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APPLICATION AND BENEFITS OF CLOUD COMPUTING IN THE COLLEGE

The Research Project Report

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Executive Summary

This report details the progress and analysis of the *Application and Benefits of Cloud Computing in the College* research project. The project focused on the benefits of the application of cloud computing in students' software development journey today. It used Microsoft Azure, a cloud computing platform, for evaluation. This report also contains descriptions of the software tools, services, and processes that were used in the project ("evaluation", "study").

It aims to echo the same facts in, and conclusions drawn from the project. That cloud computing provides certain benefits to students today that would be harder to derive without it. Some of these benefits are more evident than others. Due to this, cloud computing should be considered for incorporation into regular learning in educational institutions. Like in universities' software engineering and information technology programs. For it to be considered viable, an evaluation to determine its actual benefits and applications should be done. Hence, the desire to conduct this project.

The Project: Why?

Cloud computing has braved the rough waters of skepticism and tackled certain drawbacks that have allowed it to be what it is today. A legitimate software solution for all. It is simply the delivery of computing services over the internet – the cloud (Microsoft, 2020). It could be software infrastructure, environments, or services. Like many internet services, it faces the same culprits – data insecurity, downtimes, and cost – that fuel many skeptics (ISG Technology, 2015). Time will tell whether these drawbacks will ultimately contribute to the demise of cloud computing. However, while adversity remains to be one of the great motivators of innovation, that alternate reality may never come to be.

There is a significant shift in the way cloud services are being offered and marketed today. They used to be offered, primarily, to working professionals. Now, they are offered with tutorials so anyone can learn how to use them at any time. Among the developments to cloud computing is the embrace of and adoption by students and educators(Ko, 2019).

Variety is the spice of life, but it makes it just a little harder to decide. There are many cloud computing providers like Microsoft Azure, Google Cloud Platform, Amazon Web Services, and VMware (Dataflair Team, 2019). Deciding on a cloud platform for a corporation is easier than deciding on a platform for students. A corporation has a defined criterion of evaluating its options. Students need to sample the market because they are still growing into themselves and their careers. One of the best places to do this is at school.

Microsoft Azure ("Azure") is the Microsoft Corporation's cloud computing platform (Microsoft, 2020). It has made many advancements over the years since its inception in 2010 (Sanders,

2020). Many of these updates have been for students and educators to explore possibilities through cloud computing. The project was an evaluation to determine some of these possibilities.

The Plan: How?

Through a generous grant provisioned by the University of Arkansas at Little Rock, the author formulated a plan to get set up on, and evaluate, Azure. The evaluation was set to run for 4 months – majorly during the Spring of 2020. Azure categorizes software applications and services that each user owns through a subscription. This is what each user pays for. There are different kinds of subscriptions and several offers for free credit. The most cost-effective option for a student, without offers, is the Pay-As-You-Go subscription type. This type of subscription was the intended type for use in the study.

Tools and services on Azure are commonly referred to as resources. Each resource has an associated cost that is computed with usage over time, for billing purposes. Since the evaluation would be from a student's perspective, the author set up resources that would be relevant to a student developer. Related resources are grouped in resource groups. These logical groupings make it easier to identify, classify, and manipulate resources on the platform.

The author also included monitoring services in the evaluation plan for tracking billing and usage on the platform. Azure has some default notifications that inform users about their spending, but there are additional tools available for further analysis. The analysis of the cost of usage compared to work done on the platform would provide useful insights for the evaluation.

Furthermore, it would help highlight the benefits of Azure as a cloud computing platform for student developers.

The Process

The evaluation began in late December 2019 and is meant to last until the end of April 2020. The set-up process ran from late December 2019 to late January 2020. It made use of Azure's 30-day free trial that provided $200 free credit (Microsoft, 2020). This short trial period revealed some inadequacies of the offer for a student, even during a break from school. That time was enough to set up and configure resources, but not enough for use and analysis. This necessitated a migration to a different subscription

Azure for Students is a type of subscription available to full-time, STEM[1], two or four-year accredited college students through their institutions. It provides a student with $100 credit for a whole year for use on the platform. It has some conditions like the fact that it has a limited supply of activations – one per eligible student – per region. It is also important to note that Microsoft reserves the right to terminate the offer at their sole discretion (Microsoft, 2020).

It costs nothing to use the services included with the Azure for Students offer - not even credit card information. These services are intended for teaching and learning, not for commercial purposes. Unlike the free trial offer, this offer provides $100 credit. The offer is renewable for a student at the end of the year of use.

[1] Science, Technology, Engineering, and Math

Furthermore, the subscription allows users to download developer tools through the Education Hub. The Education Hub has free Microsoft services and software for download. Among the provided services are learning platforms like Pluralsight, tutorials on software development, and templates (Microsoft, 2020). This was the next subscription type used for the evaluation after the end of the Azure free trial. It was used for the evaluation from late January to late March - when the credit ran out. The next subscription type used from late March, is the Pay-As-You-Go type. It is still in use and will last until late April - when the evaluation ends.

The Resources

The evaluation enabled the author to deploy 6 web applications on the platform. This meant obtaining a web application service on the platform to manage any deployed applications. There are many options for web services provided on the platform. For the evaluation, the author settled for a free Azure web service plan that allows up to 10 web applications to run. 5 of the applications were based on the *FreeCodeCamp* Responsive Web Design course projects. The remaining application deployed was a student portfolio Angular application. All these applications were developed by the author. The author occasionally visited, maintained, and update the applications once deployed.

The author also set up a virtual machine for extra computing power to facilitate software development for schoolwork. Sometimes there just isn't enough memory on a personal laptop to run some needed software tools. To further facilitate schoolwork, the author set up a SQL server and database on the platform. The database was used for working on SQL assignments for a database class for the semester.

Azure monitoring could not be used while on a free trial subscription. However, monitoring and analytics were already set up for the Azure for Students subscription. This made it easier to use and track work on the platform. This is also true for the Pay-As-You-Go subscription, although, it is set up differently.

The Tools

To best show the educational benefits of incorporating Azure, the evaluation needed to also show some of its useful integrations.

Github

Microsoft Corporation is an ever-growing company. This is more evident through its many acquisitions. One of their more recent ones is the acquisition of Github, Inc. in 2018 (Microsoft News Center, 2018). Github is a software development platform where developers can host open source code and collaborate with other developers (Github, Inc., 2020).

Apart from the introduction of CI/CD[2] on Github in 2019, the company unveiled other important updates at *Github Universe*. *Github Universe* is a two-day annual conference for Github developers. 2019's theme was *Code to Cloud* – echoing the increasing popularity of cloud computing. One of the unveiled updates was the release of the Github Actions feature. Github Actions provides ways for developers on Github to orchestrate certain workflows – popularly known as builds. These workflows are easily replicable because they are stored as code on

[2] Continuous Integration and Continuous Delivery

Github. They support different languages and runtime environments like Node.js, Docker, Java, Android, iOS, and many more (Friedman, 2019).

The evaluation took advantage of Github Actions to deploy 6 applications to Azure through Docker Hub. The applications were containerized and optimized for better performance upon deployment. Basically, code hosted on Github was replicated, minified, sent to Docker Hub as an image, and finally run on Azure.

Github Actions are gaining popularity and are already being used by companies like Pinterest, Angular, Bootstrap, and Jekyll. Through them, software artifacts can be deployed to platforms like Docker Hub, in addition to cloud platforms like Microsoft Azure (Github, Inc., 2020). Microsoft's acquisition of Github was meant to further empower developers, advance Microsoft's services to more audiences, and accelerate GitHub's growth. Judging by Github's progress in 2019, it seems like those goals were achieved (Microsoft News Center, 2018).

Microsoft has its own code hosting platform, Azure DevOps (Microsoft, 2020). However, Github is more appealing and beneficial to a student developer because it is relatively free compared to Azure DevOps. It also has more integration options, in the author's opinion. This allowed the author to set up multiple CI/CD pipelines for several applications.

Docker Hub

Docker is an Operating System level (OS-level) virtualization tool. Virtualization is, basically, abstracting something physical, like a computer system, in software. What sets OS-level virtualization apart is the reduction in complexity of this process, and size of the eventual abstraction, compared to traditional virtualization. To use Docker for virtualization of software

applications, images need to be created for each application. An image is, simply, a static representation of a virtualized application. A Docker image is an image created for the Docker software tool by Docker standards. Images are run in containers, hence, the term containerization in virtualization. The agnostic nature of Docker containers promotes the tool's simplicity and agility, making it popular for virtualization (Docker, Inc., 2020).

Docker Hub is a platform that allows its users to host and share Docker images – a Github of sorts for Docker images. It provides integrations for other platforms like Github and Microsoft Azure. In the evaluation, changes made on Github to application code triggered Docker-Azure workflows to run. This means that a new image was built for every change, and the updated image was sent to Docker Hub. This would then trigger a new deployment of the application on Microsoft Azure. This automated process is sometimes referred to as building and releasing. One outstanding perk of the platform to a student is the free hosting and services, up to a certain level, that it offers.

Further Advancements on Azure

Learn

In 2016, Microsoft provided insight into the increased use of at least one of its cloud services by over 90% of Fortune 500 companies. This increased adoption led to the rise in need for Azure training and certifications for IT operators and developers. They started with 3 training offers that provided access to Microsoft's online courses and discounted certifications (White, 2016).

Now, Microsoft training has grown into *Microsoft Learn* providing free access, for all, to their online courses on their products. Especially, Microsoft Azure. These courses are categorized by roles, like Developer, and different learning paths (Microsoft, 2020).

Through these courses, users get limited but free access to Azure subscriptions for learning purposes. After completing each course, the learner receives a badge, experience points, and sometimes trophies. Apart from gaining skills and appreciation from these accolades, they can add them to resumes. Today's student developer does not need to worry about cost as a barrier to learning.

Compete

Microsoft Imagine Cup ("Imagine Cup") is an annual global technology competition by the Microsoft Corporation. It has been running for nearly 2 decades now (Microsoft, 2020). It is a fun hub for technology enthusiasts to:

- Network
- Gain new skills
- Travel
- Get mentorship
- Win prizes

Learning more about Microsoft Azure and showcasing the learned knowledge at competitions, like this one, opens many professional doors. These professional opportunities include becoming Microsoft Student Partners or Microsoft Evangelists. These opportunities come with other perks too, like getting free access to software tools (Microsoft, 2020).

Previous Imagine Cup participants used Imagine subscriptions on Microsoft Azure. This type of subscription is being replaced by Azure Dev Tools for Teaching (Education Hub) on Azure. It offers the same or more products and services as an Imagine subscription. Students do not need to have Azure accounts to access any of the software benefits of the Education Hub, they can use their Microsoft Accounts. They also have the option of going through an Azure for Students subscription (Microsoft, 2020). Of course, every student will not want to participate. However, history is filled with so many success stories based on seeds that were planted in obscurity.

The project helped reveal key benefits of cloud computing for students. It also paved way for a look into the journey that cloud computing has taken, through the eyes of Microsoft Azure. However, due to the short timeframe of the evaluation, and certain challenges faced, it is the author's opinion that the analysis was not exhaustive enough to draw more definitive conclusions. Moreover, a detailed plan should be developed for a streamlined process of analysis. This may necessitate the involvement of more people to collaborate in the evaluation.

Author's Reflection

The first time I navigated to the Microsoft Azure website, I felt immediately intimidated. I was a sophomore and I had options. So, my exploration ended there because I thought I would never need to know Microsoft Azure. The next time I found myself on the Azure website was during my first software development internship. I had no options. I learnt my way on the platform, and I haven't stopped learning on it. I can affirmatively say that Azure has grown and is still growing.

The project has been bitter-sweet. I enjoyed talking about and working with something that I love. However, the challenges involved in the process of showcasing its educational benefits were frustrating. Perhaps the challenges were rooted in the fact that this was my first time conducting research of this kind? Maybe I just had too many options to decide easily? Despite the challenges, I have learnt a lot more about the platform from trying to translate some of its features and benefits.

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