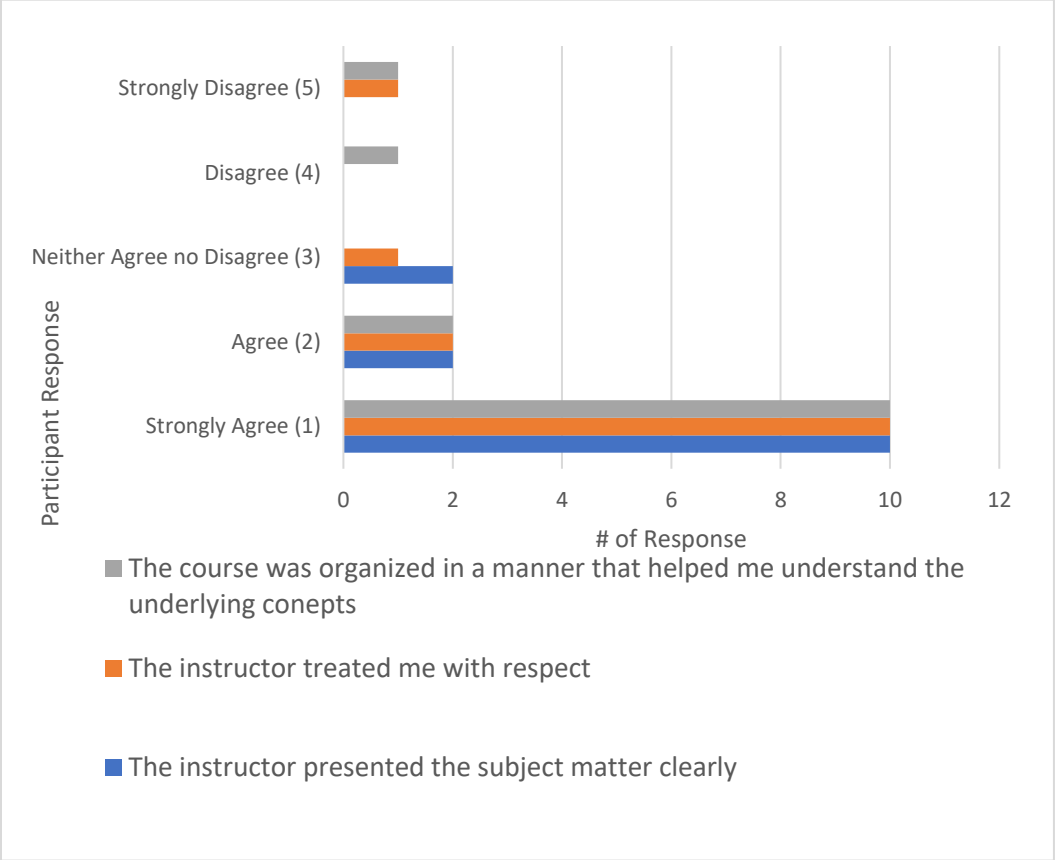

Figure 17: Participants Rating of the Course's Instructors

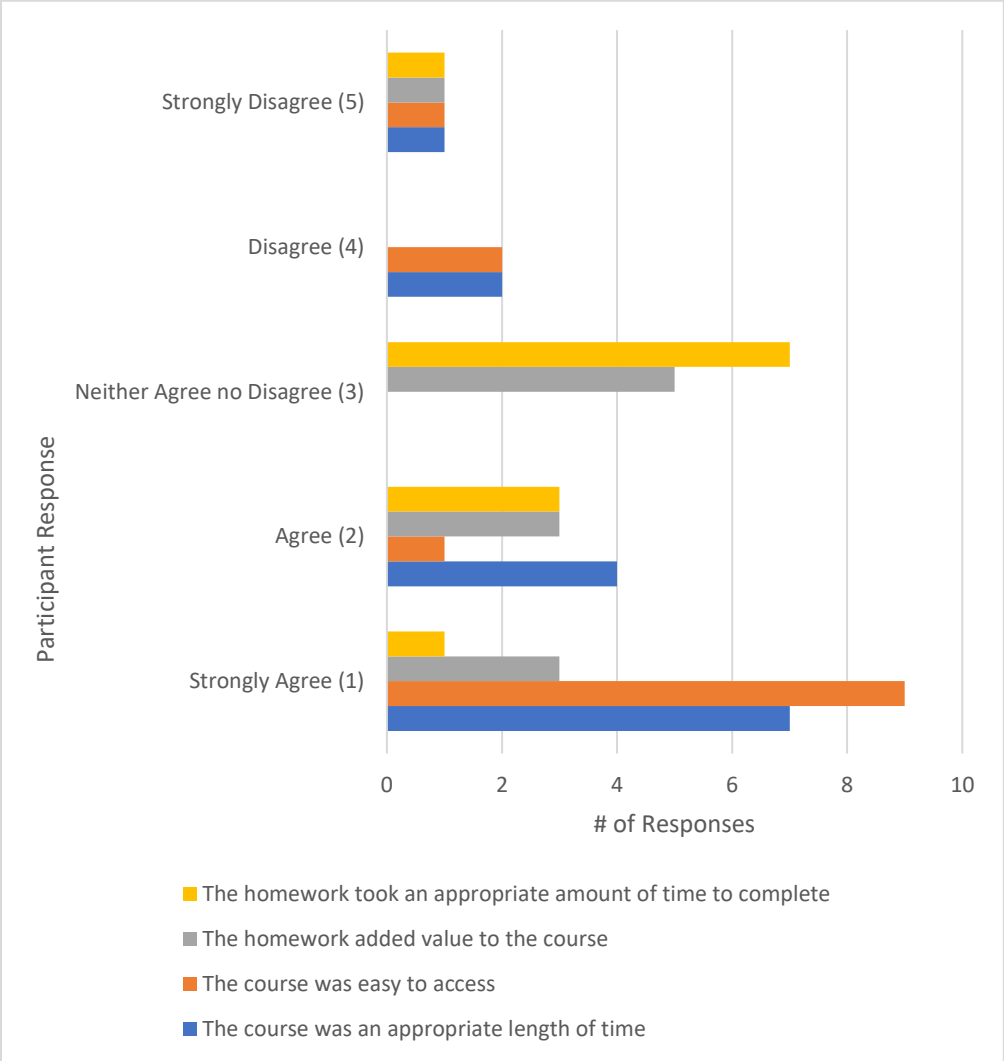

Figure 18: Participants Responses for the Course Layout

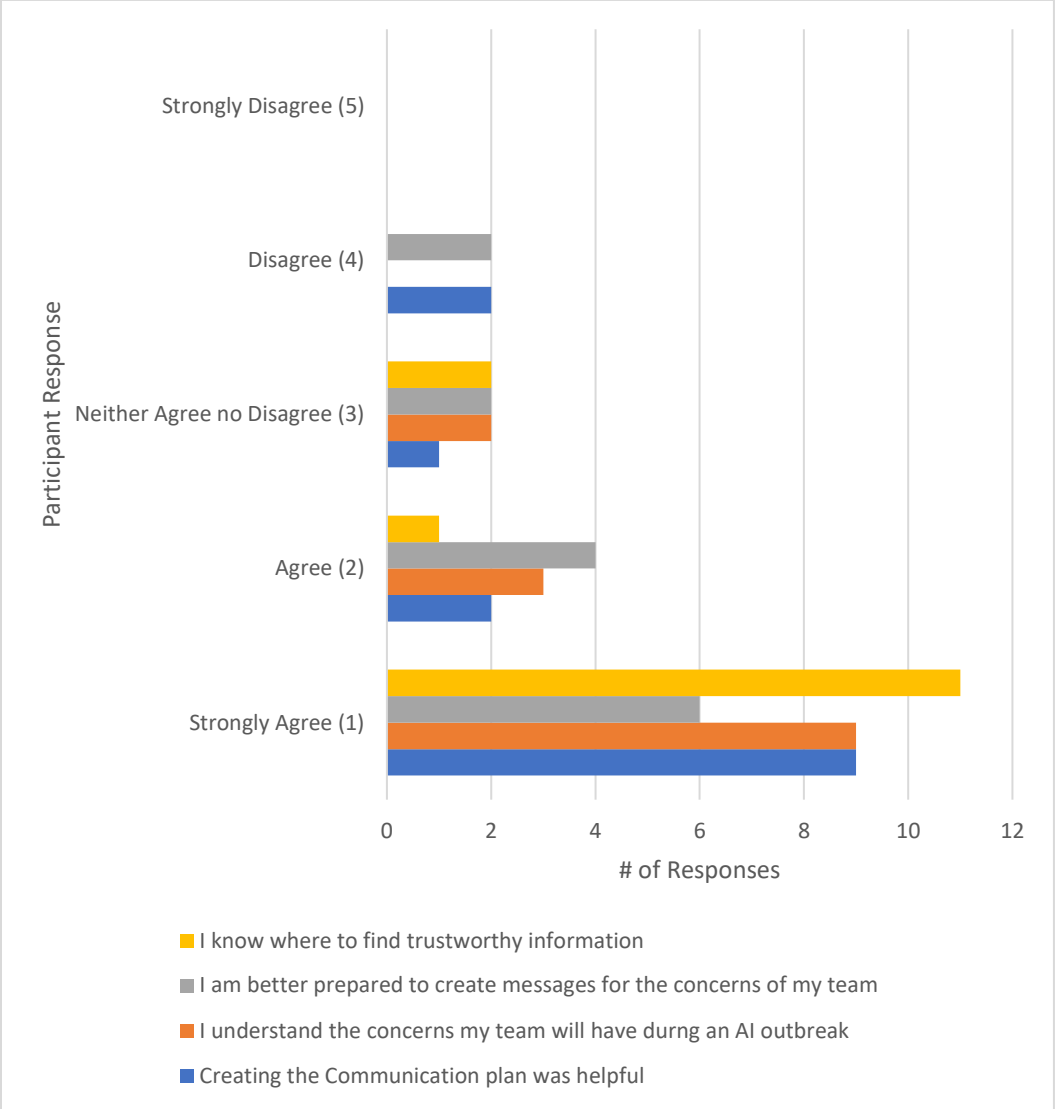

Figure 19: Participants Responses for the Communication Plan

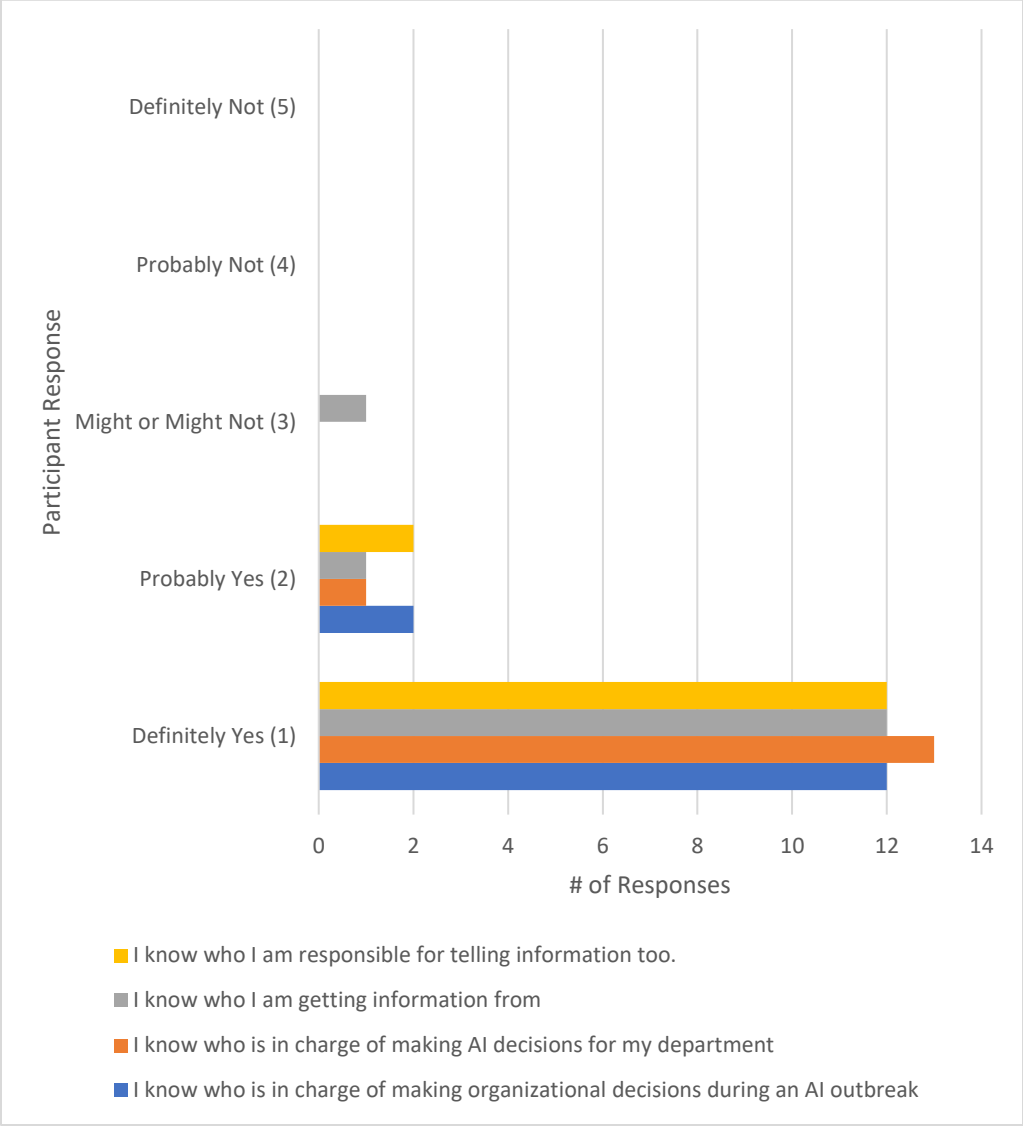

Figure 20: Participants Responses for ability to organize the AI Crisis Management Team

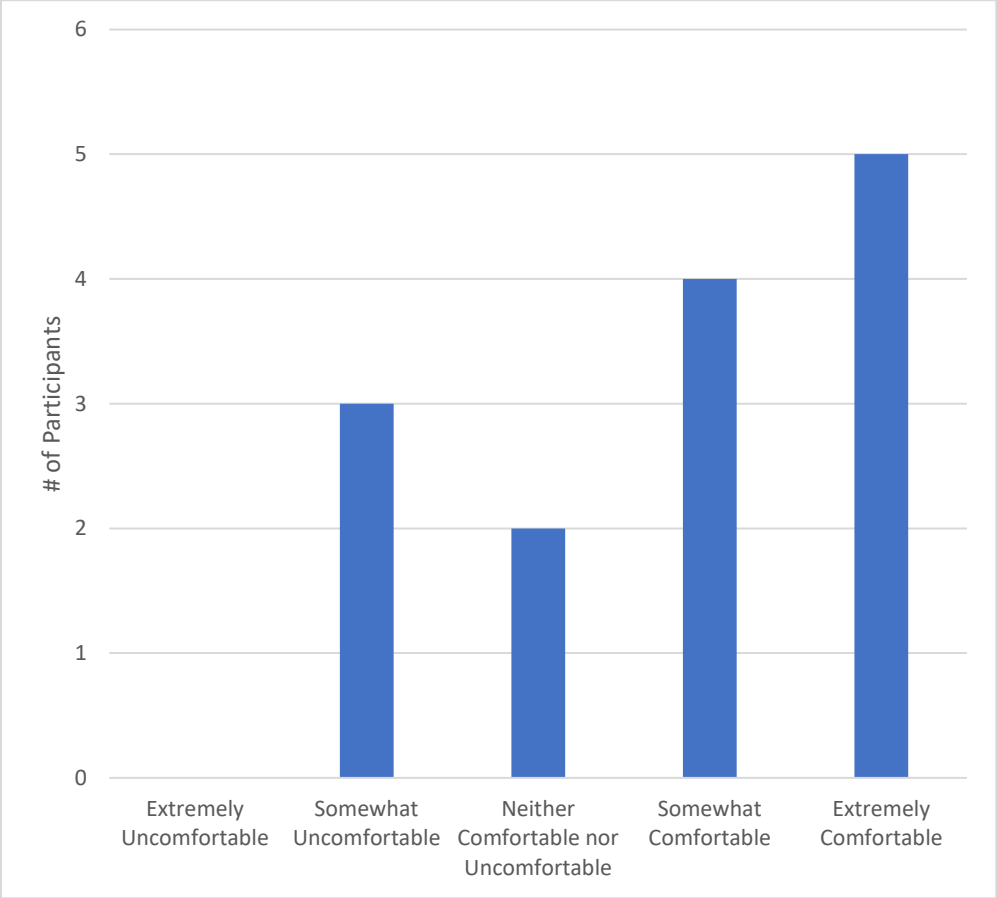

Figure 21: Pilot Training Response: Comfort Level in Making Business Related Decisions Impacted by Avian Influenza

Table 2: Industry affiliations of participants

Industry	Number of Responses	Percentage
Layers	12	86 %
Turkey	1	8 %
Other	1	8 %
Broilers	0	0 %
Swine	0	0 %
Cattle	0	0 %

Table 3: Department Representation

Department	Number of Responses	Percentage
Operations	5	38.46 %
Other	3	23 %
Live Animals	2	15 %
Sales	2	15 %
Animal Health	1	8 %
Marketing	0	0%
Finance	0	0 %

Table 4: Years of Employment in the Poultry Industry

Years of Experience	Number of Responses	Percentage
Over 15 Years	7	50 %
10 to 15 Years	4	29 %
5 to 10 Years	2	14 %
0 to 5 Years	1	7 %

Table 5: Prior Outbreak Experience

	Number of Responses	Percentage
Yes	11	92 %
No	1	8%

Table 6: Rating the Course's Instructors

Statement	# of Strongly Agree (1)	# of Agree (2)	# of Neither Agree nor Disagree (3)	# of Disagree (4)	# of Strongly Disagree (5)	Stats:
The instructor presented the subject matter clearly.	10	2	2	0	0	Mean = 1.43 Std. Dev = 0.73 Mode = 1
The instructor treated me with respect.	10	2	1	0	1	Mean = 1.57 Std. Dev = 1.12 Mode = 1
The course was organized in a manner that helped me understand the concepts	10	2	0	1	1	Mean = 1.64 Std. Dev = 1.23 Mode = 1

Table 7: Rating the Course Layout

Statement	# of Strongly Agree (1)	# of Agree (2)	# of Neither Agree nor Disagree (3)	# of Disagree (4)	# of Strongly Disagree (5)	Stats:
The course was an appropriate length of time.	7	4	0	2	1	Mean = 2.00 Std. Dev = 1.31 Mode = 1
The course was easy to access.	9	1	0	2	1	Mean = 1.85 Std. Dev = 1.41 Mode = 1
The homework added value to the course	3	3	5	0	1	Mean = 2.42 Std. Dev = 1.11 Mode = 3
The homework took an appropriate amount of time to complete	1	3	7	0	1	Mean = 2.74 Std. Dev = 0.92 Mode = 3

Table 8: Reviewing the Communication Plan

Statement	# of Strongly Agree (1)	# of Agree (2)	# of Neither Agree nor Disagree (3)	# of Disagree (4)	# of Strongly Disagree (5)	Stats:
Creating the communication plan was helpful	9	2	1	2	0	Mean = 1.71 Std. Dev = 1.10 Mode = 1
I understand the concerns my team will have during an AI outbreak.	9	3	2	0	0	Mean = 1.50 Std. Dev = 0.73 Mode = 1
I am better prepared to create message for the concerns of my team	6	4	2	2	0	Mean = 2.00 Std. Dev = 1.07 Mode = 1
I know where to find trustworthy information	11	1	2	0	0	Mean = 1.36 Std. Dev = 0.72 Mode = 1

Table 9: Reviewing and setting up the AI Crisis Management Plan

Statement	# Definitely Yes (1)	# Probably Yes (2)	# Might or Might Not (3)	# Probably Yes (4)	# Definitely Not (5)	Stats:
I know who is in charge of making organizational decisions during an AI outbreak.	12	2	0	0	0	Mean = 1.41 Std. Dev = 0.35 Mode = 1
I know who is in charge of making AI decisions for my department	13	1	0	0	0	Mean = 1.07 Std. Dev = 0.26 Mode = 1
I know who I am getting information from	12	1	1	0	0	Mean = 1.21 Std. Dev = 0.56 Mode = 1
I know who I am responsible for telling information to.	12	2	0	0	0	Mean = 1.14 Std. Dev = 0.35 Mode = 1

Table 10: Comfort around AI Business Decisions

Statement	# of Extremely uncomfortable (1)	# of Somewhat comfortable (2)	# of Neither comfortable or uncomfortable (3)	# of Somewhat comfortable (4)	# of Extremely comfortable (5)	Stats:
How comfortable are you making business decisions impacted by avian influenza?	0	3	2	4	5	Mean = 3.79 Std. Dev = 1.15 Variance = 1.31

Table 11: Participants Comments

Comment #	Comment:	Grouping
1	An online based way to access the materials would be ideal, maybe through the UMN where we could register for the course would be helpful. Would also be nice to have one of the moderators lead the 5th module to help encourage participation	Format/course layout
2	none	No comment
3	Why wasn't there any discussion on what happened during the last AI outbreak? This seemed only focused on large corporate issues, not really anything on what *actually* worked to prevent AI spread.	Additional materials
4	Prerecorded videos did no need to be shared over virtual meeting. Should have been emailed for us to watch on our own time. There was insufficient discussion or information on what worked and did not work during previous HPAI outbreaks	Course layout/additional material
5	Should have been longer did not get through all the material.	Course layout
6	These were very helpful. It would be great to have a condensed version that focused more on the biosecurity side of things to help train our live bird and processing employees. Thank you for putting this together.	Additional materials

CHAPTER 5

AVIAN INFLUENZA COURSE REFLECTION

LESSONS LEARNED

Contingencies

Several lessons were learned by piloting this course with two companies. To fully evaluate the class, we need more companies or larger systems that can provide more people to enroll in the course, specifically to understand how to adjust the course for turkey and broiler production. The timing of the course is very important and a lesson we learned first hand. Finding organizations to enroll in this course needs to be done during times when companies are not experiencing a disruptive event so as to promote engagement and course completion.

From the survey, we saw how participants felt about the content and the course overall. There were one or two participants who routinely scored the course low on the survey. These low scores could be for many reasons. We allowed the two different organizations to set up the recruitment of participants, time and location of delivery, and some course specifics based on what they thought would best fit their system and personnel. This meant that one organization had learners go through one module a day and focused on the

strategic planning session as the only thing they did in the in-person session. The other company had their in-person session include going through all the content. The low scores could be attributed to the differences in set up and not enjoying the way their company chose to schedule the course. Another reason for the low scores could be an assumption that the individual thought that they personally did not need to take the course because they know everything they need or want to know about avian influenza. Other assumptions for the low scores would be not wanting to take the course to begin with, misinterpretation of the survey.

After reviewing the data gathered from the survey of the pilot group, we identified several questions that could be improved to better understand the overall impact of the course. For example, when asking about homework, we failed to inquire if the respondent had completed the reflection work or not. This would have been a good question to add to our survey to understand if the participants were really doing what we think was an important part of the learning approach. Another question that should have been asked regarding the communication plan was how much information they knew prior to taking the course and if they knew more after completing the course. Similar questions should have been included on the company's AI crisis management team. Understanding if people knew who was responsible for making decisions for their department, organization, and who they are responsible for relaying information

to is something the participants may have known before they took the class. The last question that we should have included in the survey is how much about avian influenza they knew before they took the class to how much information they knew after they completed the course, although we have some understanding of related knowledge based on the questions about AI outbreak experience.

Another part of the survey that should have been conducted was to create a pre-course survey. This survey would have had questions that evaluated how well the participants understood avian influenza, their comfort in making business decisions, communication, and messaging prior to taking the course. Having a pre-course survey would have made it a lot easier to understand how effective the course was to the participants. Many of the pre-course questions would have been worded the exact same way as in the post-course survey to provide a very clear understanding on how impactful the course was.

Lastly, we had a very small sample size of participants that completed the post-course survey. If we would have known that we were going to have a smaller sample size we would have used more qualitative forms of analysis, such as interviews and more open-ended questions and look for themes to evaluate how effective the course was instead of quantitative results. We did incorporate this style of data at the end with the open-ended comment section, but this style of questioning could have been used to replace many of the Likert-style questions.

The other issue with the questions was that the questions were not validated, so we do not know that all respondents understand the questions in the same way, or how we intended. We should have validated the questions to know that they are written in a way that everyone will understand the question how we intended it to be written.

Content Gaps

The course that was presented to the two companies in the pilot group was a starting place for this approach, and there were many great ideas brought up during the feedback session on ways to expand and improve the course's content. One of the topics that was not included, but discussed in feedback, was to build on the continuing education option. Having this course count for continuing education would encourage more people to take and participate in the course. It also might encourage individuals in the industry who have been working for a long time to be more open to hearing and learning the material when they are able to count the hours spent going through the course to their hours needed for continuing education. In addition, this type of approach would give the opportunity to send emerging information to learners. The other component that was not included in the course distributed to the pilot group was the ability to incorporate ways for people to build relationships across the entire poultry

industry. The current course as it stands, focuses on what a privately-owned organization can control and how it will be impacted during an avian influenza outbreak, but not how different, publicly owned organizations will be impacted. The course briefly mentions how the public sector can help the private sector during an outbreak, but as of this writing 06/2024, the course does not offer an in-depth approach to engagement with the public sector for support during an HPAI outbreak and how to make and build those relationships.

Upon reviewing the course we identified the course should just focus on highly pathogenic avian influenza and not the combination of low pathogenic and highly pathogenic avian influenza. The first module becomes too large of a module with too much information when combining both LPAI and HPAI. Sticking only to HPAI will help streamline that module and help support all the future modules since they are strictly speaking about what occurs during a HPAI outbreak.

Other modules are going to be included after receiving feedback from the pilot group. One of the areas that was identified as having a content gap was in the topic of biosecurity. The biosecurity module will be a two-part module, with one focusing on farm-specific biosecurity measures that have been used to help stop outbreaks in the past, and how to evaluate a company's current biosecurity program. The second biosecurity module will focus on time spent doing

biosecurity measures and the risk associated with those activities. The second biosecurity module's goal is to show how it is possible to maintain business continuity if an organization is allowing their employees the time and resources to do those activities in a bio-secure way.

Another module that is going to be created is the relationship of HPAI and zoonotic disease. This module will discuss in detail how employees can become infected with HPAI, the signs and symptoms to be aware of, and how to encourage employees to speak up if they suspect they are sick from HPAI. This module, working with experts in public health, will walk executives through a HPAI infected site and the interactions their employees will have with infected birds, the PPE required to keep them safe, and the timeline on when and how a person will start showing symptoms.

The last module that is being created is a module on diagnostics. This module will explain what samples need to be taken on a farm if there is a suspect flock, how those samples will be processed at the lab, and what a positive result will look like. This module's goal is to explain the timeline on when an organization can expect to receive results and the events that need to occur for a positive result to be a valid positive result in the eyes of the state.

What went well

Even though we learned many lessons during the pilot group phase of this project, there were portions of the course that went well and were well-received. We were able to get a wide range of individual departments represented: transportation, quality control, animal health, live animal, operations, and sales. This whole company approach is different from most AI trainings, which focus on training people in the operations part of the company. Engagement of different departments also showed that the course was useful as a team and relationship building opportunity, which was one of the goals of the course. The pilot group also captured a great representation of people who had experienced an avian influenza outbreak and people who hadn't. The pilot group included people who had experienced LPAI and HPAI outbreaks. This range of avian influenza experience shows that this course is useful to all members of the poultry industry regardless of their experience level with AI. The survey also demonstrated that the majority of participants did have avian influenza experience, but the high ranking in the other questions concludes that the course still gave these experienced individuals new/helpful information about an outbreak. This is a major positive for the course because it shows that it is created in a way that exposes experienced AI individuals to new information or ways of thinking that can shed light on if their experience is helpful or harmful to an organization.

We don’t have enough data to really evaluate the ultimate impact of the course on preparing for AI outbreaks. However, the two companies that piloted our course as of this writing have made it through the 2022/23 HPAI outbreak with minimal or no cases. The layer company only had one case though they have farms throughout the United States including in the Minnesota and Iowa heavily populated poultry regions. The mixed poultry company as of this writing in 06/2024 has not had a positive HPAI case. These are organizations that have had prior history with avian influenza and have experienced positive cases in the past. We think that completing this course right before the major increase in positive cases during 2022 helped prepare their organizations and implement different policies and procedures to help them survive the worst HPAI outbreak in the United States.

CHAPTER 6

SUMMARY

Other Areas in which this Course could be used

This course was designed to help evolve the agricultural industry mindset around a foreign animal disease (FAD) outbreak. There are many courses available that provide in-depth explanation of the science around the disease but a lot of the information provided is too extensive, complicated, overwhelming, and provides little advice on how to apply the science to industry practices and how these outbreaks will impact employees. This course was built to start creating a format to help fix some of the gaps present in the way the agricultural industry prepares for an FAD. Currently, this course is written for avian influenza, but the course layout could be used for many other diseases and other types of disruptive events.

One of the agents that this course could be adapted for are Salmonellae. Salmonellae are problematic bacteria that can cause recalls because of their importance as food safety pathogens. If a recall occurs, there are implications for company and brand reputation, market, workflow, and because of that, causes major stress and anxiety for employees at all levels. This is a scenario that any

poultry organization can prepare for, take preventative steps, create a response team, and prepare for a recall scenario.

Foreign animal diseases are unique for American producers because, when they are introduced, they have no or little prior experience upon which to base actions. The use of this type of educational approach with poultry companies for HPAI has been implemented to fill this gap. There are other commodities that face similar needs, like the cattle industry with foot and mouth disease, or the swine industry with African swine fever (ASF).[245]

Currently ASF is present in other countries across the world and local producers can see the impact it is having to herds and producers. If this disease makes its way to the United States, it will cause devastating impacts to the swine industry because it is a highly contagious and deadly viral disease. This disease would cause major trade disruptions, economic losses, and would be traumatic for growers.[246] Currently there is no way to stop this disease other than to depopulate the affected herd, and the only way to protect a herd is through proper biosecurity. Since ASF industry responses will have many similarities to avian influenza this course would be a great asset for the swine industry. Using this course's format for ASF would provide the leaders in the swine industry the science behind viral control, how to start implementing proper biosecurity measures, how to prepare

supply chains for major disruptions, and how to support their employees during a stressful time.

Foreign animal disease outbreaks are not the only thing that can cause major disruptions to the animal agricultural industry. Natural disasters can be just as damaging. When raising animals, growers are always susceptible to what mother nature wants to throw their way whether it be flood, wildfires, drought, severe storms, extreme temperatures, or blizzards. Depending on the location of where animals are raised, some natural disasters might be more common than others, but every grower needs to be prepared to handle the outcomes of all these weather situations. This type of just-in-time course would be a valuable tool for helping growers across any agricultural industry to understand how their operation might be impacted in a natural disaster scenario. Preparing growers on the animal welfare impacts each disaster could have, such as leg problems from standing in pooled water for extensive amount of time, or extreme shivering from the cold are some examples of the animal welfare impacts of a flood or cold.[247] [248] The course would also discuss ways to prepare an operation for a disaster and offer resources or allow for conversations to occur on how to rebuild and problem solve after the weather has passed.

Review Process

Maintaining the scientific integrity of the course is crucial to ensuring that organizations are receiving the most up-to-date material available. When creating modules for the course, experts in the topic are brought in to help write and deliver the content. These experts can provide information around the disease or disruption, prevention strategies, agency roles, etc. Bringing in experts helps provide exposure to different people in research or academia, and in regulatory agencies so that they can build relationships. The course's content will be reviewed on an annual basis to make sure it is current as new findings become available.

This course not only provides the most recent scientific information to organizations, but it is built in a way using the most recent learning and teaching information available. Making sure the style of teaching is updated and current will be crucial to making sure that the information is understandable to viewers. Educational articles were used to provide current research on adult educational learning styles, needs, and techniques. These resources helped shape the format and style of the course in a way that adults in a corporate setting would resonate with and interact with the materials. To make sure that this course is always formatted in a way to encourage adult learning, current adult education research will be analyzed and reviewed to determine if we need to adjust the format.

Further Work

Using some of the feedback from the pilot group, we will create a website where organizations can access the modules and download course materials. The website will be built with different interfaces to serve the needs of different organizations. Organizations can request to meet with a member of the course team to create materials that will help their organization. An organization could request for specific infographics to help communicate a message, additional content, or other tools and resources to help their organization prepare for a catastrophic event. This website will also be a way for organizations to reach back out to the course creators to provide feedback, reach out for more information, or to find other experts in a specific area.

Making sure the information provided in each module is the most recent and reliable is crucial to ensuring quick and correct response from poultry organizations. The information provided in each module is regularly checked against new research and findings about HPAI outbreaks to make sure the information in the modules is current. The modules are built so that the slides can be rapidly changed and presentations re-recorded. All materials are aligned so that changes made to the presented material will lead to review of the linked supplementary material as well.

Conclusion

The goal of this project is to create a course that is easily adjustable to help spread scientific information pertaining to catastrophic events to help prepare organizations. The agricultural industry is always evolving and adapting to new situations and organizations are constantly having to respond. These changes could come in the form of changes in climate, increased threat of diseases, or re-emerging and new diseases that the industry has never seen before. All of these changes, unknowns, and pressures can make it challenging for organizational leaders to focus and prepare for all of them at the same time. This course helps provide scientific information quickly and in a timely fashion to organizational leaders when they are experiencing pressures from the environment that they have not experienced before or can cause major disruptions for their company. Shifting the mindset on how the agricultural industry handles major disruptions from reaction to prevention will help ensure proper animal welfare, reduce disease spread, and bring overall consistency to the agricultural markets bringing stability to leaders, workers, and consumers across the globe.

BIBLIOGRAPHY

1. Sandra Kerka. Teaching Adults: Is it Different? Myths and Realities. *Eric Publ.* 2–4 (2002).
2. Anh Nguyet Diep *et al.* Adult learners' needs in online and blended learning. *Aust. J. Adult Learn.* **59**, 223–253 (2019).
3. Davis, R. L. & Zhong, Y. The Biology of Forgetting—A Perspective. *Neuron* **95**, 490–503 (2017).
4. Murre, J. M. J. & Dros, J. Replication and Analysis of Ebbinghaus' Forgetting Curve. *PLOS ONE* **10**, e0120644 (2015).
5. Sharon Hilles & Andre Sutton. *Teaching English as a Second or Foreign Language*. (2013).
6. Palis, A. G. & Quiros, P. A. Adult Learning Principles and Presentation Pearls. *Middle East Afr. J. Ophthalmol.* **21**, 114–122 (2014).
7. Classics in the History of Psychology -- Introduction to Thorndike (1911) by R. H. Wozniak. http://psychclassics.yorku.ca/Thorndike/Animal/wozniak.htm?ref=http://klipyeri.com.

8. Skinner. *The Science of Learning and the Art of Teaching*. vol. 24 (Harvard Educational Review, 1954).
9. Piaget, J. & Cook, M. *The Origins of Intelligence in Children*. (The University of Michigan, 1952).
10. Bruner, J. S. *Toward a Theory of Instruction*. (Harvard University Press, 1966).
11. Hoban, J. D., Lawson, S. R., Mazmanian, P. E., Best, A. M. & Seibel, H. R. The Self-Directed Learning Readiness Scale: a factor analysis study. *Med. Educ.* **39**, 370–379 (2005).
12. Norman, G. R. The adult learner: a mythical species. *Acad. Med.* **74**, 886 (1999).
13. Choi, J.-I. & Hannafin, M. Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. *Educ. Technol. Res. Dev.* **43**, 53–69 (1995).
14. Mezirow, J. *Learning as Transformation: Critical Perspectives on a Theory in Progress. The Jossey-Bass Higher and Adult Education Series*. (Jossey-Bass Publishers, 350 Sansome Way, San Francisco, CA 94104, 2000).
15. Mezirow, J. Perspective Transformation. *Adult Educ.* **28**, 100–110 (1978).
16. Killen, P. O. Threshold Concepts within the Disciplines – Edited by Ray Land, Jan H.F. Meyer, and Jan Smith. *Teach. Theol. Relig.* **14**, 200–202 (2011).

17. Ryan, R. & Deci, E. Self-determination theory and the facilitation of intrinsic motication, social development, and well being. *Am. Psychol. Assoc.* **55**, 68–78 (2000).
18. Weiner, B. *Human Motivation: Metaphores, Theories, and Research*. (SAGE Publications, 1992).
19. Coleman, W. E. The Reflective Practitioner: How Professionals Think in Action.(Book). *Pers. Psychol.* **36**, 919–920 (1983).
20. Knowles, M. *The Adult Learner: A Neglected Species*. (Gulf Publishing Company, Houston, Texas, 1988).
21. David A. Kolb on experiential learning. – infed.org: https://infed.org/david-a-kolb-on-experiential-learning/.
22. Kolb's Learning Styles & Experiential Learning Cycle. https://www.simplypsychology.org/learning-kolb.html (2022).
23. The Johari Window. https://emilms.fema.gov/is_0240c/groups/63.html.
24. *Threshold Concepts and Transformational Learning*. (BRILL, 2010).
25. Haavelsrud, M. Review of Pedagogy, Symbolic Control and Identity: Theory, Research, Critique. *Int. Rev. Educ. Int. Z. Für Erzieh. Rev. Int. Educ.* **43**, 261–263 (1997).

26. Maas, J. Communities of Practice: Learning, Meaning, and Identity. *Sloan Manage. Rev.* **40**, 106–107 (1998).
27. Taylor, D. C. M. & Hamdy, H. Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide No. 83. *Med. Teach.* **35**, e1561–e1572 (2013).
28. Narayan, R., Rodriguez, C., Araujo, J., Shaqlaih, A. & Moss, G. Constructivism—Constructivist learning theory. in *The handbook of educational theories* 169–183 (IAP Information Age Publishing, Charlotte, NC, US, 2013).
29. Simonson, M. & Schlosser, C. *Distance Learning: Volume 12 #4*. (IAP, 2015).
30. Brockett, R. G. *Teaching Adults: A Practical Guide for New Teachers*. (John Wiley & Sons, 2015).
31. Instructional-Design Theory to Guide the Creation of Online Learning Communities for Adults. *TechTrends* **53**, 45–57 (2009).
32. Purwati, D., Mardhiah, A., Nurhasanah, E. & Ramli, R. The Six Characteristics of Andragogy and Future Research Directions in EFL: A Literature Review. *Elsya J. Engl. Lang. Stud.* **4**, 86–95 (2022).

33. EXPECTED ADVANTAGES AND DISADVANTAGES OF ONLINE LEARNING: PERCEPTIONS FROM COLLEGE STUDENTS WHO HAVE NOT TAKEN ONLINE COURSES. *Issues Inf. Syst.* (2012) doi:10.48009/2_iis_2012_193-200.
34. Pros And Cons Of Corporate eLearning - Roundtable Learning. https://roundtablelearning.com/pros-and-cons-of-corporate-elearning/.
35. Suhasini, R & Suganthalakshmi, T. Corporate E-Learning. *Asia Pac. J. Manag.* **4**, 176–198 (2015).
36. Yuhanna, I., Alexander, A. & Kachik, A. Advantages and disadvantages of Online Learning. *J. Educ. Verkenn.* **1**, 13–19 (2020).
37. Gherheș, V., Stoian, C. E., Fărcașiu, M. A. & Stanici, M. E-Learning vs. Face-To-Face Learning: Analyzing Students' Preferences and Behaviors. *Sustainability* **13**, 4381 (2021).
38. Dumford, A.D. & Miller, A.L. Online Learning in Higher Education: exploring advantages and disadvantages for engagement. *J. Comput. High. Educ.* **30**, 452–465 (2018).
39. Topping, K. J. Advantages and Disadvantages of Online and Face-to-Face Peer Learning in Higher Education: A Review. *Educ. Sci.* **13**, 326 (2023).

40. Topping, K. J. The effectiveness of peer tutoring in further and higher education: A typology and review of the literature. *High. Educ.* **32**, 321–345 (1996).
41. Leung, K.C. Updated Meda-Analysis on the Effect of Peer Tutoring on Tutors' Achievement. *Sch. Psychol. Int.* 200–2014 (2019).
42. Fernandez-Barros, A, Duran, D, & Viladot, L. Peer Tutoring in Music Education: A Literature Review. *Int. J. Music Educ.* 129–140 (2022).
43. Bowman-Perrott, L, Ragan, K, Boon, R.T, & Burke, M. D. Peer Tutoring Interventions for Students with or At-Risk for Emotional and Behavioral Disorders: A Systemic Review of Reviews. *Behav. Modif.* (2022).
44. Tibingana-Ahimbisibwe, B, Willis, S., Catherall, S., Butler. F, & Harrison, R. A Systemic Review of Peer-Assisted Learning in Fully Online Higher Education Distance Learning Programmes. *Open Learn* 251–272 (2022).
45. Karabulut-Ilgu, A., Jaramillo Cherrez, N. & Jahren, C. T. A systematic review of research on the flipped learning method in engineering education. *Br. J. Educ. Technol.* **49**, 398–411 (2018).
46. El Miedany, Y. Flipped Learning. in *Rheumatology Teaching: The Art and Science of Medical Education* (ed. El Miedany, Y.) 285–303 (Springer International Publishing, Cham, 2019). doi:10.1007/978-3-319-98213-7_15.

47. O'Flaherty, J. & Phillips, C. The use of flipped classrooms in higher education: A scoping review. *Internet High. Educ.* **25**, 85–95 (2015).
48. Kurbanoğlu, S. & Akkoyunlu, B. Chapter 3 - Information Literacy and Flipped Learning. in *Pathways into Information Literacy and Communities of Practice* (eds. Sales, D. & Pinto, M.) 53–84 (Chandos Publishing, 2017). doi:10.1016/B978-0-08-100673-3.00003-4.
49. Zakareya, S. & Alahmad, S. Inverted Teaching for Improving the Teaching Performance of EFL Student Teachers at Jubail College of Education. *Engl. Lang. Teach.* **12**, 15–20 (2019).
50. Keeping Up With...Flipped Classrooms | Association of College and Research Libraries. https://www.ala.org/acrl/publications/keeping_up_with/flipped_classrooms .
51. Using the inverted classroom to teach software engineering | Proceedings of the 30th international conference on Software engineering. https://dl.acm.org/doi/abs/10.1145/1368088.1368198?casa_token=PJsjwyxyaTkAAAAA:2Ec37Tx1hKmFmX8CQ3SrRR0XVvdLyPFoA3rtth-OtFDfhqypjs5zni1TZSAhvxUJ1RLcnMwswnGUc0g.

52. Michel, J., Hurst, S. & Revelle, A. Vodcasting, iTunes U, and Faculty Collaboration. *E-JASL 1999-2009 Vol. 1-10* (2009).
53. Lage, M. J., Platt, G. J. & Treglia, M. Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. *J. Econ. Educ.* **31**, 30–43 (2000).
54. Timothy C. Clapper. Professionals Against Improperly Labeling Active Learners. *Pailal Newsl.* **3**, 1–6 (2010).
55. Y. Hong, C. Chiu, C. S. Dweck, D. M. Lin, & W. Wan. Implicit theories, attributions, and coping: A meaning system approach. *J. Pers. Soc. Psychol.* **77**, 588–599 (1999).
56. C. M. Mueller & C. S. Dweck. Praise for intelligence can undermine children's motivation and performance. *J. Pers. Soc. Psychol.* **75**, 33–52 (1998).
57. D. A. Nussbaum & C. S. Dweck. Defensiveness Versus Remediation: Self-Theories and Modes of Self-Esteem Maintenance. *J. Pers. Soc. Psychol.* **34**, (2008).
58. Stephen Brookfield. Adult Learning: An Overview. in 229 (1995).
59. Eric Jensen. Brain-Based Learning: The new paradigm of teaching. in 43–44 (Corwin Press, 2008).

60. What Is Psychological Trauma? *SoberRecovery : Alcoholism Drug Addiction Help and Information* https://www.soberrecovery.com/forums/friends-family-alcoholics/214177-what-psychological-trauma.html.
61. Neil Bindemann. Becoming Trauma Informed: Learning How Trauma Can Impact Emotions. *Eur. J. Integr. Med.* **48**, (2021).
62. van der Kolk, B. Posttraumatic stress disorder and the nature of trauma. *Dialogues Clin. Neurosci.* **2**, 7–22 (2000).
63. Bryant, R. A. Post-traumatic stress disorder: a state-of-the-art review of evidence and challenges. *World Psychiatry* **18**, 259–269 (2019).
64. Andrea Kopstein. *Trauma-Informed Care in Behavioral Health Services*. vol. 57 (Substance Abuse and Mental Health Services Administration, 2014).
65. Bremner, J. D. Traumatic stress: effects on the brain. *Dialogues Clin. Neurosci.* **8**, 445–461 (2006).
66. Arnsten, A. F. T. Stress signalling pathways that impair prefrontal cortex structure and function. *Nat. Rev. Neurosci.* **10**, 410–422 (2009).
67. Emmett M. Larsen. Effects of Childhood Trauma on Adult Moral Decision-Making: Clinical Correlates and Insights from Bipolar Disorder. *J. Affect. Disord.* **244**, 180–186 (2019).

68. Vadim Zotev. Real-Time Fmri Neurofeedback Training of the Amygdala Activity with Stimultaneous EEG in Veterans with Combat-Related PTSD. *Neuroimage Clin.* **19**, 106–121 (2018).

69. Dailey, S. F., Campbell, L. N. P. & Ramsdell, J. Law enforcement officer naturalistic decision-making in high-stress conditions. *Polic. Int. J.* **ahead-of-print**, (2024).

70. Aupperle, R. L., Melrose, A. J., Stein, M. B. & Paulus, M. P. Executive function and PTSD: Disengaging from trauma. *Neuropharmacology* **62**, 686–694 (2012).

71. Williams, J. M. G., Mathews, A. & MacLeod, C. The emotional Stroop task and psychopathology. *Psychol. Bull.* **120**, 3–24 (1996).

72. Morey, R. A. *et al.* The role of trauma-related distractors on neural systems for working memory and emotion processing in posttraumatic stress disorder. *J. Psychiatr. Res.* **43**, 809–817 (2009).

73. Araminta. How To Avoid Trauma-Driven Decisions. *Khiron Clinics* https://khironclinics.com/blog/how-to-avoid-trauma-driven-decisions/ (2021).

74. Johnson, S. & Taylor, K. *The Neuroscience of Adult Learning*. (John Wiley & Sons, 2006).

75. McCarty, R. Chapter 4 - The Fight-or-Flight Response: A Cornerstone of Stress Research. in *Stress: Concepts, Cognition, Emotion, and Behavior* (ed. Fink, G.) 33–37 (Academic Press, San Diego, 2016). doi:10.1016/B978-0-12-800951-2.00004-2.

76. Morris, L. *et al.* Chapter 7 - Session 3 Feeling in Control Short Term vs Getting Control of Your Life. in *Transdiagnostic Group Therapy Training and Implementation* (eds. Morris, L. et al.) 97–111 (Academic Press, 2018). doi:10.1016/B978-0-12-813989-9.00007-5.

77. McCarty, R. Chapter 4 - The Fight-or-Flight Response: A Cornerstone of Stress Research. in *Stress: Concepts, Cognition, Emotion, and Behavior* (ed. Fink, G.) 33–37 (Academic Press, San Diego, 2016). doi:10.1016/B978-0-12-800951-2.00004-2.

78. Arnsten, A., Mazure, C. M. & Sinha, R. Neural circuits responsible for conscious self-control are highly vulnerable to even mild stress. When they shut down, primal impulses go unchecked and mental paralysis sets in. *Sci. Am.* **306**, 48–53 (2012).

79. DeFraia, G. Workplace Disruption following Psychological Trauma: Influence of Incident Severity Level on Organizations' Post-Incident Response Planning and Execution. *Int. J. Occup. Environ. Med.* **7**, 75–86 (2016).

80. Michael A. Simpson. How to Use Role-Play in Medical Teaching. **7**, 75–82 (1985).

81. Yvonne Steinert. Twelve Tips for Using Role-Plays in Clinical Teaching. *Med. Teach.* **15**, 283–291.

82. Kovoor-Misra, S., Zammuto, R. F. & Mitroff, I. I. Crisis Preparation in Organizations: Prescription versus Reality. *Technol. Forecast. Soc. Change* **63**, 43–62 (2000).

83. C.F. Smart & I. Vertinsky. Design for Crisis Decision Unites. *Adm. Sci. Q.* **22**, 640–657 (1977).

84. S. L. Fink. Crisis Management: Planning for the Inevitable. *AMACOM* (1986).

85. I. I. Mitroff. Crisis Managment: Cutting through the Confusion. *Sloan Manage. Rev.* **29**, 15–20 (1988).

86. P. Shrivastava. *Managing Industrial Crises*. (1987).

87. Gerald C. Meyers & John Holusha. *When It Hits the Fan: Managing the Nine Crises of Business*. (Houghton Mifflin, 1986).

88. P. C. Nystrom & W. H. Starbuck. To Avoid Organizational Crises, Unlearn. *Organ. Dyn.* **12**, 53–65 (1985).

89. T. W. Milburn, R. S. Schuler, & K. H. Watman. Organizational Crisis. Part II: Strategies and Responses. *Hum. Relat.* **36**, 1161–1180 (1983).

90. N. L. Phelps. Setting Up a Crisis Recovery Plan. *J. Bus. Strategy* 5–11 (1986).

91. J. Z. Wisenblit. Crisis Management Planning among U.S. Corporations: Empirical Evidence and a Proposed Framework. **54**, 31–41 (1989).

92. Christine M. Pearson & Ian I. Mitroff. From crisis prone to crisis prepared: a framework for crisis management. in *Risk Management* 175–187 (2000).

93. C. F. Hermann. Some Consequences of Crises Which Limit the Viability of Organizations. *Adm. Sci. Q.* **8**, 343–358 (1963).

94. O. R. Holsti. Limitations of Cognitive Abilities in the Face of Crisis. *Stud. Crisis Manag.* 35–52 (1978).

95. A. D. Baddeley. Selective Attention and Performance in Dangerous Environments. **63**, 537–546 (1972).

96. D. T. Hall & R. Mansfield. Organizational and Individual Response to Externmal Stress. *Adm. Sci. Q.* **16**, 533–547 (1971).

97. K. E. Weick. The Collapse of Sensemaking and Organizations: The Mann Gulch Disaster. *Adm. Sci. Q.* **38**, 628–652 (1993).

98. L. Barton. The Use of Scenario-Based Planning for Management Executives. **33**, 8–11 (1991).

99. J. R. Harrold, H. S. Marcus, & W. A. Wallace. The Exxon Valdez: An Assessment of Crisis Prevention and Managment Systems. *Interfaces* **20**, 14–30 (1990).

100. J. B. Hillenberg & K. L. Wolf. Psychological Impact of Traumatic Events: Implications for Employee Assistance Intervention. *Empl. Assist. Q.* **4**, 1–13 (1988).

101. B. Z. Lawson. Work-Related Post-Traumatic Stress Reations: The Hidden Dimension. *Health Soc. Work* **12**, 250–258 (1987).

102. C. B. Wilkinson. Aftermath of a Disaster: The Collapse of the Hyatt Regency Hotel Skywalk. *Am. J. Psychiatry* **140**, 1134–11349 (1983).

103. D. G. Doepel. Crisis Management: The Psychological Dimension. *Ind. Crisis Q.* **5**, 177–188 (1991).

104. Capua, I. & Marangon, S. Control of Avian Influenza in Poultry. *Emerg. Infect. Dis.* **12**, 1319–1324 (2006).

105. Capua I, Alexander DJ. Avian Influenza: Recent Developments. *Avian Pathol.* 393–404 (2004) doi:10.1080/03079450410001724085.

106. USDA APHIS | 2014-2015 HPAI Outbreak. https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/avian/2014-2015-hpai-outbreak.

107. CDC. H5N1 Bird Flu Detections across the United States in Backyard and Commercial Poultry. *Avian Influenza (Bird Flu)* https://www.cdc.gov/bird-flu/situation-summary/data-map-commercial.html (2024).

108. Ramos, S. Impacts of the 2014-2015 Highly Pathogenic Avian Influenza Outbreak on the U.S. Poultry Sector.

109. Sonnberg, S., Webby, R. J. & Webster, R. G. Natural history of highly pathogenic avian influenza H5N1. *Virus Res.* **178**, 63–77 (2013).

110. R. G. Webster, W. J Bean, O. T Gorman, T. M Chambers, & Y Kawaoka. Evolution and ecology of influenza A viruses. *Microbiol. Rev.* **56**, 152–179 (1992).

111. D. M Knipe & P. M Howley. Orthomyxoviridae: the viruses and their replication. *Fields Virol.* **5**, 1647–1689 (2007).

112. CDC. Avian Influenza in Birds. *Centers for Disease Control and Prevention* https://www.cdc.gov/flu/avianflu/avian-in-birds.htm (2022).

113. Alexander, D. J. An overview of the epidemiology of avian influenza. *Vaccine* **25**, 5637–5644 (2007).

114. Neumann, G., Chen, H., Gao, G. F., Shu, Y. & Kawaoka, Y. H5N1 influenza viruses: outbreaks and biological properties. *Cell Res.* **20**, 51–61 (2010).

115. Swayne, D. E. & Suarez, D. L. Highly Pathogenic Avian Influenza. *Rev. Sci. Tech. OIE* 463–82 (2000) doi:10.20506/rst.19.2.1230.

116. Influenza Type A Viruses | Avian Influenza (Flu). https://www.cdc.gov/flu/avianflu/influenza-a-virus-subtypes.htm.

117. Genetic versus antigenic differences among highly pathogenic H5N1 avian influenza A viruses: Consequences for vaccine strain selection - ClinicalKey. https://www-clinicalkey-com.ezp1.lib.umn.edu/#!/content/journal/1-s2.0-S0042682217300211.

118. C. Scholtissek, W. Rohde, V. Von Hoyningen, & R. Rott. On the origin of the human influenza virus subtypes H2N2 and H3Ns. *Virology* 13–20 (1978).

119. S. Krauss, D. Walker, S. P. Pryor, L. Niles, & R. G. Webster. Influenza A viruses of migrating wild aquatic birds in North America. *Vector Borne Zoonotic Dis.* 177–189 (2004).

120. S. Krauss *et al.* Coincident ruddy turnstone migration and horseshoe crab spawning creates an ecological 'hot spot' for influenza viruses. *Proc. Biol. Sci.* 3373–3379 (2010).

121. S. Krauss *et al.* Influenza in migratory birds and evidence of limited intercontinental virus exchange. *PLos Pathog.* 167 (2007).

122. R. A Fouchier *et al.* Characterization of a novel influenza A virus hemagglutinin subtype (H16) obtained from black-headed gulls. *J. Virol.* 2814–2822 (2005).

123. P.F Wright, G. Neumann, & Y. Kawaoka. Orthomyxoviruses. *Fields Virol.* 1691–1740 (2007).

124. R. J. Garten *et al.* Antiggenic and genetic characteristics of swine-origin 20019 A(H1N1) influenza viruses circulating in humans. *Science* 197–201 (2009).

125. Y. Guan *et al.* The emergence of pandemic influenza viruses. *Protein Cell* **1**, 9–13 (2010).

126. B.J. Hoye, V. J Munster, H. Nishiura, M. Klaassen, & R. A Fouchier. Surveillance of wild birds for avian influenza viruse. *Emerg. Infect. Dis.* **16**, 1827–1834 (2010).

127. J. K Taubenberger & J. C Kash. Influenza virus evolution, host adaptation, and pandemic formation. *Cell Host Microbe* **7**, 440–451 (2010).

128. K.J Vandegrift, S. H. Sokolow, P. Daszak, & A.M. Kiplatrick. Ecology of avian influenza viruses in a changing world. *Year Ecol. Conserv. Biol.* 113–128 (2010).

129. G.J Smith *et al.* Dating the emergence of pandemic influenza viruses. *Proc. Natl. Acad. Sci.* **106**, 11709–11712 (2009).

130. G. J. Smith *et al.* Origins and evolutionary genomics of the 2009 swine-origin H1N1 influenza A epidemic. *Nature* **459**, 1122–1125 (2009).

131. Kaplan, B. S. & Webby, R. J. The avian and mammalian host range of highly pathogenic avian H5N1 influenza. *Virus Res.* **178**, 3–11 (2013).

132. Reperant L. A., Rimmelzwaan G. F., & Kuiken T. Avian Influenza Viruses in Mammals. *Rev. Sci. Tech. OIE* **28**, 137–159 (2009).

133. Tong, S. *et al.* A distinct lineage of influenza A virus from bats. *Proc. Natl. Acad. Sci.* **109**, 4269–4274 (2012).

134. Spickler, A. R. The Onset of Virus Shedding and Clinical Signs in Turkeys Infected with High and Low Pathogenicity Avian Influenza Viruses.

135. Yee, K. S., Carpenter, T. E. & Cardona, C. J. Epidemiology of H5N1 avian influenza. *Comp. Immunol. Microbiol. Infect. Dis.* **32**, 325–340 (2009).

136. NVAP Reference Guide: Avian Influenza | Animal and Plant Health Inspection Service. https://www.aphis.usda.gov/nvap/reference-guide/poultry/ai.

137. Avian Influenza in Poultry and Wild Birds - Poultry. *Merck Veterinary Manual* https://www.merckvetmanual.com/poultry/avian-influenza-in-poultry-and-wild-birds/avian-influenza-in-poultry-and-wild-birds.

138. Elbers, A. R. W., Koch, G. & Bouma, A. Performance of clinical signs in poultry for the detection of outbreaks during the avian influenza A (H7N7) epidemic in The Netherlands in 2003. *Avian Pathol.* **34**, 181–187 (2005).

139. B. Dodet & M. Vicari. Ecology of avian influenza in domestic birds. *Proc. Int. Symp. Emergence Control Zoonotic Ortho- Paramyxovirus Dis.* 25–34 (2001).

140. Avian influenza basics for urban and backyard poultry owners | UMN Extension. https://extension.umn.edu/poultry-health/avian-influenza-basics-noncommercial-poultry-flock-owners.

141. Avian Influenza (Bird Flu) | NIOSH | CDC. https://www.cdc.gov/niosh/topics/avianflu/default.html (2023).

142. Technical Report: Highly Pathogenic Avian Influenza A(H5N1) Viruses. *Centers for Disease Control and Prevention* https://www.cdc.gov/flu/avianflu/spotlights/2022-2023/h5n1-technical-report.htm (2023).

143. Altmüller, A. *et al.* Genetic relatedness of the nucleoprotein (NP) of recent swine, turkey, and human influenza Avirus(H1N1) isolates. *Virus Res.* **22**, 79–87 (1992).

144. Bird flu can infect cats. What does that mean for their people? https://www.sciencenews.org/article/bird-flu-h5n1-infect-cats-people (2024).

145. Features of H5N1 influenza viruses in dairy cows may facilitate infection, transmission in mammals. *National Institutes of Health (NIH)* https://www.nih.gov/news-events/news-releases/features-h5n1-influenza-viruses-dairy-cows-may-facilitate-infection-transmission-mammals (2024).

146. Goat in Minnesota tests positive for HPAI | American Veterinary Medical Association. https://www.avma.org/news/goat-minnesota-tests-positive-hpai (2024).

147. Avian influenza virus type A (H5N1) in U.S. dairy cattle | American Veterinary Medical Association. https://www.avma.org/resources-tools/animal-health-and-welfare/animal-health/avian-influenza/avian-influenza-virus-type-h5n1-us-dairy-cattle.

148. sharbiso. Highly Pathogenic Avian Influenza (HPAI) and Dairy Cattle | College of Veterinary Medicine. https://vetmed.tennessee.edu/highly-pathogenic-avian-influenza-hpai-and-dairy-cattle/ (2024).

149. Highly Pathogenic Avian Influenza (HPAI) H5N1 Detections in Alpacas | Animal and Plant Health Inspection Service. https://www.aphis.usda.gov/livestock-poultry-disease/avian/avian-influenza/hpai-detections/mammals/highly-pathogenic-avian.

150. Alpacas infected with H5N1 avian flu in Idaho | CIDRAP. https://www.cidrap.umn.edu/avian-influenza-bird-flu/alpacas-infected-h5n1-avian-flu-idaho (2024).

151. CDC Reports Second Human Case of H5 Bird Flu Tied to Dairy Cow Outbreak. *CDC* https://www.cdc.gov/media/releases/2024/s0522-human-case-h5.html (2024).

152. CDC. Current H5N1 Bird Flu Situation in Dairy Cows. *Avian Influenza (Bird Flu)* https://www.cdc.gov/bird-flu/situation-summary/mammals.html (2024).

153. Charostad, J. *et al.* A comprehensive review of highly pathogenic avian influenza (HPAI) H5N1: An imminent threat at doorstep. *Travel Med. Infect. Dis.* **55**, 102638 (2023).

154. Cumulative number of confirmed human cases for avian influenza A(H5N1) reported to WHO, 2003-2023, 3 October 2023. https://www.who.int/publications/m/item/cumulative-number-of-confirmed-human-cases-for-avian-influenza-a(h5n1)-reported-to-who--2003-2023--3-october-2023.

155. Shengjie Lai *et al.* Global epidemiology of avian influenza A H5N1 virus infection in humans, 1997-2015: a systematic review of individual case data. *The Lancet* **16**, 108–118 (2016).

156. Bui, C. *et al.* A Systematic Review of the Comparative Epidemiology of Avian and Human Influenza A H5N1 and H7N9 – Lessons and Unanswered Questions. *Transbound. Emerg. Dis.* **63**, 602–620 (2016).

157. Beigel JH, Farrar J, & Han AM. Avian Influenza A (H5N1) infection in humans. *N. Engl. J. Med.* **353**, 1374–1385 (2005).

158. Gao HN, Lu HZ, & Cao B. Clinical findings in 111 cases of influenza A (H7N9) virus infection. *N. Engl. J. Med.* **368**, 2277–2285 (2013).

159. Taylor HR & Turner AJ. A case report of fowl plague keratoconjunctivitis. *Br. J. Ophthalmol.* **61**, 86–88 (1977).

160. Webster RG, Geraci J, & Petursson G. Conjunctivitis in human beings caused by influenza A virus of seals. *N. Engl. J. Med.* **304**, 911 (1981).

161. Kurtz J, Manvell RJ, & Banks J. Avian influenza virus isolated from a women with conjunctivitis. *Lancet* **348**, 901–902 (1996).

162. Amonsin, A. *et al.* Genetic characterization of H5N1 influenza A viruses isolated from zoo tigers in Thailand. *Virology* **344**, 480–491 (2006).

163. Chen, Y. *et al.* Human infections with the emerging avian influenza A H7N9 virus from wet market poultry: clinical analysis and characterisation of viral genome. *The Lancet* **381**, 1916–1925 (2013).

164. Kim, S. M., Kim, Y.-I., Pascua, P. N. Q. & Choi, Y. K. Avian Influenza A Viruses: Evolution and Zoonotic Infection. *Semin. Respir. Crit. Care Med.* **37**, 501–511 (2016).

165. Shinya, K. *et al.* Influenza virus receptors in the human airway. *Nature* **440**, 435–436 (2006).

166. Lewis, D. B. Avian Flu to Human Influenza. *Annu. Rev. Med.* **57**, 139–154 (2006).

167. The Status of Wildlife Associated with the 1983-84 Avian Influenza Outbreak in Pennsylvania/Virginia on JSTOR. https://www-jstor-org.ezp3.lib.umn.edu/stable/3298726?searchText=The+Status+of+Wildlife+Associated+with+the+1983-84+Avian+Influenza+Outbreak+in+Pennsylvania%2FVirginia&searchUri=%2Fa

ction%2FdoBasicSearch%3FQuery%3DThe%2BStatus%2Bof%2BWildlife%2BAssociated%2Bwith%2Bthe%2B1983-84%2BAvian%2BInfluenza%2BOutbreak%2Bin%2BPennsylvania%252FVirginia&ab_segments=0%2Fbasic_search_gsv2%2Fcontrol&refreqid=fastly-default%3A295bd3afd4cd9b8fcdc4e00d566d4f72&seq=3.

168. Eckroade, R. J. & Bachin, L. A. S. Avian Influenza in Pennsylvania the Beginning. *Avian Dis.* **47**, 22–32 (2003).

169. Bean, W. J., Kawaoka, Y., Wood, J. M., Pearson, J. E. & Webster, R. G. Characterization of virulent and avirulent A/chicken/Pennsylvania/83 influenza A viruses: potential role of defective interfering RNAs in nature. *J. Virol.* **54**, 151–160 (1985).

170. Lee, C.-W., Swayne, D. E., Linares, J. A., Senne, D. A. & Suarez, D. L. H5N2 Avian Influenza Outbreak in Texas in 2004: the First Highly Pathogenic Strain in the United States in 20 Years? *J. Virol.* **79**, 11412–11421 (2005).

171. Review of the highly pathogenic avian influenza outbreak in Texas, 2004 in: Journal of the American Veterinary Medical Association Volume 228 Issue 12 (). https://avmajournals.avma.org/view/journals/javma/228/12/javma.228.12.1869.xml.

172. Zhao, Y. *et al.* Airborne transmission may have played a role in the spread of 2015 highly pathogenic avian influenza outbreaks in the United States. *Sci. Rep.* **9**, 11755 (2019).

173. Seeger, R. M., Hagerman, A. D., Johnson, K. K., Pendell, D. L. & Marsh, T. L. When poultry take a sick leave: Response costs for the 2014–2015 highly pathogenic avian influenza epidemic in the USA. *Food Policy* **102**, 102068 (2021).

174. Youk, S. *et al.* H5N1 highly pathogenic avian influenza clade 2.3.4.4b in wild and domestic birds: Introductions into the United States and reassortments, December 2021–April 2022. *Virology* **587**, 109860 (2023).

175. EFSA ECDC, EURL *et al.* Avian influenza overview september - December 2021. *Eur. Food Saf. Auth.* **19**, (2021).

176. Avian influenza overview May – September 2021 - - 2022 - EFSA Journal - Wiley Online Library. https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2022.7122.

177. Bevins, S. N. *et al.* Intercontinental Movement of Highly Pathogenic Avian Influenza A(H5N1) Clade 2.3.4.4 Virus to the United States, 2021. *Emerg. Infect. Dis.* **28**, 1006–1011 (2022).

178. threat from both sides: Multiple introductions of genetically distinct H5 HPAI viruses into Canada via both East Asia-Australasia/Pacific and Atlantic flyways | Virus Evolution | Oxford Academic. https://academic.oup.com/ve/article/8/2/veac077/6675431.

179. WOAH. CHAPTER 10.4. Infection with High Pathogenicity Avian Influenza viruses. *Terrestrial Code Online Access – WOAH – World Organisation for Animal Health* https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_avian_influenza_viruses.htm.

180. Ramey, A. M., DeLiberto, T. J., Berhane, Y., Swayne, D. E. & Stallknecht, D. E. Lessons learned from research and surveillance directed at highly pathogenic influenza A viruses in wild birds inhabiting North America. *Virology* **518**, 55–63 (2018).

181. The Asia-to-America Influx of Avian Influenza Wild Bird Hosts Is Large | Avian Diseases. https://meridian.allenpress.com/avian-diseases/article-abstract/54/s1/477/136031/The-Asia-to-America-Influx-of-Avian-Influenza-Wild.

182. Outbreaks of Avian Influenza A (H5N2), (H5N8), and (H5N1) Among Birds — United States, December 2014–January 2015. https://www.cdc.gov/Mmwr/preview/mmwrhtml/mm6404a9.htm.

183. Çakır, M., Boland, M. A. & Wang, Y. The Economic Impacts of 2015 Avian Influenza Outbreak on the U.S. Turkey Industry and the Loss Mitigating Role of Free Trade Agreements. *Appl. Econ. Perspect. Policy* **40**, 297–315 (2018).

184. USDA. *Wild Bird Highly Pathogenic Avain Ifluenza Cases in the United States*. https://www.aphis.usda.gov/media/document/1298/file (2016).

185. USDA APHIS | 2022-2023 Confirmations of Highly Pathogenic Avian Influenza in Commercial and Backyard Flocks. https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/avian/avian-influenza/hpai-2022/2022-hpai-commercial-backyard-flocks.

186. USDA APHIS | 2022-2023 Detections of Highly Pathogenic Avian Influenza in Wild Birds. https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/avian/avian-influenza/hpai-2022/2022-hpai-wild-birds.

187. Bui, C. M., Chughtai, A. A., Adam, D. C. & MacIntyre, C. R. An overview of the epidemiology and emergence of influenza A infection in humans over time. *Arch. Public Health* **75**, 15 (2017).

188. Avian flu outbreak exacerbates concerns for farmers' mental health | Penn State University. https://www.psu.edu/news/agricultural-sciences/story/avian-flu-outbreak-exacerbates-concerns-farmers-mental-health/.

189. As avian flu cases slow, farmers struggle with mental stress | MPR News. https://www.mprnews.org/story/2022/05/24/as-avian-flu-cases-slow-farmers-struggle-with-mental-stress.

190. Werner, B. Mental health resources available for poultry producers struggling with avian flu epidemic. *Minnesota News Network* https://minnesotanewsnetwork.com/mental-health-resources-available-for-poultry-producers-struggling-with-avian-flu-epidemic/ (2022).

191. Talking Highly Pathogenic Avian Influenza with Jeff Bender - School of Public Health - University of Minnesota. https://www.sph.umn.edu/news/talking-highly-pathogenic-avian-influenza-with-jeff-bender/.

192. Dealing with HPAI-related compassion fatigue. https://extension.umn.edu/news/dealing-hpai-related-compassion-fatigue.

193. Why poultry employees leave or stay | WATTAgNet | WATTPoultry. https://www.wattagnet.com/articles/34821-why-poultry-employees-leave-or-stay?v=preview.

194. Executives And Leaders Are Leaving Their Roles Due To Burnout. https://www.forbes.com/sites/karadennison/2022/07/28/executives-and-leaders-are-leaving-their-roles-due-to-burnout/?sh=16a9606cdb95.

195. *Public-Private Partnerships*. (John Wiley & Sons, Ltd, 2003). doi:10.1002/9780470690703.

196. Beltran-Alcrudo, D., Bunn, D. A., Sandrock, C. E. & Cardona, C. J. Avian flu school: a training approach to prepare for H5N1 highly pathogenic avian influenza. *Public Health Rep* vol. 123 323–32 (2008).

197. Walz, E. *et al.* Garbage Management: An Important Risk Factor for HPAI-Virus Infection in Commercial Poultry Flocks. *Front. Vet. Sci.* **5**, 5 (2018).

198. Dale Lauer & Sarah Mason. *Report of the Committee on Transmissible Diseases of Poultry and Other Avian Species*. (2015).

199. Fact Sheet: USDA Continues Partner Engagement to Mitigate Highly Pathogenic Avian Influenza for 2023 Season.

https://www.usda.gov/media/press-releases/2023/04/14/fact-sheet-usda-continues-partner-engagement-mitigate-highly.

200. Green, A. L. *et al.* Investigation of risk factors for introduction of highly pathogenic avian influenza H5N1 virus onto table egg farms in the United States, 2022: a case–control study. *Front. Vet. Sci.* **10**, 1229008 (2023).

201. USDA-APHIS. *Epidemiologic and Other Analyses of HPAI Affected Poultry Flocks*. (2022).

202. Yasser Sanad. *The Role of Migratory Birds as Reservoirs for Transmitting Highly Pathogenic Avian Influenza*. (2022).

203. Puryear, W. B. & Runstadler, J. A. High-pathogenicity avian influenza in wildlife: a changing disease dynamic that is expanding in wild birds and having an increasing impact on a growing number of mammals. (2024) doi:10.2460/javma.24.01.0053.

204. Organ, C. 7 Organizational Structure Types (With Examples). *Forbes Advisor* https://www.forbes.com/advisor/business/organizational-structure/ (2023).

205. Avdelidou-Fischer, N. The Relationship between Organizational Structures and Performance: The Case of the Fortune 500. in *Value Creation*

in Multinational Enterprise (eds. Jay Choi, J. & W. Click, R.) vol. 7 169–206 (Emerald Group Publishing Limited, 2006).

206. Lead Management and Key Personnel Positions in a Business | Ag Decision Maker. https://www.extension.iastate.edu/agdm/wholefarm/html/c5-111.html.

207. Ma, S., Kor, Y. Y. & Seidl, D. Top management team role structure: A vantage point for advancing upper echelons research. *Strateg. Manag. J.* **43**, O1–O28 (2022).

208. Zhuo, J. As Your Team Gets Bigger, Your Leadership Style Has to Adapt. *Harvard Business Review* (2019).

209. Smith, W. K. & Tushman, M. L. Managing Strategic Contradictions: A Top Management Model for Managing Innovation Streams. *Organ. Sci.* **16**, 522–536 (2005).

210. Hakovirta, M., Denuwara, N., Topping, P. & Eloranta, J. The corporate executive leadership team and its diversity: impact on innovativeness and sustainability of the bioeconomy. *Humanit. Soc. Sci. Commun.* **10**, 1–10 (2023).

211. Adams, R. B., Hermalin, B. E. & Weisbach, M. S. The Role of Boards of Directors in Corporate Governance: A Conceptual Framework and Survey. *J. Econ. Lit.* **48**, 58–107 (2010).

212. Myeong-Gu Seo & Lisa Feldman Barret. Being emotional during decision making - good or bad? An Empirical investigation. *Pubmed Cent.* **50**, 923–940 (2008).

213. Morse, G. Decisions and Desire. *Harvard Business Review* (2006).

214. Izard, C. E. Emotion Theory and Research: Highlights, Unanswered Questions, and Emerging Issues. *Annu. Rev. Psychol.* **60**, 1–25 (2009).

215. Sharon Griffin & Michael F. Mascolo. *What Develops in Emotional Development? Emotions, Personality, and Psychotherapy.* (1998).

216. Post-Traumatic Stress Disorder - National Institute of Mental Health (NIMH). https://www.nimh.nih.gov/health/publications/post-traumatic-stress-disorder-ptsd.

217. Kensinger, E. A. Remembering the Details: Effects of Emotion. *Emot. Rev.* **1**, 99–113 (2009).

218. James W. The principles of psychology. *Thoemmes Press - Class. Psychol.* (1998).

219. Neisser U & Harsch N. Phantom flashbulbs: false recollections of hearing the news about Challenger. *Camb. Univeristy Press* 9–31 (1992).

220. Hammond, J. S., Keeney, R. L. & Raiffa, H. The Hidden Traps in Decision Making. *Harvard Business Review* (1998).

221. *Final Report for the 2014-2015 Outbreak of Highly Pathogenic Avian Influenza (HPAI) in the United States*. (2016).

222. Merle E. Mast & Mary John Van Atta. Applying Adult Learning Pcrinciples in Instructional Module Design. *Nurse Educ.* **11**, 35 (1986).

223. Islam, M., Kim, D.-A. & Kwon, M. A Comparison of Two Forms of Instruction: Pre-Recorded Video Lectures vs. Live ZOOM Lectures for Education in the Business Management Field. *Sustainability* **12**, 8149 (2020).

224. Nestel, D. & Tierney, T. Role-play for medical students learning about communication: Guidelines for maximising benefits. *BMC Med. Educ.* **7**, 3 (2007).

225. M. D. N Lew & H. G. Schmidt. Writing to learn: Can reflection journals be used to promote self-reflection and learning? *High. Educ. Res. Dev.* (2011).

226. Lew, M. D. N. & Schmidt, H. G. Self-reflection and academic performance: is there a relationship? *Adv. Health Sci. Educ.* **16**, 529–545 (2011).

227. C. E. Weinstein & R. E. Mayer. The teaching of learning strategies. in *The Teaching of Learning Strategies* 315–327 (1986).

228. Jennifer A. Moon. *A Handbook of Reflective and Experiential Learning; Theory and Practice*. (Routledge Falmer, 1999).

229. I. D. Anyfantis, D. Papagiannis, & G. Rachiotis. Burnout among labour inspectors in Greece: A national cross-sectional study. *Saf. Sci.* **135**, (2021).

230. Lam, L. T., Lam, M. K., Reddy, P. & Wong, P. Factors Associated with Work-Related Burnout among Corporate Employees Amidst COVID-19 Pandemic. *Int. J. Environ. Res. Public. Health* **19**, 1295 (2022).

231. O. Aydemir & I. Icelli. Burnout: Risk Factors. *Burn. Experts* (2013).

232. Oliver Hammig. The Key Role of Supervisor Support. *SSM - Popul. Health* **3**, 393–402 (2017).

233. Kalavar, S. & Mysore, M. Are you prepared for a corporate crisis?

234. Hartmann, A. W. Building Relationships to Last. (2010).

235. Jaques, T. Crisis leadership: a view from the executive suite. *J. Public Aff.* **12**, 366–372 (2012).

236. Knowles, M. *The Adult Learner: A Neglected Species*. https://eric.ed.gov/?id=ED084368 (1973).

237. Understanding your Learning Style. (2008).

238. Kirby, J. R., Moore, P. J. & Schofield, N. J. Verbal and visual learning styles. *Contemp. Educ. Psychol.* **13**, 169–184 (1988).

239. Dobson, J. L. Learning style preferences and course performance in an undergraduate physiology class. *Adv. Physiol. Educ.* **33**, 308–314 (2009).

240. Rajshree S. Vaishnav. Learning style and academic achievement of secondary school students. *Voice Res.* **1**, (2013).

241. Annette Vincent & Dianne Ross. Learning Style Awareness: A basis for developing teaching and learning strategies. *J. Res. Comput. Educ.*

242. Allen, I. E. & Seaman, J. *Changing Course: Ten Years of Tracking Online Education in the United States*. *Sloan Consortium (NJ1)* https://eric.ed.gov/?id=ED541571 (2013).

243. Ross-Gordon, J. M. Research on Adult Learners: Supporting the Needs of a Student Population that Is No Longer Nontraditional. *Peer Rev.* **13**, 26–29 (2011).

244. Autumn Luscinski. Best Practices in Adult Online Learning. (Pepperdine University, 2017).

245. USDA APHIS | African Swine Fever (ASF). https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/swine-disease-information/african-swine-fever/seminar.

246. Sánchez-Vizcaíno, J. M., Laddomada, A. & Arias, M. L. African Swine Fever Virus. in *Diseases of Swine* 443–452 (John Wiley & Sons, Ltd, 2019). doi:10.1002/9781119350927.ch25.

247. National Academies of Sciences, E. *et al.* Disaster Resilience and Animal Research Programs. in *Strengthening the Disaster Resilience of the Academic Biomedical Research Community: Protecting the Nation's Investment* (National Academies Press (US), 2017).

248. Filipe, J. F., Herrera, V., Curone, G., Vigo, D. & Riva, F. Floods, Hurricanes, and Other Catastrophes: A Challenge for the Immune System of Livestock and Other Animals. *Front. Vet. Sci.* **7**, 16 (2020).