Study of the Feasibility of a Virtual Environment for Home User Cybersecurity

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By Sean Powell[*]

I.   INTRODUCTION

There is always a need to discover new or improved ways to help protect people from the dangers on the cyber world. With companies continuing to try and create the new, most secure security software for home computers, it seems people forget one of the best security plans. Defense in depth is a method that works to minimize the ability of a hacker to successfully attack another entity. I have used virtual environments for different classes throughout my time at university. It was through these experiences that I realized the possibility of using a virtual machine to add another layer of a home computer's cybersecurity, giving the home computer user another layer to help protect themselves from cyber threats.

Virtual machine programs have been used to securely test programs in a controlled environment. The virtual environment that is created from the virtual machine is isolated from the rest of the computer that it is running on: the host. These environments can be set up to simulate a typical operating system used on everyday computers. The isolation of these environments helps protect the host computer from possible damage or attack when a possible dangerous program is tested on it. A feature of a virtual machine is the ability to delete a virtual environment, allowing the user to erase all traces of the environment. There is also the capability

of restoring the environment or resetting the environment to a previously saved state and removing any traces of alteration. This is useful when the environment becomes corrupted by a computer virus or another form of malware. The environment can be deleted without worry of corrupting other aspects of the computer.

Virtual machines are best used for more than just testing possibly dangerous programs. They allow users the ability to access multiple types of operating systems on one host computer. The purpose of this research is to begin exploring the use of a virtual machine as part of a home user's computer cybersecurity. With the capability of isolating possibly dangerous programs from the rest of the computer, as well as restoring and deleting the environments, this would allow home users to have an environment where they are better protected against the dangers on the web. When accessing the web, home users can encounter different types of dangers from many different areas. A virtual environment would allow said users to access and download material from the web with the knowledge that they can restore their environment to a safe state should they download malicious content onto the environment.

This experiment was built to focus on the average home user's ability to download, set up and manage a virtual environment. Should an average home user struggle with handling the environment, then their ability to use it for computer security purposes will not be successful. This is important because a cybersecurity method that is improperly used could cause damage instead of protection. There is always a need for stronger cybersecurity protection and this research is striving to develop another layer to help protect the average home computer user.

II. EXPERIMENT

A.   Study Design

This experiment was conducted using volunteers who would be given step-by-step instructions to follow. The volunteers were people whose computer expertise does not include strong technical knowledge on computer systems. The aim was to use volunteers with the same computer knowledge of an average home computer user. The instructions would lead the volunteers through the process of downloading an operating system file, downloading the virtual machine application, setting up the virtual environment, and managing the virtual environment with multiple operational steps. After completing the given instructions, the volunteers were each given a questionnaire to survey their experience with downloading, setting up and managing the virtual environment. Throughout the entire process, I watched over each volunteer's work and took detailed notes on their process and ability to work through the given instructions. Each volunteer worked one at a time to allow me the opportunity to observe them individually. I allowed myself the chance to answer any questions that were asked throughout the process, though any question that was asked was recorded. There was no reward for the volunteers; each gave their time freely to help with this research.

B.   Instructions & Questionnaire

The instructions were a 150-step process that was broken into two parts: installation and tutorial. The installation section focused on the downloading of the virtual machine application and the operating system, along with setting up the virtual environment to user specifications (which were given in the instructions). The tutorial section walked the volunteers through basics of how to use the virtual environment. Among these steps were how to properly enter and exit the

virtual environment, save the environment's state, and restore the environment to a previously saved state.

The instructions were written in a step-by-step method to simplify the process for each volunteer. Each instructional step handled one action at a time as to not confuse the volunteers on the process. An example of a step:

Step 26: On the "Ready to Install" window, select "Install".

Accompanying the written instructions were 43 pictures that were spread throughout. The pictures were supplied to give the volunteer a visual representation of what their screen should look like and a better understanding of certain instructional steps. The pictures were screenshots taken from when I worked through the instructions to ensure that they were correct and could be followed.

The questionnaire consisted of 12 rating questions with three open response questions. The rating style questions asked the volunteers to give a rating of 1 (Strongly Disagree) to 7 (Strongly Agree) to a statement about their experience. An example of a questionnaire statement would be:

10. It was easy enough to use that I could see myself using it daily.

The questionnaire was divided up into four sections. The "Install & Set Up" section held rating questions that focused on how difficult the user felt setting up the virtual machine was and their confidence in being able to do so again in the future. The next section, "Ease of Use," asked the volunteers to give their opinion on their comfortability of using the virtual machine in six rating style questions. Along with their comfortability in using the environment, it also focused on

difficulty of learning how to use the virtual environment. Then in an open response question, it asked the volunteer's opinion on reasons as to why is was not easy to use. The "Security" section asked two rating style questions on their understanding of how a virtual environment can be used for computer security and their openness to using one on their home computer. The final section, "Reaction," asked two open-ended questions about the positive and negative aspects they felt and encountered about their experience with the virtual environments.

C.   Hardware & Software

To ensure that each volunteer's experiment environment was the same, the same laptop was provided for them to work on. Each volunteer worked on a Lenovo Ideapad 130S-11IGM with a 64-bit operating system, 1.10 GHz processor and 4.00 GB of RAM. Before each new volunteer was set to begin, the laptop would have all memory and saved data pertaining to the experiment deleted and set back to the same state it was in before the last volunteer had made changes to the laptop. This was done with the idea that each volunteer begin and work in a similar environment to each other. Along with each volunteer working with the same scenario, using the same laptop that was set up in the same manner minimized unforeseen difficulties. The laptop was tested and known to be able to properly handle all the requirements that the experiment demanded. There was also no worry of having to adjust computer settings on the host computer to ensure that the virtual environment was able to work properly.

With the laptop that could handle the virtual machine application, there was the need to decide which virtual machine application would be used for the experiment. After looking at the various virtual machine software programs, the choice came down to three popular brands: Parallels Desktop, Oracle VM VirtualBox, and VMware Workstation. While looking between

these programs, the decision came down to the technical requirements, the price, and what a

home computer user would think when looking to download on their home device.

Looking at some of the technical specifications for each virtual machine software

program, Parallel Desktop was immediately removed from the list. The laptop that each would

use for the experiment was a Windows operation system PC. With Parallel only working if the

host computer was a Mac, it would not work for the experiment. The choice was between

VMware Workstation and Oracle VM VirtualBox. VirtualBox had two aspects that made it

more favorable than VMware. The first specification was that the minimum and recommended amount of RAM required for the virtual machine software programs were less for VirtualBox than VMware. The second aspect was the price of both software programs with VirtualBox being free for the entire enterprise version. The basic/personal version of VMware, which would have been enough for the purposes of this experiment, was also free. Since the purpose of this experiment is to determine if an average

	VMware [1]	VirtualBox [2]	Parallel [3]
RAM (min.)	2 GB	512 MB	4 GB
RAM (rec.)	4 GB	2 GB	8 GB
Disk Space	1.2 GB	100 MB – 10 GB*	600 MB – 16 GB*
Price	Free (Basic Version) $63.99 - $199.99 (Pro Versions)	Free	$79.99
Notes	Product differs depending on host type (PC vs. Mac)	Backed by Oracle	Only runs on a Mac host

Table 1: *amount may vary depending on operating system used within virtual environments

home computer user would and could use a virtual machine software program for their home

computer's security, a home user would be more inclined to use the free software that offers the

full version, instead of the version which he/she believes is only part of the entire product.

Therefore, Oracle VM VirtualBox was used for the virtual machine software program for this experiment.

The final bit of software that was used for the experiment was the operating system that would be uploaded to the virtual environment. A version of a Microsoft Windows operating system was decided to be used for this experiment. This is because Windows is the most popular operating system in the world for desktops, with some version of Windows downloaded onto 82% of those PCs [4]. Deciding which version of Microsoft Windows came down to availability, expense and experience. The 64-bit Windows 8.1 version was available for a free download at the time along with a free version of Windows. I was also most familiar with Windows should any issues have arisen during the experiment. Should the volunteer need help, then it was best for me to have in-depth knowledge in order to assist in any issue.

D.   Data Analysis Method

When looking at the data that was collected from the experiment, two sources of data were to be considered. The first comes from the volunteers' responses to the questionnaire. This gives the volunteers' direct opinions and input from their experience during the experiment. The second method was the volunteers' behavior during the experiment. This includes how many questions the volunteer asks, if they get confused multiple times following the instructions, and more of their overall demeanor towards the experience. This helps point to certain areas within the experiment that may cause multiple volunteers an issue or other observations that are not revealed through the questionnaire.

III.   RESULTS

Each volunteer was able to completely work through the instructions and finish the experiment before answering the questionnaire. The average time it took each volunteer to complete the

experiment was 2.5 hours. Within that time, it took just under 1.5 hours to download the Microsoft Windows operating system. The last hour was filled by the downloading of the virtual machine software program, setting up and managing the virtual environment, and the occasional delays due to system configuration (such as the Windows operating system automatically setting up within the virtual environment).

Statement	Average Rating out of 7
The virtual machine (VM) was easy to install.	6.00
I can go and install a virtual machine on my own computer without issues.	6.30
The virtual machine was easy to set up/configure.	5.67
I understand how to set up a virtual machine without issues.	4.67
The virtual machine was easy to use.	5.30
The virtual machine was user friendly.	5.67
It was easy to learn how to use the virtual machine.	5.00
I do not need instructions to use a virtual machine in the future.	3.67
It takes little effort to use a virtual machine.	6.00
It was easy enough to use that I could see myself using it daily.	5.67
I understand why a virtual machine can be used to help protect people's home computers.	6.30
I can see myself using a virtual machine to help protect my computer's data.	5.30

From the questionnaire, volunteers rated statements on a degree from 1 (Strongly Disagree) to 7 (Strongly Agree) about their experience and opinions from the experiment. Listed below are the average ratings given for each statement.

Volunteers also responded to three open response questions. The first asked to list any reasons as to why they thought the virtual machine was not easy to use. The only response to this question was the need to capture and uncapture the virtual environment screen after most actions became tedious. The next question asked for the volunteers to list any negative aspects about their entire experience with the virtual machines. Responses from the volunteers to

this question are as followed:

- Downloads take a significant amount of time.

- Setup took too much time.

- Virtual environment controls take time getting understood and familiar with.

- Struggled to know when I was in the virtual environment and when I was on the host laptop.

- Not confident in my ability to use without instructions and may take a lot of time till I am comfortable with it.

The final open response question asked the volunteers to list any positive aspects they attribute towards their experience with the virtual machine. They gave the following responses:

- Easy steps to download virtual machine.

- Low cost (free).

- Can use any operating system.

- Can have multiple virtual environments with different operating systems.

Throughout the experiment, the volunteers were able to follow the instructions. Outside of needing clarification on a step or two, the volunteers required no assistance when working through the given instructions.

IV. DISCUSSION

A. Interpretations

Looking at the volunteers' ability to complete the installation and management of the virtual environment shows that it is possible for people who have no experience with virtual machine software to properly use it by following instructions. While they can be shown how to use the software, they are not comfortable enough using it without extra guidance; with only being given a 3.67 out of 7 on their confidence in their abilities to continue to use a virtual environment

without any more guidance. Even in other results from the questionnaire (4.67 on their

understanding on using a virtual machine without issue and 5.67 on the ease of daily use), it

shows that that while it was not overly difficult to be shown how to use a virtual environment,

the continued use is a different matter. There is little confidence in being able to continue use

without additional tutorials and continued guidance.

Outside of requiring further instructions, volunteers showed a great amount of

unhappiness with the time it took to install and set up. Especially with the downloads of the

operating system and the virtual machine software program taking around 1.5 hours to complete.

Along with the time it took to download and install, the extra time and steps it takes to log in to

the virtual machine software each time it is used was another factor that was looked at poorly.

Volunteers appeared to not like the fact that while they would have to log into their computer as

usual, they would then have to start up the virtual machine software and access the virtual

environment. They would have preferred to access the virtual environment upon initially

logging onto the computer.

There were some positive aspects about the virtual environments the volunteers

responded to. The volunteers liked the fact that the whole software program is free to start up

and use. They understood how the virtual environment is another layer of security, on a

conceptual level. They appreciated the knowledge that a method to help protect themselves from

cyber threats is free. However, reminders had to be made that this method adds another level of

security to their computer. It does not replace their cybersecurity software.

B.   Limitations

While the experiment went off without major issues, there are still some areas where the research

comes up short. One area that limited this experiment was the time frame given. This research

was conducted over a four-month period. That period of time caused the amount of research that could have been done to be drastically cut. There are multiple types of virtual machine software programs along with different types of operating systems that could have been tested and provided different results. A longer time frame would have given the chance to broaden the range of tests that could have been completed.

Another limitation for this experiment was the number of volunteers that were recorded. There was a small number of people who participated in this study due to the amount of time it took for each volunteer to work through the instructions. It was difficult to get volunteers who had 2 to 3 hours available for this research. To get a more accurate reading on the general public's view of this topic, a larger sample size would be needed.

Finally, volunteers were not able to spend a large amount of time working with the virtual machine software programs. A major reason that the volunteers did not have the confidence to go forth and work with a virtual environment by themselves is that they were not given proper time or tutorial to fully operate the program. For the purpose of this research, volunteers were given an abbreviated walk-through to gain the basic understanding on how to work in the virtual environments.

V.   CONCLUSION

This research was conducted to determine the plausibility of the average home computer user using a virtual machine software program as another layer of security on their home computer. This research points toward positive plausibility for a home user using the program. While there was data that pointed towards the volunteers' frustration in using the software program, much of that had to deal with the time requirements. The volunteers showed the willingness to use a virtual machine software program to help secure their home computers.

Based on the volunteers' willingness, the next steps should be to conduct further research. There are a large variety of virtual machine software programs to decide from that may be easier for average computer users to handle. Research could focus on what the home user struggles with in understanding how to operate a virtual environment. The technology used by the virtual machine software is available for anyone to use. It is the user interfaces that will cause people to stumble or not use.

This research could help prevent someone from being the victim of a cyber-attack. Helping people defend themselves by giving them an option of adding another layer of defense is a huge step towards protecting their computer. My hope is that this research will be continued and worked upon until more people understand that there is another method to helping them protect themselves from cyber threats. Protecting one's home computer is not simply done by purchasing the top-of-the-line anti-malware software. The results of this research will work towards helping people use an in-depth defense approach to protecting themselves and their home computers.

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