



Capitol Technology University Institutional Review Board Application to Conduct Research Using Human Subjects

The Capitol Technology University Institutional Review Board (IRB) must review all requests to conduct research involving human subjects.

Please note that it is the researcher's responsibility to give complete information. The IRB form is a stand-alone document. The IRB team is not provided a copy of anything other than this form and do not assume they will know, The following as applicable must be part of the document, not separate files: organization consent form signed, a copy of the participant consent form, Data collection tool (e.g. survey instrument or interview/guiding questions, verbal script), and a copy of the CITI certificate. If the student is working with protected groups additional material will be required. Please note that your specific study may include additional requirements/forms. Make sure the form is signed by your Chair and they submit to irb@captechu.edu

Please be very detailed in your responses to the following questions. This will make the IRB process much more efficient.



Primary Investigator (faculty, staff, student, etc.)	
Your name:	Kammi Kai Hefner
Your status: (e.g. student, faculty)	Doctoral Student
Your affiliation: (college/dept.)	Cyber and Information Security
Phone contact:	C: 304 216-3617
Email contact:	kkhefner@captechu.edu Kammi@pobox.com
Submission date:	01/21/2022 <input checked="" type="checkbox"/> new <input type="checkbox"/> amendment to protocol number: <input type="checkbox"/> renewal of protocol number:
Any vulnerable subjects (risks)?	<input type="checkbox"/> minors <input type="checkbox"/> pregnant women <input type="checkbox"/> medically sensitive <input type="checkbox"/> prisoners <input type="checkbox"/> other:
Additional permissions needed? (e.g. employer)	Consent from participants (i.e., CTF Exercise Designers) to respond to the instrument is obtained at the beginning of the survey.

DECLARATION BY ALL INVESTIGATORS: This proposal is guided by the ethical principles regarding research involving human subjects as set forth in the [Belmont Report](#). I/We agree to abide by the policies and procedures of the IRB, including obtaining appropriate training in human subject research. I/We will not initiate any research associated with this application until authorized by the IRB. I/We will report to the IRB about any adverse events or unanticipated problems (unexpected, possible greater risk, etc.) that occur. I/We will inform the IRB of a need to modify the study design requiring an amendment. I/We understand that approval, when granted, is valid for up to one year and will submit a renewal for its continuation if needed.

(PI) Primary Investigator: _____ Date: _____01/21/22_____

IRB office use		
Approval: <input type="checkbox"/> Approved <input type="checkbox"/> Not Approved	Research Classification: <input type="checkbox"/> Full Review <input type="checkbox"/> Expedited <input type="checkbox"/> Exempt <input type="checkbox"/> Not Human Research	
Date Re'd:	Approval Date:	Application #:
Name	Signature	Date
Click or tap here to enter text.		Click or tap here to enter text.
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Statement of Authenticity

Do you have any outside interests related to this research (ex: personal stock/equity in the company sponsoring the research, receipt of income, including royalties and entitlement to royalties, from the sponsor of this research for purposes other than this research, etc.) that could possibly be perceived as introducing bias into the research or as a conflict of interest? (y/n): n

If yes, submit an explanation of how this will be managed and provide supporting documentation.

STUDENT STATEMENT:

A handwritten signature in black ink that reads "Kammi Kai Hefner". The signature is written in a cursive style and is positioned above a dashed horizontal line.

Student Signature

Research Proposal and Concepts

The principal investigator should answer each of the questions below adequately enough so that ethical standards and human protection can be determined by an outside reviewer. Address all questions asked within each section, as this will help to speed the review and approval process of your protocol. If a question is not applicable, be sure to answer 'not applicable'.

1. Research Concepts

1.1 Purpose

Twenty years ago, most of us had never heard the term, cybersecurity. Now, we hear the term used on a daily basis to describe the lack of skills needed to protect our information systems from cyber-attacks. As educators, we continue to struggle to identify ways of teaching cybersecurity skills. Most U.S. Computer Science programs do not offer core cybersecurity classes, nor do they provide elective cybersecurity courses. The literature review reveals learners are reaching beyond the traditional schoolroom or university setting and turning to competing in Capture the Flag (CTF) Competitions to build their cybersecurity skill set.

CTF Competitions have been described in the literature from an observational perspective, providing anecdotal insights such as its educational, effective, engaging, enjoyable, entertaining, fun, innovative, motivational, popular, and successful. Yet, there is minimal academic research dedicated to investigating the teaching techniques used in designing the CTF Exercises.

The purpose of this dissertation study will be to bridge the gap between the *informal* teaching constructs being implemented by today's cyber-enthusiasts in developing CTF Exercises and the traditional, educational theories of Curriculum and Instruction (C&I). Impromptu conversations with CTF Exercise Designers revealed a lack of intentionally incorporating traditional Instructional Design Strategies (i.e., blended learning, cognitive strategies, group-based instruction, task analysis, summative evaluation) into their CTF Exercises.

The objective of this dissertation will be to capture these *informal* teaching constructs and map them to the traditional theories of Instructional Design Strategies to produce a CTF Exercise Teaching Paradigm. The CTF Exercise Teaching Paradigm can then be used by future CTF Exercise Designers to purposefully integrate traditional Instructional Design Strategies (i.e., the discovered *informal* teaching constructs) into the future development of CTF Exercises. Traditional classroom teachers from other disciplines (e.g., STEM) will be

encouraged to utilize the Paradigm to capitalize on its potential educational benefits.

1.2 Research Question(s)

RQ1: What are the teaching constructs used by CTF Exercise Designers in developing CTF Exercises?

RQ2: What is the mapping of the teaching constructs used by CTF Exercise Designers in developing CTF Exercises back to traditional educational theories of Instructional Design?

1.3 Hypotheses

No hypotheses are being tested.

1.3 Significance

CTF Competitions began nearly 20 years ago (CyberPatriot, 2018; National Collegiate Cyber Defense Competition, 2018; The UCSB iCTF, 2018). The academic research dedicated to statistically investigating the educational effects of using CTF-like exercises to learn introductory cybersecurity topics is minimal (Chung & Cohen, 2014; Katsantonis, Fouliras, & Mavridis, 2017). Identifying ways to create CTF-like exercises using established pedagogical strategies to educate non-technical Internet users in cybersecurity is the focus of this study (Mirkovic, Tabor, Woo, & Pusey, 2015).

Capturing the *informal* teaching constructs (i.e., concepts, theories) and mapping them to traditional theories of Instructional Design for other educators to incorporate into teaching cyber security skills will be one way to address the critical shortage of cyber security professionals sought by industry, government, and the military entities.

The objective of this study is to capture the *informal* teaching constructs used in developing CTF Exercises and to map the *informal* teaching constructs to the traditional theories of Instructional Design Strategies.

The significance of this study is to document a CTF Exercise Teaching Paradigm (i.e., archetype, model, pattern, standard, theory (Merriam-Webster Dictionary, 2018)), so other teachers may embrace its potential educational benefits.

Explicitly identifying these *informal* teaching constructs will allow CTF Exercise Designers to purposefully integrate traditional Instructional

Design Strategies (i.e., the discovered *informal* teaching constructs) into the future development of CTF Exercises.

Sharing new ways to create CTF Exercises and organize CTF Competitions using established Instruction Design Strategies to teach cybersecurity is an additional benefit of this study. Combining these factors may have begun to address the critical shortage of cyber professional sought by private industry, government, and military entities (Burns, Rios, Jordan, Gu, & Underwood, 2017). Providing this mapping will allow other inspired educators, formally trained in the traditional, educational theories of Curriculum and Instruction (C&I) (i.e., Instructional Design Strategies), to adopt the CTF Exercise Teaching Paradigm to teach other science, technology, engineering, and mathematic (STEM) disciplines (e.g., accounting, biology, chemistry, civil engineering, computer programming, computer science, electrical engineering, mathematics, physics, psychology, software engineering) and capitalize on all this fun and motivational leaning. Other studies reported participating in a CTF Competition may prompt a participant to pursue a career in cyber.

2. Methods

2.1 Design

This study will use a qualitative design.

Qualitative research is widely used in educational settings to gather information about the human element expressing themselves via a particular activity where the variables are unknown. Human behavior is studied through observations, interviews, documents, and audiovisual materials using data collected by case studies and surveys. Comparing the two groups' behavior (i.e., use of terminology), traditional educators versus CTF Exercise Designers, in their attempts to create CTF Exercises lends itself to a qualitative approach using a grounded theory design. Grounded theory was chosen for this study because it "is a systematic, qualitative procedure used to generate a theory that explains, at a broad conceptual level, a process, an action, or an interaction about a substantive topic" (Creswell, 2012, p.423).

This study will attempt to analyze a phenomenon, how cyber-enthusiasts develop CTF Exercises, and then develop a pedagogical theory (i.e., archetype, paradigm, model) instructors may incorporate when teaching other science, technology, engineering, and mathematic (STEM) disciplines (e.g., accounting, biology, chemistry, civil engineering, computer programming, computer science, electrical

engineering, mathematics, physics, psychology, software engineering) to capitalize on all this fun, engaging and motivational leaning.

This study will be based on the works of Barton (2017), Bashir, Lambert, Guo, Memon, and Halevi (2015), Baumann (2016), Burns et al. (2017), Davis, Leek, Zhivich, Gwinnup, and Leonard (2015), Katsantonis, Fouliras, and Mavridis (2017), McDaniel, Talvi, and Hay (2016), Nakama and Paullett (2018) and Wee and Bashir (2016) to further attempts to understand how the design of CTF Exercises can be used as educational tools to teach cybersecurity.

2.2 Protocol

After IRB/Approval:

Month 1: Begin data collection (including Pilot Study)

Month 1-2: Finish data collection

Month 2-3: Begin data analysis

Month 3-4: Finish data analysis

Month 4: Defend

2.3 Pilot

Yes, a Pilot Study will be conducted with the CTF-experts listed in Table 1. Discussions will be held to obtain additional feedback from the last survey question *Please tell us about your CTF Exercise Design Survey experience.*

Table 1

List of Potential CTF Exercise Designer Pilot Study Candidates

Name	Association	<u>CTF</u> Event Name	Reference
Alvarez, Wilfredo "Fred"	Booz Allen Hamilton	Chief Industrial Cyber Security Engineer	(W. Alvarez, personal communication, August 24, 2018)
<u>Doupé</u> , Adam	University of California, Santa Barbara	UC Santa Barbara <u>iCTF</u>	(https://ictf.cs.ucsb.edu/ , 2018)
Doyle, Ray			(G. Galloway, personal communication, October 23, 2018)
Galloway, Garrett	Principal Security Engineer	<u>CarolinaCon</u>	(https://www.carolinacon.org 2018)
Thompson, Michael	Naval Postgraduate School	DARPA Cyber Grand Challenge	(Thompson & Vaidas, 2018)
Nary, Tim	Booz Allen Hamilton - Senior Lead Technologist	Dark Labs	(T. Nary, personal communication, September 12, 2018)
<u>Pruitt-Mentle</u> , Davina	National Initiative for Cybersecurity Education (NICE)	NICE Challenge Project	(D. <u>Pruitt-Mentle</u> , personal communication, August 27, 2018)
Vaidas, Timothy	<u>Secureworks</u>	DARPA Cyber Grand Challenge	(Thompson & Vaidas, 2018)
Vigna, Giovanni	University of California, Santa Barbara	UC Santa Barbara <u>iCTF</u>	(https://ictf.cs.ucsb.edu/ , 2018)

2.4 Reliability and Validity

The instrument will be designed based on Gagné's Nine Events of Instruction to ensure the questions measure established Instructional Design concepts (e.g., gain attention, convey learning objectives, stimulate recall, present content, provide guidance, allow practice, provide feedback, assess performance, enhance retention) The survey questions will be meaningful, clear, and concise.

Validity will be addressed by verifying the URL/Name of the a publicly advertised CTF Exercise provided by the participant during collection of demographic data and by asking the participants to identify what CSRF is via the answer to a multiple-choice question. If the URL/Name of their publicly advertised CTF Exercise cannot be verified or they

cannot define CSRF their data submission will be removed. [Two](#) other elimination [questions](#) are included in the survey.

3. Participants

3.1 Population

The general population for this study will be cyber-enthusiasts who have designed a minimum of five CTF Exercises included in a publicly advertised CTF Competition (i.e., having a recognized CTF Competition name listed on CTFTIME.org) requiring some form of CTF Participant registration. CTF Exercises Designers can have experience as the sole author of the CTF Exercise or they may have worked in collaboration with other CTF Exercise Designers.

All respondents will be over the age of 18 years.

3.2 Sample

Fifty participants are expected to be included in this research. This is based on the number of CTF Exercise Designers who responded to an online competition for designing CTF Exercises.

3.3 Participants Benefits

Explicitly identifying these *informal* teaching constructs will allow CTF Exercise Designers to purposefully integrate traditional Instructional Design Strategies (i.e., the discovered *informal* teaching constructs) into their future development of CTF Exercises. Sharing new ways to create CTF Exercises using established Instruction Design Strategies to teach cybersecurity is an additional benefit of this study.

3.4 Participant Compensation

No, participants in this research will not be compensated.

3.5 Participant Recruitment

The Twitter account CTFTIME has been dedicated to tracking and archiving CTF Competitions since 2011. Their web site provides links to upcoming CTF Events; archives to past events, tasks, and writeups; overall CTF Team rating; and communication to 16K Followers via their Twitter feed and they Follow 56 accounts. The researcher's Twitter account Follows the same 56 accounts plus additional CTF-related accounts.

The Twitter account Nicolas Krassas who "is always discussing capture the flag challenges" has 60.6K Followers and Follows 695 accounts.

Participants will be solicited via Tweets using appropriate hashtags such as #CTF, #CTFExercises, and #CTFExerciseDesignStudy from the researcher's

Twitter account. Collaboration with CTFTIME and Nicolas Krassas will be utilized to solicit participants.

Yes, participation is voluntary.

3.6 Recruitment Procedures

Participants will be solicited via Tweets using appropriate hashtags such as #CTF, #CTFExercises, and #CTFExerciseDesignStudy from the researcher's Twitter account. Collaboration with CTFTIME and Nicolas Krassas will be utilized to solicit participants.

4. Vulnerable Participants

4.1 Minors

No children, minors, or wards will be included in this research.

4.2 Others

No prisoners, pregnant women, or other vulnerable groups be included in this research.

5. Data Collection

5.1 Participant Data

A SurveyMonkey [survey](#) and a complimentary website will be used to administer a survey and collect numerical, selection of answer, and textual elaborations data.

5.2 Research Measures, Instruments, and Procedures

This is a qualitative study. However, the chi square analyses for determining goodness-of-fit and independence are appropriate for determining any significance differences that may exist (Airasian, 2000; Dowdy & Wearden, 1983; Gravetter & Wallnau, 1988; McMillan & Schumacher, 1989) between the sample and population.

5.3 Instrumentation

A SurveyMonkey [survey](#) and a complimentary .guru website will be used to collect data.

5.4 Timeline

Collecting data will begin upon receiving IRB approval and will finish by 30 days.

6. Data Security

6.1 Data Access

Only the Committee Chair, Committee Member, and researcher will have access to the data.

6.2 Data Protection

How will collected data be protected? How will raw data be coded prior to analysis? Will data be retained after completion of the research (if so, how long?)

Traditional security measures will be taken to ensure the data collected is protected (i.e., password protected, encrypted). Individual names will not be used to identify participants. Data will be encrypted and retained on the researcher's personal computer. Data will be retained long enough to support publication.

6.3 Data Usage

The data will appear in a dissertation and publications.

7. Research Risks

7.1 Potential Risks

There is no expected harm, discomfort, or inconvenience for respondents. There are no known or expected risks from participating in this study (see attached ANONYMITY & CONFIDENTIALITY statement).

7.2 Risk Control Procedures

Respondents do not have to take the survey and may opt out of the survey at any time. Respondents may exit the survey at any time by closing their Browser window (see attached ANONYMITY & CONFIDENTIALITY statement).

7.3 Research Confidentiality

Yes, participants will remain anonymous during data collection by disabling IP address tracking in SurveyMonkey.

8. Human Participant Research Training

8.1 Principal Investigator Training Details

CITI 29-Jan-2018 25889033

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
**COMPLETION REPORT - PART 1 OF 2
 COURSEWORK REQUIREMENTS***

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Kammi Hefner (ID: 6903501)
- **Institution Affiliation:** Capitol Technology University (ID: 2146)
- **Institution Email:** kkhefner@captechu.edu
- **Institution Unit:** IA

- **Curriculum Group:** IRB Members
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course

- **Record ID:** 25889033
- **Completion Date:** 29-Jan-2018
- **Expiration Date:** 28-Jan-2023
- **Minimum Passing:** 75
- **Reported Score*:** 99

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Students in Research (ID: 1321)	22-Jan-2018	4/5 (80%)
History and Ethical Principles - SBE (ID: 490)	28-Jan-2018	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	28-Jan-2018	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	28-Jan-2018	5/5 (100%)
Assessing Risk - SBE (ID: 503)	28-Jan-2018	5/5 (100%)
Informed Consent - SBE (ID: 504)	28-Jan-2018	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	28-Jan-2018	5/5 (100%)
Records-Based Research (ID: 5)	28-Jan-2018	3/3 (100%)
Research with Prisoners - SBE (ID: 506)	28-Jan-2018	5/5 (100%)
Research with Children - SBE (ID: 507)	28-Jan-2018	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	28-Jan-2018	5/5 (100%)
International Research - SBE (ID: 509)	28-Jan-2018	5/5 (100%)
International Studies (ID: 971)	28-Jan-2018	3/3 (100%)
Internet-Based Research - SBE (ID: 510)	28-Jan-2018	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	28-Jan-2018	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	29-Jan-2018	4/4 (100%)
Hot Topics (ID: 487)	29-Jan-2018	No Quiz
Conflicts of Interest in Human Subjects Research (ID: 17464)	29-Jan-2018	5/5 (100%)
The IRB Member Module - 'What Every New IRB Member Needs to Know' (ID: 818)	29-Jan-2018	7/7 (100%)
Capitol Technology University (ID: 14538)	29-Jan-2018	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?k67b4b35e-6d54-4143-8173-40cbfb27d4d-25889033

Collaborative Institutional Training Initiative (CITI Program)

Email: support@citiprogram.org

Phone: 888-529-5929

Web: <https://www.citiprogram.org>

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COMPLETION REPORT - PART 2 OF 2
COURSEWORK TRANSCRIPT**

** NOTE: Scores on this [Transcript Report](#) reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Kammi Hefner (ID: 6903501)
- **Institution Affiliation:** Capitol Technology University (ID: 2146)
- **Institution Email:** kkhefner@captechu.edu
- **Institution Unit:** IA

- **Curriculum Group:** IRB Members
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course

- **Record ID:** 25889033
- **Report Date:** 29-Jan-2018
- **Current Score**:** 100

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
Students in Research (ID: 1321)	29-Jan-2018	5/5 (100%)
Capitol Technology University (ID: 14536)	29-Jan-2018	No Quiz
History and Ethical Principles - SBE (ID: 490)	28-Jan-2018	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	28-Jan-2018	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	28-Jan-2018	5/5 (100%)
Records-Based Research (ID: 5)	28-Jan-2018	3/3 (100%)
Assessing Risk - SBE (ID: 503)	28-Jan-2018	5/5 (100%)
Informed Consent - SBE (ID: 504)	28-Jan-2018	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	28-Jan-2018	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	28-Jan-2018	5/5 (100%)
Research with Children - SBE (ID: 507)	28-Jan-2018	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	28-Jan-2018	5/5 (100%)
International Research - SBE (ID: 509)	28-Jan-2018	5/5 (100%)
International Studies (ID: 971)	28-Jan-2018	3/3 (100%)
Internet-Based Research - SBE (ID: 510)	28-Jan-2018	5/5 (100%)
The IRB Member Module - 'What Every New IRB Member Needs to Know' (ID: 816)	29-Jan-2018	7/7 (100%)
Research and HIPAA Privacy Protections (ID: 14)	28-Jan-2018	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	29-Jan-2018	4/4 (100%)
Hot Topics (ID: 487)	29-Jan-2018	No Quiz
Conflicts of Interest in Human Subjects Research (ID: 17464)	29-Jan-2018	5/5 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?k67b4b35e-6d54-4143-8173-40cbfb27d4d-25889033

Collaborative Institutional Training Initiative (CITI Program)
 Email: support@citiprogram.org
 Phone: 888-629-5929
 Web: <https://www.citiprogram.org>

8.2 Research Staff Training Details

Not applicable.

9. Informed Consent

9.1 Obtaining Consent

The survey instrument will solicit consent from each participant (see [ANONYMITY & CONFIDENTIALITY](#)).

9.2 Vulnerable Participant Consent

Not applicable.



Research Advisor and Committee Approvals

Faculty advisor/chair, facilitator, sponsor (if applicable, e.g. dissertations, theses)	
Your name:	Dr. Connie F. Justice
Signature:	Date: Click or tap here to enter text.
Your status: (e.g. student, faculty)	Faculty
Your affiliation: (college/dept.)	Capitol Technology University
Phone contact:	317-278-3830
Email contact:	cjustice@iupui.edu
Is this research:	<input checked="" type="checkbox"/> Full Review <input type="checkbox"/> Expedited <input type="checkbox"/> Exempt <input type="checkbox"/> Not Human Research

Committee Members (if applicable, e.g. dissertations, theses)		
Name:	Signature:	Date:
Dr. William Butler		Click or tap here to enter text.
Your status: (e.g. student, faculty)	Faculty	
Your affiliation: (college/dept.)	Capitol Technology University	
Phone contact:	813-495-4536	
Email contact:	whbutler@captechu.edu	

Committee Members (if applicable, e.g. dissertations, theses)		
Name:	Signature:	Date:
Click or tap here to enter text.		Click or tap here to enter text.
Your status: (e.g. student, faculty)	Click or tap here to enter text.	
Your affiliation: (college/dept.)	Click or tap here to enter text.	
Phone contact:	Click or tap here to enter text.	
Email contact:	Click or tap here to enter text.	



IRB Submission Checklist

Please submit the IRB package through your chair.

You may NOT conduct any research, including pilot studies, until you have IRB approval.

IRB Submission:

- You cannot have too much information. Most of this information should be a cut and paste from the dissertation.
 - You must have signatures of Chair and committee. Signature/approval can be in the form of email consent from the committee, but not the chair. The student must also sign. Chair section still must be completed by the Chair. Send the completed application and emails to the IRB (irb@captechu.edu).
 - The IRB request must come from the student. The document must come as a single document, not separate files.
 - The results of IRB will be provided to the Chair, not the student unless the Chair requests the student be copied.
 - The IRB form is a stand-alone document. The following as applicable must be part of the document, not separate files: organization consent form signed, a copy of the participant consent form, Data collection tool (e.g. survey instrument or interview/guiding questions, verbal script), and a copy of the CITI certificate. If the student is working with protected groups additional material will be required. Please note that your specific study may include additional requirements/forms.
-

Version 11, this supersedes all previous versions, April 2020



The Capture the Flag (CTF) Exercise Design Study

Research Purpose:

The purpose of this qualitative study is to bridge the gap between *informal* teaching constructs being implemented by today's cyber-enthusiasts in developing exercises for CTF Competitions and the traditional educational theories of Instructional Design.

Survey Overview:

Please read and respond to all questions, clicking the Next button to navigate to the next question. Questions marked with an asterisk require an answer.

Each survey question consists of one open-ended question resembling interview discussion (i.e., a conversation between you and the researcher, me). They are specifically designed to solicit as much pertinent information as possible from you with respect to each topic. Please provide your elaborated responses in the Comments Box at the end of each applicable question further detailing your experiences with designing CTF Exercises. Your knowledge will be used to enhance this survey for future studies and to provide guidance in the way forward for the CTF Community. Thank you in advance for your attention to providing details in your answers!

Please [click here](#) to launch a PDF file in a separate Browser window that contains a list of all terms used throughout the CTF Exercise Design Study. Once the Table of Definitions is loaded, you will have access to this information throughout the remainder of the survey.

Please contact the Principal Investigator at kkhefner@captcehu.edu after September 1, 2022 or visit TheCTFExerciseStudy.guru website to see a summary of the results of this research.

Thank you!

Demographic Questions

* 1. Have you written (i.e., authored, co-authored, created, designed) and published at least five CTF Exercise used in a public CTF Competition in the last five years?

Yes No – then go to the [End of the Survey](#)

* 2. Approximately, how many CTF Exercises have you written (i.e., authored, co-authored, created, designed) and published a CTF Exercise used in a public CTF Competition in the last five years (an estimated number is fine)?

- less than 4 - then go to the [End of the Survey](#)
- 5-10
- 11-15
- 16-20
- more than 20



*The Capture the Flag (CTF)
Exercise Design Study*

Please elaborate on your answer.
{ Open-ended Comment Box }

Please elaborate on your selection.



*The Capture the Flag (CTF)
Exercise Design Study*

* 3. Please select all of the sites where your CTF Exercises have been published for competition.

- | | |
|---|---|
| <input type="checkbox"/> *ctf | <input type="checkbox"/> Kaspersky Industrial CTF |
| <input type="checkbox"/> OCTF/TCTF | <input type="checkbox"/> Meepwn CTF |
| <input type="checkbox"/> Access Denied | <input type="checkbox"/> Midnight Sun CTF |
| <input type="checkbox"/> AceBear Security Contest | <input type="checkbox"/> N1CTF |
| <input type="checkbox"/> AltayCTF | <input type="checkbox"/> NeverLAN CTF |
| <input type="checkbox"/> angstromCTF | <input type="checkbox"/> North.SecNorth.Sec |
| <input type="checkbox"/> ASIS CTF | <input type="checkbox"/> noxCTF |
| <input type="checkbox"/> ASIS CTF Quals | <input type="checkbox"/> Nuit du Hack CTF |
| <input type="checkbox"/> b00t2root | <input type="checkbox"/> nullcom HackIM |
| <input type="checkbox"/> BackdoorCTF | <input type="checkbox"/> OmCTF |
| <input type="checkbox"/> BSIDES CTF | <input type="checkbox"/> P.W.N. CTF |
| <input type="checkbox"/> Break In CTF | <input type="checkbox"/> PACTF |
| <input type="checkbox"/> BSides Delhi CTF | <input type="checkbox"/> patriotCTF |
| <input type="checkbox"/> Byte Bandits CTF | <input type="checkbox"/> Ph0wn CTF |
| <input type="checkbox"/> Carthage Cyber Arena | <input type="checkbox"/> picoCTF |
| <input type="checkbox"/> CODE BLUE | <input type="checkbox"/> PlaidCTF |
| <input type="checkbox"/> Codefest CTF | <input type="checkbox"/> Pragyan CTF |



*The Capture the Flag (CTF)
Exercise Design Study*

- | | |
|--|--|
| <input type="checkbox"/> Codegate CTF | <input type="checkbox"/> PSUT CTF |
| <input type="checkbox"/> CSAW CTF | <input type="checkbox"/> Pwn2Win CTF |
| <input type="checkbox"/> CTF Russian Cup | <input type="checkbox"/> QCTF Starter |
| <input type="checkbox"/> CTF.Moscow | <input type="checkbox"/> RCTFC |
| <input type="checkbox"/> CTFZONE | <input type="checkbox"/> Real World CTF |
| <input type="checkbox"/> DEF CON | <input type="checkbox"/> RHme3 |
| <input type="checkbox"/> DefCamp CTF | <input type="checkbox"/> RITSEC |
| <input type="checkbox"/> Dragon CTF | <input type="checkbox"/> RuCTF |
| <input type="checkbox"/> EasyCTF IV | <input type="checkbox"/> RuCTFE |
| <input type="checkbox"/> EvlzCTF | <input type="checkbox"/> Sans CTF |
| <input type="checkbox"/> Facebook CTF | <input type="checkbox"/> SECCON |
| <input type="checkbox"/> FAUST CTF | <input type="checkbox"/> SEC-T CTF |
| <input type="checkbox"/> Game of Pwners | <input type="checkbox"/> Secura Grand Slam CTF |
| <input type="checkbox"/> GirlsGoCyberStart | <input type="checkbox"/> Securinets CTF |
| <input type="checkbox"/> Google Capture the Flag | <input type="checkbox"/> Security Case Study CTF |
| <input type="checkbox"/> GreHack CTF | <input type="checkbox"/> Security Fest CTF |
| <input type="checkbox"/> Hack Zone Tunisia | <input type="checkbox"/> SOC Battle |
| <input type="checkbox"/> Hack.lu CTF | <input type="checkbox"/> Square CTF |
| <input type="checkbox"/> Hackcon | <input type="checkbox"/> STEM CTF: Cyber Challenge |
| <input type="checkbox"/> HackIT CTF | <input type="checkbox"/> STMCTF |
| <input type="checkbox"/> Hackover CTF | <input type="checkbox"/> Sunshine CTF |
| <input type="checkbox"/> Harekaze CTF 2018 | <input type="checkbox"/> SwampCTF |
| <input type="checkbox"/> HCTF | <input type="checkbox"/> TAMUctf |
| <input type="checkbox"/> HITB CTF Amsterdam | <input type="checkbox"/> Teaser Dragon |
| <input type="checkbox"/> HITB-XCTF GSEC CTF | <input type="checkbox"/> THC CTF |
| <input type="checkbox"/> HITCON CTF | <input type="checkbox"/> Timisoara CTF |



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- | | |
|--|---|
| <input type="checkbox"/> HSCTF 5 | <input type="checkbox"/> TJCTF |
| <input type="checkbox"/> HumanCTF | <input type="checkbox"/> TokyoWestems CTF |
| <input type="checkbox"/> hxpCTF | <input type="checkbox"/> Trend Micro CTF |
| <input type="checkbox"/> IceCTF | <input type="checkbox"/> Tunisie Telecom Security Day |
| <input type="checkbox"/> ICON CTF | <input type="checkbox"/> TyumenCTF |
| <input type="checkbox"/> IFIP SCE | <input type="checkbox"/> UCSB iCTF |
| <input type="checkbox"/> InCTF | <input type="checkbox"/> UIUCTF |
| <input type="checkbox"/> Inno CTF Junior | <input type="checkbox"/> Viettel Mates CTF |
| <input type="checkbox"/> InnoCTF | <input type="checkbox"/> VolgaCTF |
| <input type="checkbox"/> INS'hAck | <input type="checkbox"/> WCTF |
| <input type="checkbox"/> Insomni'hack | <input type="checkbox"/> WhiteHat |
| <input type="checkbox"/> ISITDTU CTF | <input type="checkbox"/> WPICTF |
| <input type="checkbox"/> Jordan & Tunisia National CTF | <input type="checkbox"/> Xiomara CTF |
| <input type="checkbox"/> Kaizen Arabia CTF | |
| <input type="checkbox"/> Other (please specify) | |

* 4. Do you prefer to write (i.e., author, co-author, create, design) and published a CTF Exercise for use in a public CTF Competition for individual or team competition?

* 5. What is your gender?

- Male
- Female
- Prefer not to say
- Other

* 6. What is your age?



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- 18-24 years
- 25-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65+ years

* 7. What is the highest level of school you have completed?

- Primary school
- Some high school, but no diploma
- High school diploma (or GED)
- Some college, but no degree
- 2-year college degree
- 4-year college degree
- Graduate-level degree
- Doctorate-level degree
- Government/DoD Trained
- None of the above
- Other (please specify)

Please elaborate on your selection.

* 8. Which of the following best describes your current Job Category?



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- Accounting
- Admin - Clerical
- Biotech
- Business Development
- Consultant
- Design
- Engineering
- Entry Level
- Executive
- Finance
- Human Resources
- Information Technology
- Other (please specify)
- Installation - Maintenance - Repair
- Legal
- Management
- Marketing
- Professional Services
- Real Estate
- Research
- Science
- Skilled Labor - Trades
- Strategy - Planning
- Training



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- * 9. Please rank the Top Ten reasons, in order of importance from 1 to 10 (1 being the most important), why you have written and published CTF Exercises for public CTF Competitions?
- I heard (i.e., from friends, read on the Internet, through the grapevine, etc.) designing CTF Exercises was one way to get started at competing at CTF Competitions
 - I heard designing CTF Exercises was the best way to get started at competing at CTF Competitions
 - I know (i.e., from my personal experience) designing CTF Exercises are worth my time
 - I know designing CTF Exercises is a FREE way to learn about cybersecurity
 - I know I usually learn something valuable from designing CTF Exercises
 - I know I might get better at solving challenges by designing CTF Exercises
 - I know I might get quicker at solving challenges by designing CTF Exercises
 - I know I might find better technical ways to solve a challenge by designing CTF Exercises
 - I know designing CTF Exercises is one of the best ways to become the best CTF Competitor I can become
 - I am training for my next CTF Competition, so I design CTF Exercises for practice
 - I want to check up on the competition, so I re-design their CTF Exercises
 - I am establishing myself as a “known” Author of a certain “style” of CTF Exercises
 - After I compete in a CTF Competition, I usually attempt to improve the design of the CTF Exercises, for challenges I could solve myself
 - After I compete in a CTF Competition, I usually attempt to reverse engineer the design for challenges I could not solve myself
 - As a team player, my Team encourages me to design CTF Exercises for practice
 - As a team player, my Team reviews my CTF Exercises designs and provides feedback
 - I have no real reason



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Please elaborate on your selection.

* 10. How would you describe your overall level of knowledge for competing in CTF Competitions?

- 7 - Expert - I have been actively placing in the top 10 in CTF Competitions for over 5 years and working in the security industry in technical roles for more than 10 years. I am well versed in all security topics inclusive of reverse engineering, forensics, and offensive methodology and tooling. I am capable of operating within any constraints or odd requirements. I am comfortable in all attack scenarios. I can pick out vulnerabilities and likely attack scenarios with new technologies with little to no hands-on experience with these new technologies. I have CVEs under my name. I keep 0days in my back pocket.
- 6 - Master - I am well versed in the usage and combination of offensive tools. I am learning advanced offensive security methodology and chaining. I am well versed in most forensic topics. I have been engaged in CTF competitions for 3 years and regularly place in the top 50%. I have been working in the security industry in technical roles for more than 5 years. I am well versed with known vulnerabilities and am capable of discovering and exploiting new vulnerabilities.
- 5 - Proficient - I know how to use offensive tools. I am well versed in nearly all security and reverse engineering concepts. I have mastered the command line on multiple operating systems. I am familiar with well-known vulnerabilities in general. I am learning how to discover and attack new vulnerabilities.
- 4 - Competent - I am proficient in at least one of the scripting languages such as Perl, Python, Ruby, Powershell, batch scripting or BASH. I understand many security topics. I am familiar with some offensive tools. I am comfortable on the command line. I am learning common vulnerabilities. I am learning the basics of forensics.
- 3 - Beginner - I am learning a scripting language or two. I am learning general security topics. I am learning of offensive security tools. I am well versed with most system administrative and networking topics.
- 2 - Novice - I am learning the command line. I am learning the basics of system administration and networking.

1 - Introductory - I am just now hearing about CTF Competitions. - [then go to the End of the Survey](#)



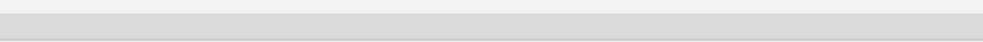
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Please elaborate on your selection.

* 11. On a scale of 1 to 10, how important do you feel it is for a CTF Exercise Designer to have competed in a CTF Competition, before attempting to write (i.e., author, co-author, create, design) and publish a CTF Exercise for use in a public CTF Competition.

1 Least Important

Most Important 10



Please elaborate on your selection.

* 12. True/False. Cross Site Request Forgery is a web application vulnerability in which the server does not check whether the request came from a trusted client or not. The request is just processed directly.

- True
- False - then go to the [End of the Survey](#)



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Please elaborate on your selection.

* 13. Yes/No. Do you access, execute, read, review and/or use CTF Writeups to aid in your design of CTF Exercises?

Please elaborate on your selection.

* 14. Please select all of the sites where you typically access, execute, read, review and/or use CTF Writeups.

{See same answer selection used for Question 8}

Research-related Questions

* 15. **For this next series of questions, please take a few minutes to recall FIVE CTF Exercises you have written (i.e., authored, co-authored, created, designed) published, and used in a public CTF Competition in the last five years.**

Please use the input fields for this question to identify meta data for your one most "memorable" CTF Exercise (regardless if the CTF Exercise was useful or not). Please indicate N/A if the data field is not applicable to your "memorable" CTF Exercise. Please feel free to access the Internet to locate the meta data information. The next question's comment box will be available for your to briefly describe the CTF Exercise in your own words.

Please note IF you have another (or more) CTF Exercises you have written (i.e., authored, co-authored, created, designed) published, and used in a public CTF Competition in the last five



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years and you want to provide feedback on these events as well, please submit its meta data in the Open-ended Comment Box!

Name of CTF COMPETITION

URL for CTF Competition

Date of CTF Competition

Organizers of CTF Competition

Name of CTF Exercise

URL for CTF Exercise

Author(s) of CTF Exercise

Type of CTF Exercise (i.e., jeopardy, scenario, mixed)

Other Pertinent Data #1

Other Pertinent Data #2

Other Pertinent Data #3

Please elaborate on your selection.

* 16. As a CTF Exercise Designer, what *teaching construct* did you incorporate to gain the attention of the Player (select all answers that apply)?

- I provide a link to a teaser video to create an awareness
- I share an interesting animated video to set the context
- I outline WIIFM (What Is In It For Me)
- I pose thought-provoking questions to help players channelize their attention on what follows
- I offer a reward as an incentive
- I do not do anything special to gain the attention of the Player
- Someone else did this for me
- I really don't know what you are talking about



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Please elaborate on your selection.

* 17. As a CTF Exercise Designer, when do you inform the Player of the Learning Objectives for your CTF Exercise?

- Before they start the CTF Exercise
- During the start the CTF Exercise
- After they finish the CTF Exercise
- Someone else did this for me
- I do not convey the Learning Objectives of my CTF Exercise to the Player
- I don't know what you are talking about

Please elaborate on your selection.

* 18. As a CTF Exercise Designer, what *teaching construct* did you incorporate to identify the Learning Objectives of your CTF Exercise to the Player (select all answers that apply)?

- I highlight what skills they will walk away with after attempting to solve this CTF Exercise
- I point out how will playing this CTF Exercise will help them perform better or acquire new skills
- I do not do anything special to convey the Learning Objectives of my CTF Exercise to the Player
- Someone else did this for me
- I really don't know what you are talking about



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Please elaborate on your selection.

- * 19. As a CTF Exercise Designer, what *teaching construct* did you incorporate to stimulate a Player's recall of previous knowledge (or learning) (select all answers that apply)?
- I provide a personalized learning path based on their proficiency or preference. This can be set based on a pre-test or a survey.
 - I use Information Highlights to draw their attention to what they know (for instance, use "Did You Know" and connected them back to the current schema).
 - I do not do anything specific to stimulate a Player's recall of previous knowledge
 - Someone else did this for me
 - I really don't know what you are talking about

Please elaborate on your selection.

- * 20. As a CTF Exercise Designer, what *teaching construct* did you incorporate to present the content (select all answers that apply)?
- I use microlearning (including learning journeys) for formal training
 - I use microlearning (including learning journeys) for Performance Support intervention
 - I use active learning featuring guided exploration
 - I use scenario-based learning videos
 - I use scenario-based learning interactive videos
 - I use scenario-based learning videos with complex and branching simulations
 - I use storytorials or story-based learning.
 - I offer training nuggets.
 - I did not do anything specific to present the content to the Player
 - Someone else did this for me
 - I really don't know what you are talking about



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Please elaborate on your selection.

* 21. As a CTF Exercise Designer, what *teaching construct* did you incorporate to provide guidance (select all answers that apply)?

- I use scaffolds/hints and cues as they progress through the learning path
- I use scenarios to help them relate to real-life situations
- I include examples and non-examples
- I use analogies and metaphors to assist in comprehending complex concepts
- I use rabbit holes
- I did not do anything specific to provide guidance to the Player
- Someone else did this for me
- I really don't know what you are talking about

Please elaborate on your selection.

* 22. As a CTF Exercise Designer, what *teaching construct* did you incorporate to provide room for practice (select all answers that apply)?

- I provide adequate opportunity for practice (without consequences)
- I did not do anything specific to provide practice for the Player
- Someone else did this for me
- I really don't know what you are talking about



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Please elaborate on your selection.

* 23. As a CTF Exercise Designer, what *teaching construct* did you incorporate to provide feedback to the Player?

- I use corrective (or formative) feedback
- I use analytical feedback
- I redirect for remediation, if required.
- I provide just-in-time learning aids to reinforce
- I did not do anything specific to provide feedback to the Player
- Someone else did this for me
- I really don't know what you are talking about

Please elaborate on your selection.

* 24. As a CTF Exercise Designer, what *teaching construct* did you incorporate to assess the Players performance (Repeated assessments keep the learner aligned to their learning goals)?

- I administer a Pre-test
- I use interim check-points
- I craft an assessment strategy that pushes the Player's cognition from recall or understanding to application
- I use repeated assessments to keep Players aligned to their learning goals
- I administer a Summative test (and compare gain vs the pre-test)
- I did not do anything specific to provide for assess a Player performance
- Someone else did this for me
- I really don't know what you are talking about



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Please elaborate on your selection.

* 25. As a CTF Exercise Designer, what *teaching construct* did you incorporate to enhance the Player's retention and its application on the job?

- I use performance support intervention to aid recall and application on the job
- I craft an assessment strategy that pushes the Player's cognition from recall or understanding to application
- I use nudges to mastery by incorporating challenges (quizzes) that help the learners keep their information current, and they can be progressively fed tougher challenges
- I did not do anything specific to enhance the Player's retention
- Someone else did this for me
- I really don't know what you are talking about

Please elaborate on your selection.

* 26. As a CTF Exercise Designer, what are the learning challenges students have in meeting the goals set?



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Please elaborate

* 27. As a CTF Exercise Designer, what design techniques do you use in developing your CTF Scenario Exercises to facilitate learning?

Please elaborate

* 28. What is it about how you design the CTF Scenario Exercises that creates a learning event for the player?

Please elaborate

* 29. As a CTF Exercise Designer, **how important** do you feel it is to write CTF Exercises that reflect current, real-life events (i.e., a particular challenge reflecting hackers breaking into a system recently published in the news like the North Korean Hackers stealing \$400 million in crypto)?



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- Extremely important
- Very important
- Somewhat important
- Not so important
- Not at all important

Please elaborate

* 30..

As a CTF Exercise Designer, do you rely more on **art** or **science** in developing your CTF Exercise?

- I never paid much attention to this aspect of creating a CTF Exercise, so I don't know.
- Art
- Science
- Both

Please elaborate

* 31.

Which Learning Style do you target for your anticipated audience (select all that apply)?

- I don't know.
- I don't know, because I never thought of considering the CTFer's Learning Style.
- Auditory Learner (i.e., I like to hear people explain things out loud - I listen).
- Kinesthetic Learner (i.e., I need to physically repeat the steps on my own computer as I feel the keys on the keyboard and/or touch the screen - I touch).



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- o Textual Learner (i.e., I prefer to read a written description of the solution or follow a checklist of steps - I read).
- o Video Learner (i.e., I want to hear the Author talk through the steps, watch a demonstration of the Author typing and moving their mouse to show their solution, and see the computer respond accordingly - I look & listen).
- o Visual Learner (i.e., I prefer to see charts/diagrams/graphics/pictures/screenshots to show the steps - I watch).
- o Four Senses Learner (i.e., I want to hear the solution explained, while I watch the results of the Author typing and moving their mouse, and I like to see the computer respond accordingly. Then I will physically repeat the steps on my own computer. - I experience

Please elaborate

* 32. Please elaborate on how you perceive your audiences' primary Learning Style when developing a CTF Exercise.

Please elaborate



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* 33. Please elaborate on what techniques (i.e., learning constructs) you incorporate when

Please elaborate

* 34. On a scale of 1 to 10, how important do you feel it is for the Author of a CTF Exercise, to take into account the Learning Style of the anticipated players?

1 - Least Important Most Important - 10

Please elaborate

END OF SURVEY

* 35. Please tell us about your CTF Exercise Design Survey experience (e.g., accessibility of survey, clarity of questions, focus of study, readability, navigation through questions, structure of questions {comment box vs. multiple choice vs. ranking}, use of SurveyMonkey, terminology, etc.). Your comments will be used to improve the CTF Exercise Design Survey experience!



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Please elaborate

To THANK YOU!



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ANONYMITY & CONFIDENTIALITY

INFORMATION

The Capture the Flag (CTF) Exercise Design Study

INTRODUCTION

You have been selected to participate in The Capture the Flag (CTF) Exercise Design Study. This research is being conducted by Kammi Kai Hefner, EDD as partial requirements for completing a Doctorate of Science in Cybersecurity degree from Capitol Technology University.

PURPOSE(S) OF THIS STUDY

The objective of this study is to capture the informal teaching constructs used in developing CTF Exercises and to map the informal teaching constructs to the traditional theories of Instructional Design Strategies. The results of this study will document a CTF Exercise Teaching Paradigm (i.e., archetype, model, pattern, standard, theory (Merriam-Webster Dictionary, 2018)), so other teachers may embrace its potential educational benefits

Capturing the informal teaching constructs (i.e., concepts, theories) and mapping them to traditional theories of Instructional Design for other educators to incorporate into teaching cybersecurity skills will be one way to address the critical shortage of cyber security professionals sought by industry, government, and the military entities.

DESCRIPTION OF PROCEDURES

This study involves completing a Web-based questionnaire and will take approximately 15 minutes for seasoned CTF-enthusiasts to respond. Approximately, 300 subjects are expected to participate in this study. Questions marked with an asterisk require an answer. You may view the questionnaire by emailing kkhefner@captechu.edu before deciding to participate.

RISK AND DISCOMFORTS

There are no known or expected risks from participating in this study.

ALTERNATIVES

You do not have to participate in this study.

EXIT THE SURVEY

You may exit the survey at any time by closing your Browser window.



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BENEFITS

This study is not expected to be of direct benefit to you, but the knowledge gained may be of benefit to others.

ANONYMITY

The data collection tool SurveyMonkey has been set not to collect IP Addresses. Respondents are completely unknown to anyone associated with the survey.

CONTACT PERSONS

For more information about this research, you can contact Kammi Kai Hefner, kkhefner@captechu.edu at 304 216-3617, or my Committee Chair, Dr. Connie Justice at cjustice@iupui.edu.

Any information about you obtained as a result of your participation in this research will be kept as confidential as legally possible. Your research records and test results, just like hospital records, may be subpoenaed by court order or may be inspected by the study sponsor or federal regulatory authorities without your additional consent. In any publications that result from this research, neither your name nor any information from which you might be identified will be published. Your anonymity will be protected electronically by using data storing and retrieving processes that require password protection and encryption. No one but the researcher and CTU will have access to the data collected. CTU will not know who responds or who does not respond. CTU will not see raw data. All details of individual data collected will be kept private by the researcher and not disclosed to any third party. Summations of data will be presented in data analysis.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You are free to withdraw your willingness to participate in this study at any time and that such refusal to participate will not affect your future employment. Refusal to participate or withdrawal will involve no penalty to you. You have been given the opportunity to access The Capture the Flag (CTF) Exercise Design Study located a SurveyMonkey link.