Engaging Airmen with Cyber Education and Training: Designing a Platform Using Gamification

Lt. Landon Tomcho
landon.tomcho@afit.edu

Lt. Col Mark Reith
mark.reith@afit.edu

Air Force Institute of Technology
2950 Hobson Way, Wright-Patterson AFB, OH 45433

Abstract - Several issues have impeded the effectiveness of United States Air Force cyber education and training in terms of ensuring that enough Airmen at all different levels of cyber education and training are appropriately prepared. The framework proposed in 'Rethinking USAF Cyber Education and Training' [1] is a response to this issue. The framework suggests a platform built around the idea of crowd-sourced content, community engagement, and feedback. This paper proposes several ideas of implementing gamification and human-focused design concepts on the platform and includes an analysis of how this can affect Airmen at different tiers of cyber development. Ideas relating to social involvement, introducing non-cyber-experts to the platform, and a navigable cyber topic map are proposed. These ideas are only a subset of the foundational concepts that can be applied to the platform; data from the platform should be used to continuously tailor the platform to maximize user engagement and consequently users' cyber knowledge.

Keywords

cyber education and training, gamification, human-focused design, topic map, 21st century learning

1 INTRODUCTION

The rapid development of cyber technology as well as its increasing integration into various US Air Force career fields has led to a demand for better, more accessible cyber training and education for all Airmen. The USAF would benefit from a 21st century approach to education and training where individual Airmen contribute to and consume crowd-sourced content that is up to date and presented at different levels from multiple perspectives. This approach has been proposed as a response to the present Air Force cyber education and training problems of currency, scalability and breadth, and complexity [1]. The framework in *Rethinking USAF Cyber Education & Training* [1] emphasizes the application of gamification and human-focused design to motivate and engage Airmen with cyber education and training. In order to experience the benefits of the platform entirely, the users must first be attracted to the platform and convinced to stay. Pulling in all types of Airmen to voluntarily learn about cyber is one of the non-trivial challenges we seek to overcome by designing an experience that considers human motivation in each stage of the learner's journey.

2 CURRENT CYBER EDUCATION AND TRAINING PROBLEMS

Many of the current problems relating to Air Force cyber education and training are stated in [1]. Among these are the currency problem, the scalability and breadth problem, and the complexity problem. The low number of sufficiently cyber-educated personnel in the Air Force is likely a result of several impediments. These include the military's approach to training and problems related to education in general. These observations have led to a crowd-based approach to keep content fresh and sourced from multiple perspectives for users of different skill levels.

The military's general approach to training and educating may not lend to the absorption of cyber knowledge by Airmen involved at all stages of cyber education and training. Note that it can work better in other areas that do not apply to all Airmen and are not as dynamic as cyber, however. The military's sink or swim approach to training means that Airmen either meet a required minimum threshold or fail out. This approach can ensure that everyone has completed some preset benchmark but does not inspire further progress. Specialized cyber training is generally only offered to those in the cyber career field or those in certain leadership positions; all other Airmen are only required to click through the hour-long annual Cyber Awareness Challenge, which has its own abundance of challenges. There are several development tiers of cyber education and training in the USAF based on career field and leadership position and are more specifically described in [1]. The effect of our proposed platform on each of these groups in discussed in the Analysis section of this paper.

Even outside of the military, the global demand for cybersecurity jobs is skyrocketing, resulting in a dramatic deficiency in the supply of cyber professionals. Cisco estimates there is more than one million unfilled cybersecurity jobs worldwide [2]. Even most college graduates with cybersecurity-related degrees come into the workforce unprepared and ineffective for some time [3]. How we can begin to resolve these problems from the cyber education perspective? Before proceeding, we must understand why many students elect not to purse cyber education and why those who do are unprepared. Some of the issues stem from traditional education delivery, a perceived lack of relatedness and relevance of cyber, and the idea that learning about cyber is simply too challenging.

The aforementioned issues are noted in two different papers [4] [5] as they relate to getting students involved and interested in STEM and in the classroom in general, respectively. When applying these observations to cyber, one may note that in the typical classroom setting, learning generally builds off of prior knowledge from prerequisite courses. Students may either be dissuaded by the prerequisite courses or fear of receiving lower marks for taking harder classes (like cyber) in an

environment with a large emphasis on extrinsic motivators (grades). Also note that in a typical classroom, content is passed over only once; whereas learning based on Spaced Repetition decreases the slope of the forgetting curve and leads to longer-term knowledge [6].

The education and training for USAF's specialized cyber forces has similar challenges. In addition, the benefits of updating course material and lab infrastructure must be weighed against causing setbacks in an already clogged pipeline (currency problem). Also, only half of recent cyber accessions have STEM degrees [7], resulting in a wide range of background knowledge among students. Teaching to the highest level may yield a handful of well-educated Airmen at the cost of leaving the majority of Airmen frustrated and in the dust. Instead, these courses are generally taught to the lowest level, lending to boredom and cynicism in the Airmen with more background knowledge and skill.

The third issue is that just like STEM, learners may get the impression that cyber is only for the ultra-bright students. The idea that it takes too much time to learn about cyber or that it is simply just too hard for the average person is harmful. Csikszentmihalyi's Flow Theory tells us that optimal performance occurs when the challenge meets the user's skill [8]. If people believe that the challenge of learning cyber is too far out of their reach, then you can't reasonably expect them to invest their time. How can we introduce Airmen, or civilians, to cyber in a manner that the perceived challenge meets their current skill?

3 GETTING AIRMEN UP TO SPEED WITH CYBER

As discussed previously, the worldwide cybersecurity force is severely undermanned. This issue even trickles down and affects the USAF. The commercial sector of cyber has several practices that can be adopted and adapted to help alleviate some of the USAF's challenges [9]. Although these techniques may help, they will not be silver bullets. The limited manning of dedicated USAF cyber forces means that it is every Airman's duty to uphold security standards to diminish cyber threats. The USAF cannot only worry about recruiting and selecting Airmen that will be

proficient in cyber career-fields but must also ensure that every Airman is more than just compliant with cybersecurity; they must be educated and inspired to increase cyber fortitude and resiliency [10].

One strategy set forth by different sources such as the National Integrated Cyber Education Research Center [11] and Sobiesk, et al. [12] is to place more emphasis on cyber as part of elementary, secondary, and undergraduate core curriculum. This strategy can certainly prove useful (even if there are problems with traditional education) for future cyber professionals, but current professionals cannot be forgotten. Airmen of all ages must be familiarized with cyber. It is harmful to assume that the younger generation understands cyber, and especially cyber conflict, just because they grew up with technology. "A perception exists that using a computer equates to knowing how it works" which is simply not the case [13]; and cyber conflict involves more than just understanding technology.

Some other ways to help set the foundation for Airmen could be to get everyone familiar with the cyber domain and terminology via reading and understanding *Building and Ontology of Cyber Security* [14] or *Cybersecurity: What Everyone Needs to Know* [15]. Aside from the currency issue, it is not simple to ensure that everyone in the USAF reads and understands this material without creating mandates and tests, which are troublesome techniques in themselves. As an alternative to these ideas, we propose a well gamified system that builds on the platform proposed in [1] in hopes to avoid the pitfalls of the other ideas and current education and training methods.

3.1 Gamification of Cyber Education

Gamification is a relatively young term that encapsulates the idea of using human-focused design and applying game elements to systems, platforms, and experiences to motivate users and increase engagement. This technique is effective [16] and has been successfully applied to many successful modern-day platforms. Some examples of well-gamified platforms include Facebook, YouTube, and Netflix. Together, these platforms accounted for over half of all internet traffic in

North America in 2016 [17]. Well-implemented gamification can certainly motivate people and can even cause ethical dilemmas in certain cases. For example, after backlash from parents, Netflix decided to retract a system that rewarded children with stickers for watching episodes [18]. However, cyber education is arguably a better goal to push people towards than watching television.

There are several examples of gamification applied to various forms of education including Software Engineering, Information Systems, Math and Science, Programming, etc. Some popular examples are Stack Overflow, Khan Academy, and WebWork. These platforms use game elements to produce outcomes of motivation, engagement, increased interest, and a sense of achievement in the learners [19]. There are also several papers discussing self-determination theory, which relates to human motivation and gamification, and its place in education [20][21][22]. For a juxtaposition, one can look at the DoD's Cyber Awareness Challenge (evaluated in [1]). This education/training module which DoD members must complete annually is an example of a platform that is not well-gamified.

The books [23] and [24] explain many of the foundational concepts of gamification. *Actionable Gamification* [25] presents the Octalysis framework (Figure 1) which breaks down human motivation into eight Core Drives. The author mainly focuses on Level 1 Octalysis but also presents Level 2 and 3 Octalysis which relates to designing for different stages of the game and different player types, respectively. Level 1 Octalysis can be leveraged to apply common game elements when designing our educational platform. Level 2 Octalysis considers motivating people to join, buy-in to, and continue an experience; the cyber-education journey in this case.

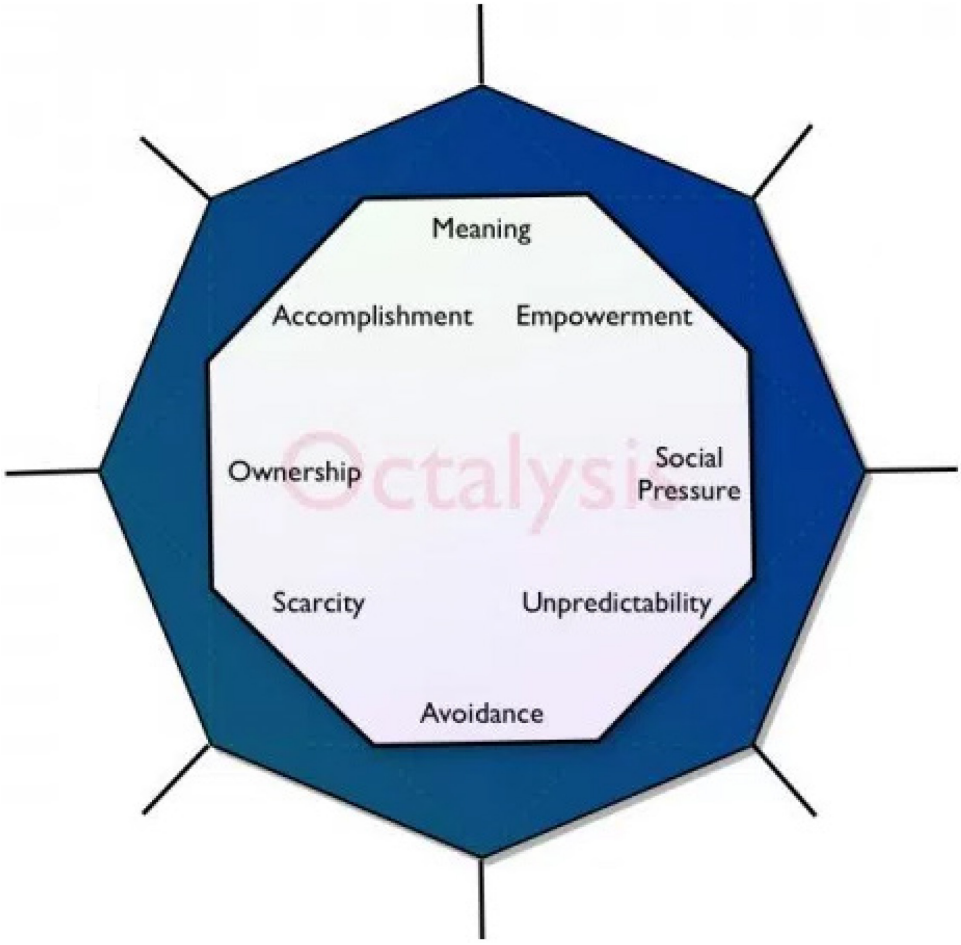

Figure 1: Octalysis Framework [25]

3.2 Applying Basic Game Elements

Crowd-sourced modular educational content not only alleviates the problems of currency, scalability and breadth, and complexity mentioned earlier [1], it naturally lends to several Octalysis core drives. The Empowerment of Creativity & Feedback core drive relates directly to users creating their own content and receiving feedback from the community (also Social Influence & Relatedness core

drive). This reinforces good content production and allows producers to learn and improve. Most games provide instant feedback to the user. Although a crowd-based feedback system may not be instant, the process of uploading and sharing content should be as smooth as possible with little to no barriers such as a review process to allow for the quickest possible feedback. This may raise a concern over 'false' or unprofessional content. Outside the fact that all content is attributable to someone's actual identity, content that fails to meet community guidelines can be reported as 'inappropriate' or 'misinformative.' The reporter can then be required to give a detailed explanation of the problem with the content so that the exact problem is noted.

The community can provide positive feedback on the content via comments or 'likes.' Commenting can not only be a place for high praise or compliments on certain parts of the content, but also a place for users to ask questions to clear up confusion or have a discussion among other community members. 'Likes' are an easy way for a user to demonstrate that they received the content positively whether it was useful, thoughtful, interesting, engaging, etc. Not having a 'dislike' or 'thumbs down' option helps prevent early users from becoming dissuaded from posting content that may not be 'expert' quality. In the early stages especially, gaining content from as many sources and as many perspectives as possible will be vital to the success of the platform. If the content is 'bad' enough to warrant negative feedback, the report options can be used. This design decision will circumvent users disliking content presented in a manner not best for that specific user (i.e. a learner that prefers videos downvotes all blog posts) and also users disliking content that presents new disruptive ideas that are valuable in their own way.

Recommending and sharing videos to specific people takes advantage of the Social Influence & Relatedness core drive. If you share content with a specific person, it can remind them to log in to the platform or create a profile and join. Simply being on the platform can spark more content consumption. Allowing users to join groups can establish a sense of community and encourage sharing between units as small as a squadron or as large as an entire career field. Giving a social aspect

to the platform ensures that it is more than just a media dump or a distributed learning system.

Personal profile on the platform lends to the Ownership & Possession core drive. Being able to build a profile with a user's background, career field, interests, and past experiences can not only allow other users to gain some perspective behind that user's generated content but also give each user a place that they 'own' to display their achievements and content. Other personalization's such as a custom layout, custom lists, and a tailored content recommendation algorithm also give the user a greater sense of ownership and can encourage them to use the platform more often.

Challenges and levels for earning badges and other rewards directly relates to the Development & Accomplishment core drive. Having clear goals and direction, while still allowing autonomy, can motivate users to achieve while developing their 'skills' (education level) along the way. Weekly challenges that urge users to view/create content could be a simple way to increase engagement with the platform. Displaying progress bars on tasks is another game element that has been shown to increase completion rates [25]. However, when it comes to points, badges, and other extrinsic motivators, the designer must be careful not to apply so much extrinsic motivation that it overtakes the intrinsic motivation of the user. Using extrinsic elements is great to let users know what they've accomplished and inspire them to achieve more, but too much can have negative effects [25].

Some game elements from the Scarcity & Impatience core drive could also be utilized on this platform. Artificial caps are a way of putting limits which most users would not usually surpass on some part of the platform. For example, if most users only view eight content items per day, the platform could advertise a limit of viewing only ten. This internally motivates users to maximize the value of the platform by consuming more. If users wanted to break the limit they could either unlock unlimited views for the week by posting a content item or permanently bypassing the cap after they become a 'power user' by achieving a certain status. The exact limits and rules need to be carefully considered and tailored based on user

data from the platform. Another common game technique is to keep extra features hidden from early users so that they can learn the platform basics without being overwhelmed.

Unpredictability & Curiosity could be targeted with a simple 'random content' button similar to the StumbleUpon website. This can help users find unique and interesting content while sparking interest in new topics and giving users' brains a sensation similar to that of playing a slot machine. The game elements discussed are some features that can fit well into the educational platform proposed by [1] and increase user engagement, even in a military context.

3.3 Designing for Each Phase

The Level 2 Octalysis, discussed in *Actionable Gamification*, deals with the four phases of a game (or gamified platform). The phases are Discovery, Onboarding, Scaffolding, and Endgame (Figure 2). These phases overlap with Kevin Werbach's theories of Identity, Onboarding, Scaffolding, and Mastery. The Discovery phase deals with the first impression and convincing users to try out a product or platform [25]. This directly relates to the issue of effectively introducing Airmen and the civilian population to cyber education in a motivating manner. In the military context, it is very important that the educational platform is introduced in such a way that the Airman does not associate it with mandatory training or another clunky military website that doesn't properly motivate users.

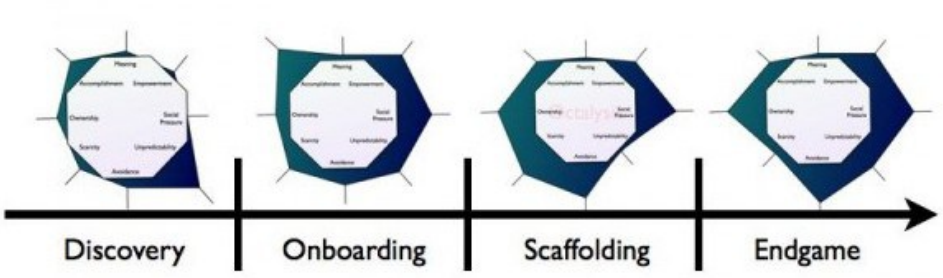

Figure 2: Level 2 Octalysis [25]

3.3.1 Discovery and Onboarding Phases

One Core Drive that could be leveraged during the Discovery phase is Epic Meaning & Calling. If Airmen see the platform as a place to contribute to the community and help the USAF, DoD, and the United States, they may be more likely to try the platform. Since Unpredictability & Curiosity is the strongest core drive during this phase [25], one may expect humans to constantly be trying new things because of their curiosity, so why do we balk at trying new things sometimes? Nir Eyal, best-selling author of *Hooked*, claims that "People don't want something truly new, they want the familiar done differently" [26].

For an example that supports this claim we can look at the California Roll [26]. During the 1970s there was hardly any market for sushi in the United States. Nowadays, Americans consume about 2.25 billion dollars of sushi annually [27]. So, how did one roll spark the growth of this market? For many Americans in the '70s, sushi was too unfamiliar. Much like cyber, the perception of facing too hard of a challenge turned many people away. The California Roll brought the challenge down to a lower level and delivered familiar ingredients like avocado and crab to give consumers a reason to try sushi; the only really strange ingredient for most was seaweed. The later redesigning of the roll to hide the seaweed on the inside was another simple innovation that brought the challenge even lower [28].

This innovation of the California Roll fits perfectly with psychologist Mihaly Csikszentmihalyi's flow theory [8] illustrated in Figure 3. It presented Americans that had low exposure to sushi (low skill) to something familiar with a twist (low challenge). After Americans were past the Discovery stage of consuming sushi, they could then try other varieties (harder challenges) and grow their pallet (increase their skill) during the Onboarding phase and eventually become sushi aficionados during the Scaffolding and Endgame phases. There are many other examples of presenting users with the familiar done differently to attract users. For instance, the user interface of personal computers that used common ideas like folders, windows, notepads, trash cans, etc. was more inviting for users than the command line [26]. On the other hand, new technologies that do not easily fit into the ecosystem and

relate to what users already know and possess often have a hard time taking off [26] [29].

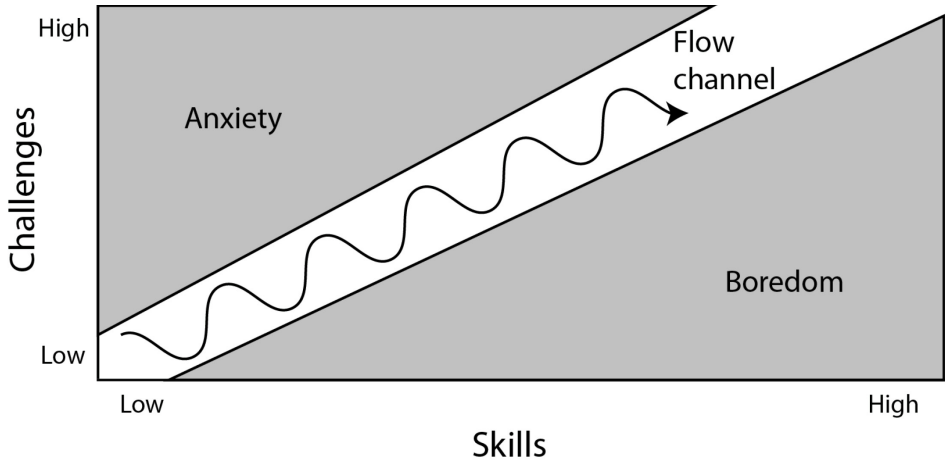

Figure 3: Flow Theory [8]

An example in the domain of education and science is one approach of attracting students to surgical careers. Researchers designed a preclinical surgical experience to introduce medical students to basic surgical skills, familiarize them with the career field, and attract them to the surgical career field by matching the challenge level with their skills [30]. As for a cyber example, a four-week summer program was able to increase high-schoolers' interest in pursuing cybersecurity related college majors through hands-on activities relating to cybersecurity [31]. Also, an interactive module detailed in [32] that presented the consequences of careless cyber habits to college students was effective in raising cyber awareness, particularly among non-Computer Science students. How can we apply similar ideas to take a diverse population of Airmen that may be unfamiliar with and intimidated by the challenge of cyber and present it in a way that takes them through the Discovery and Onboarding phase to becoming committed to the game of cyber education?

One method would be putting a cyber twist on things that the user is already familiar with. Talk to high school students about the details of how their 'magic' smart phones connect to GPS so that they can navigate to the nearest mall. Get college students, who use Social Networks Sites so much that it negatively effects their GPA [33], to realize the impact of cybersecurity in social media and their daily lives. Show an Airman in the aircraft maintenance career field how the aircraft navigation system is equipped to deal with spoofing. Explain how the ID card reader used by Security Forces personnel is connected to the network in order to access the database of valid IDs. Discuss with medical personnel how patient data is encrypted and securely stored on a remote server. After these initial connections are made, it will prove useful for the learner to be able to navigate to other related topics. If the user doesn't know where to go next, they may become frustrated and quit [25]. A solid tutorial which helps users learn the platform will be crucial, but some sort of map could also prove useful.

3.3.2 Topic Map

A topic map which shows relationships between content can increase the relatedness of content and help ease the educational journey of the learner. But before the learner can navigate, they must have a starting point. By relating topics in cyber to people's everyday lives and careers we can not only clarify that cyber is important to them, but they are more likely be motivated to care and learn about something they can associate with [25]. Whether the student is in high school or an adult, the student will want to know why they should learn about cyber [4][34]. Showing learners that cyber has an effect on their lives can help convince them that cyber education is beneficial.

Accomplishment & Development and Social Influence & Relatedness are the strongest core drives during the Onboarding phase. Having a topic map for cyber similar to Dominic Walliman's maps of biology, chemistry, computer science, etc. [35] would allow people to orient themselves at topics they relate to and navigate to connected topics using the map. As the learner covers more and more topics they can see where they started and how much they have accomplished while they

developed themselves along the way. The topic map could also be dynamic and change based on community suggestions. As users realize changes or additions to the cyber domain that are not present in the map they can suggest edits and be rewarded by this minigame within the platform. The topic map can also show the learner topics which they didn't know that they didn't know. Raising this type of awareness also helps adults want to learn [36].

Bethesda Softworks games like Fallout 4 and The Elder Scrolls V: Skyrim can give insight into some features that can be adopted for mapping cyber education. In game there is a main storyline to follow, but the user is also free to explore the map on their own or take part in side quests. As the user visits different locations, each with their own challenges and difficulty levels, the user hones their skills, increases their character's abilities, and gains more loot. In the beginning of the game, the map is basic. A single location is highlighted over an immense terrain. The user has direction but can also see the vastness of the world that they can explore at will. As the user explores the map, areas that they come relatively close to will populate on the map. Each location has an associated emblem, which is hollow but becomes solid once that location is explored. Locations can also appear on the map if an in-game character sets you on a quest to that location. If you have visited that location before, you have the option to 'fast travel' or teleport there. Conversely, if you have not been there, your quickest option is to teleport to a location you have visited that is close and then work your way to the quest location, discovering other close locations along the way. Some locations even require you to pay a guide or bring friends along to make sure that you get there safe and complete the objective. In order to minimize clutter on the map (and avoid overwhelming the user), the player can select certain quests from an active list, and flags are placed only at those associated locations.

These maps and quests could be adapted into a cyber education topic map. One main difference is that in these game maps, the terrain defines proximity, whereas nodes and edges may be more appropriate for cyber topics and connections, respectively. Therefore, something like the skill tree in *Path of Exile* may be more

appropriate for representing content on the platform. Unlike navigating terrain, one person can visit multiple cyber topics without visiting all the points in-between. There is also the reality that some topics require more than one pre-requisite to adequately understand.

Nonetheless, applying these game elements can take advantage of human-motivating core drives and increase engagement. The autonomy of exploration fits in with Empowerment of Creativity & Feedback core drive. The user can discover topics that they may not yet have the tools or skills to deal with or find quests that are at the appropriate challenge level and yield helpful rewards. The rewards can include the development of the user's knowledge as well as extrinsic rewards such as job qualifications or progress points that can display on the user's profile. These points could even be used in the Air Force's Talent Marketplace, which is an agile solution to place personnel in appropriate jobs based on experience and skill in different areas [37]. These points can demonstrate to unit commanders that the Airman has a certain familiarity level within specific cyber topic areas. This can provide incentive for users to diversify their cyber knowledge and also become experts in certain areas.

Associating quests with locations on the map makes the users feel competent and also gives them achievable goals to work toward (Development & Accomplishment core drive). In the Bethesda games mentioned above, undiscovered locations are not visible on the map, however this should be altered for the cyber map. A three-color system that displays visited topics as solid color, related topics to what has been visited as grey, and topics that have not been 'discovered' as black may be an appropriate hybrid. This way the user can still track where they have been and where they should go next, but they are also not kept in the dark about other topics that exist. These topics may be 'too high of a challenge' for the user's current skill but they could choose a topic that they want to navigate to and can then know where to start and how to get there. Also, in order to manipulate the map as a community (Social core drive), all nodes and edges should be visible.

The topic map and its associated quests and navigation adds significant value and uniqueness to the education platform. This element would be a great distinguisher between this platform and other educational platforms such as Udemy and other crowd-sourced content platforms like YouTube. The topic map gets the community involved to add, change, and remove nodes and edges to alleviate the currency problem, and also empowers users to navigate their own journey while developing themselves and feeling accomplished along the way.

3.3.3 Onboarding (cont.), Scaffolding, and Endgame Phases

To focus on the social part of the Social Influence & Relatedness core drive the user's personal map could be optionally shown on their profile or shared with specific peers. Users can also be motivated to share their progress and take the educational journey with others. Also related to this core drive is the detail that in general, people do what their peers and friends are doing [25]. A big part of convincing Airmen to voluntarily use a cyber education platform like that presented in [1] will deal with what their friends and peers tell them about the platform. The more people on the platform that the user knows, the more likely the user will be to get on board and stay. The phenomena where a product 'goes viral' and spreads like a wildfire as more and more people buy in is called getting past the tipping point [38]. Ensuring that users have a good experience with the platform and convincing them to buy-in through the Onboarding phase will be crucial to reaching the tipping point of cyber education for all Airmen.

Another core drive that is strong in the Onboarding and Scaffolding phases is the golden core drive Empowerment of Creativity & Feedback. The idea of including autonomy into education fits perfectly in this core drive. Even with a topic map, some learners may be faced with too many choices and have trouble choosing a path. As mentioned previously, adults learn better when they discover what they don't know [36]. One idea would be to assess the knowledge of users to determine their baseline in different cyber topics. Quizzes could be procedurally generated from a bank of user generated questions to maintain currency and community ownership. After the learner's baseline knowledge is determined the

system could suggest content that is just challenging enough to motivate the learner to choose to learn about that topic, develop their knowledge, and repeat this cycle without getting bored or frustrated. The repeated engagement with the platform is the key idea of the Scaffolding phase [25].

During the Scaffolding phase users will likely find gaps in the content offered or find content that the think could be presented in a better way. The users are encouraged to contribute content as members of the community to add unique perspectives and present ideas in ways that may better reach different types of learners. Through this activity, certain users will likely rise to the top and publish content that is recognized to be valuable to the community. These users will be established as experts within the community and may transition to the Endgame phase of the game (although in the cyber realm learning is never truly complete). Many games struggle to keep users in the Endgame as some users' skill becomes higher than any challenge and they get bored. To alleviate this issue in the new educational platform we can promote these community experts to the role of 'mentor.' Mentors can be assigned to new users to whom they can suggest content to consume, give tips on producing content, and answer questions about the platform and the organization in general.

4 ANALYSIS

The three core problems of current USAF cyber education and training discussed in [1] of currency, scalability and breadth, and complexity are addressed by the framework in the same paper and are further developed in this paper. Cyber education and training effects all Airmen, but based on career-field and other factors, the education and training received is different. The broad categories of current USAF education and training discussed in [1] demonstrates how the USAF increases investment into smaller and smaller groups of Airmen. Each development tier has challenges which can be alleviated by the gamified platform we have discussed.

All Airmen (and all DoD personnel) are required to complete the Cyber Awareness Challenge annually. While this platform may not replace this module, it

is a place where users can learn about how to deal with cyber threats and practice good cyber hygiene daily. If their peers have explained ideas in a manner that relates to them in a style that they can understand (scalability and breadth problem), users may learn more from consuming and creating content than clicking through a rarely-updated (currency problem) 3D quiz once a year. This platform also presents the opportunity to go above and beyond the yearly requirement. Airmen can be motivated to perform deeper research (complexity problem) to develop themselves and also share their unique perspective to contribute to the community. This platform adds value to the USAF by allowing many more Airmen to participate in deeper cyber education and current topics and pushes the boundaries of the current pyramid-shaped cyber education and training model.

Airmen in the cyber career-field experience Initial Skills Training & USAF eLearning as well as Cyber Weapon System Training. These airmen could see several benefits from the platform during these education and training stages and also afterwards. As mentioned previously, there is a wide range of background knowledge for Airmen entering cyber careers. With this platform Airmen can prepare themselves for initial training and education by consuming introductory content (complexity) on the platform as well as skimming the topic map to get an idea of the cyber realm. Course content could not only be hosted on this platform, but as Airmen see that content needs updated or could be presented better, they could upload their own content. Course developers could then pull new content from the platform that is presented in several different styles (scalability and breadth), giving the learners opportunities to learn in their preferred style. Lastly, after initial training, Airmen can share ideas, struggles, and innovations from their units with other cyber squadrons, reducing duplication of effort and increasing force efficiency.

The next group includes Airmen who receive graduate and/or undergraduate cyber education. Again, course content could be hosted on or pulled from this platform, but the research performed at the graduate level along with the projects completed at the undergraduate level could also be posted as content items on the platform. This content may relate to cutting-edge cyber topics (currency) and

present views from the educational versus the technical perspective. A great benefit would be that the lessons learned could be shared outside the university bubble to the forces that are actively practicing in the field (scalability and breadth).

The last group discussed is military leadership, who take courses to refine their cyber knowledge as it relates to strategic and operational level decision making. These courses can also take advantage of hosting and pulling content from this platform. Leadership can stay up-to-date (currency) on new cyber ideas and technology and how the terrain is changing in relation to operations and strategy. With different users presenting content at different levels and depths, commanders can gain insight into how changes in cyber can affect their unit no matter what their cyber background is (complexity).

5 FUTURE WORK

This paper leads to several possible future research avenues relating to more efficiently educating people about cyber. The game elements that are applied should be monitored to detail their effectiveness. If something is not effectively motivating users to take desired actions it should be modified or removed. If an element is performing well, analysis should be performed to understand why and how it could be altered to be more successful. More game elements than those presented in this paper could also be introduced to the platform. Empirical research on how different gamification methods work at different states of the game for different player types is of specific interest.

Time should also be invested in deciding how to roll out the platform to different user groups. Should the platform be released as the minimum viable product to all Airmen? Should only the cyber community have access first to find and report bugs with the platform and generate baseline content before rolling out to other career-fields? Would the last option form a stigma that the platform is only for cyber experts? The tipping point as it relates to a military community should also be researched: how many users need to buy in before everyone jumps on the bandwagon?

Another question that should be researched is whether there is a best way to present content to specific people based on their demographics such as age, career-field, education level, personality type, etc. Perhaps machine learning can be used on this data and user's feedback to suggest content that is effective and enjoyable. Along the same lines, work should be put in to developing an effective algorithm for suggesting content to users based on their content consumption. The topic map idea can likely be integrated into this algorithm to suggest content that relates to what the user has seen and avoid content that is too disconnected. The topic map itself also warrants more research. The map could be designed with gamification principles to encourage users to insert/remove topics and edit connections based on the current state of cyber. The design and reward system associated for this map should be further discussed.

6 CONCLUSION

Although there is work to be done in the future, this paper progresses the framework proposed in [1] by introducing gamification and human-focused design techniques to increase human motivation and engagement with the platform. These design ideas may be a good start but the platform should be revised and supplemented based on the response of the users. As the population on the platform increases and as more users enter each stage of the game there will be more opportunities to continue to develop the cyber knowledge of Airmen from different backgrounds at different stages of their careers.

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