

EDFX - Combining Cloud Architecting with Education

A Senior Project Presented to
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Introduction

What is the cloud? That is a question that many students like myself have had at least once while pursuing their degree. This new technology is rapidly taking over the world providing a fortified basis for millions of companies, yet many individuals in tech still do not understand the concept of the cloud. The cloud is the network of remote servers planted across the world whose services can be accessed over the internet in a pay-as-you-go manner⁷. The best metaphor for the cloud, to break it down more, is the internet. As users utilize the cloud, they are able to access data and applications from devices with an internet connection⁷. The cloud enables businesses to massively scale their computing resources without having to invest in physical infrastructures such as data centers and physical servers⁷. This is because there are various cloud providers such as Amazon Web Services (AWS), Google Cloud Platform (GCP), Oracle Cloud, Microsoft Azure who are more than happy to provide customers with a vast range of cloud computing services.

As wonderful as this new technology is, it does not come without its drawbacks. *Datapine* highlights one such issue with cloud technology is the lack of resources or expertise in the field⁶. I have worked with cloud technologies for nearly two years, and a common issue I see in the workspace is a lack of knowledge of cloud technologies, which leads to a lack of cost optimization and operational excellence among other problems. To combat this issue, Amazon Web Services (AWS) has offered certifications about various subjects that stand out on a resume. These certifications are quite prestigious and can be a huge factor in negotiating for a higher salary compared to other candidates. Aside from these professional benefits, it also displays that AWS is determined to offer accessible education about the cloud and its services to anyone.

Application

These are instructions for navigating the Educeri course page as well as finding the course I utilized for the AWS Certified Solutions Architect Professional SAP-C02 exam at the time of writing this report. Both of these platforms and courses may change.

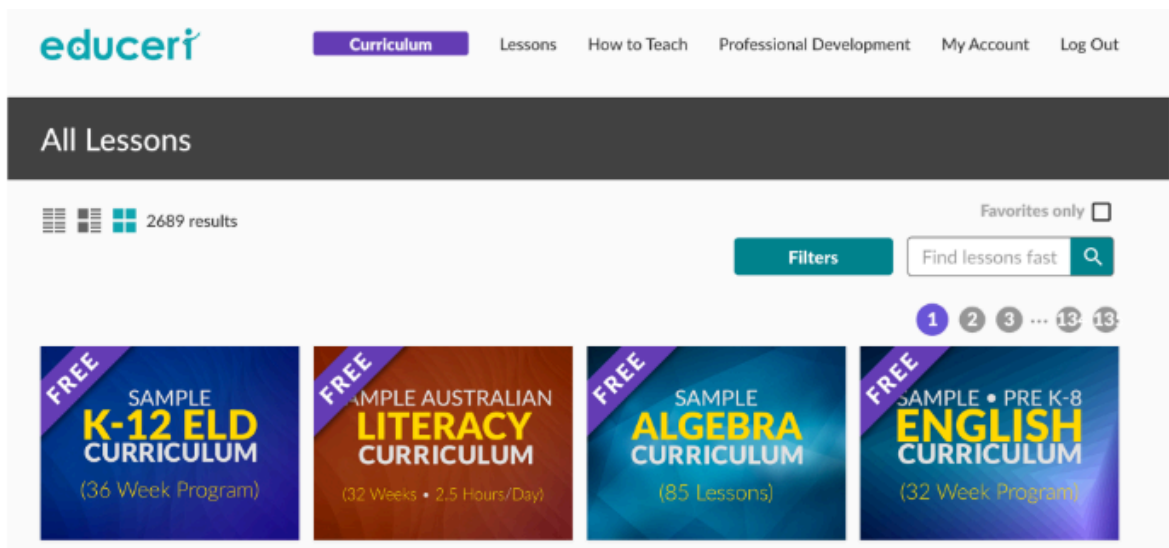


Figure 1: The Educeri Curriculum page⁹

When navigating to the Educeri page after logging in, you are presented with over 2500 lesson plans for all sorts of subjects. When clicking on a specific lesson, you see both the student and teacher views of the lesson plan.

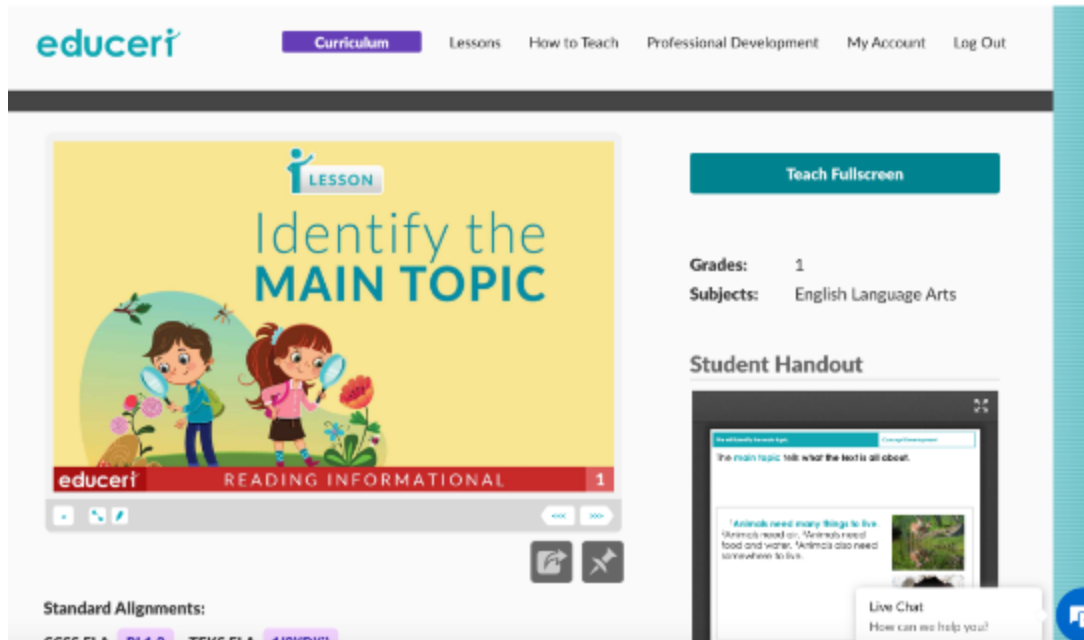


Figure 2: View of Lesson in Student And Teacher perspective⁹

The teacher plan is a powerpoint format, while the student handout is similar but more of a workbook based format. Larry Federico, my client and the owner of EDFX, would like to complete various technological updates that would allow more synchronization of learning and communication during lessons to improve the educational experience.

These technological improvements involve utilizing the cloud to support various infrastructure operations as well as storage. As part of my senior project, in an effort to further assist with cloud related activities, I will be pursuing the Amazon Web Services (AWS) Solutions Architect Professional certification. To register for the course, go to Udemy to find AWS Certified Solutions Architect Professional SAP-C02⁴. Add the course to your shopping cart and check out when ready.



AWS Certified Solutions Architect Professional SAP-...

Neal Davis | AWS Certified Solutions...

Figure 3: Image of AWS Certified Solutions Architect Professional SAP-C02 Course⁴

Background

EDFX

Educeri is an interactive educational technology company whose foundation establishes effective teaching pedagogy. They are owned by Dataworks Educational Research, which is a company that utilizes instruction to improve student performance. They dedicate their time traveling around the world to provide teachers and students with excellent instruction that is at the top of the industry. Educeri is a platform developed by Dataworks, which includes lessons that are delivered in a subscription based format that teachers and students can utilize to enrich their learning. EDFX desires to improve Dataworks by updating various technological components to make it more applicable to a variety of students.

Some of the issues that Larry hopes to eliminate with his product that I will be assisting with is to allow students to see what the teacher is writing down on the whiteboard from any part of the classroom, allowing students to ask questions anonymously if they have a shy disposition, and to allow teachers to create a better learning experience for all their students.

Amazon Web Services (AWS)

AWS, in specific, has significantly more services and a multitude of unique features, compared to other cloud providers¹⁵. They are a pioneer in cloud technologies and pave the way for other cloud providers¹⁵. On top of the services they provide, AWS offers various certifications in important cloud subjects. The certification in focus for this project is the AWS Solutions Architect Professional Exam, which validates an individual's expertise in "designing, implementing, migrating, and operating" a variety of workloads or infrastructures in AWS⁵.

The reasons for pursuing cloud certifications are cardinal when it comes to the technology industry. AWS has provided four reasons to pursue AWS certifications in specific: cloud computing is dominating various organizations, industries view certifications as a competitive advantage, there is a high demand for AWS certifications in specific, and professionals holding certifications display an increase in job effectiveness¹¹.

Design

My project consisted of familiarizing myself with the various companies involved in this project, which are Dataworks, Educeri, EDFX, Chordify, and Biglee as well as getting through all the modules of the AWS Solutions Architect Professional course. I had an initial phone call with Larry, who gave me a brief overview of the company, and I then took the time to establish modes of communication such as email and text. I also utilized that phone call to find out who ran the AWS environment as well as the engineering contacts involved.

Following that vein, I set up weekly meetings with the engineering contacts as well as Larry to further investigate the AWS architecture as well as the project scope. The engineering contacts gave me read only access into their current AWS architecture as well as their monthly invoice. I was analyzing six specific components in their architecture, which are the six pillars of the AWS Well-Architected Framework¹⁰.

- 1) Operational Excellence¹⁰
- 2) Security¹⁰
- 3) Reliability¹⁰
- 4) Performance Efficiency¹⁰
- 5) Cost Optimization¹⁰
- 6) Sustainability¹⁰

In addition to a review of their architecture, I wanted to clearly get down what the company's minimum viable product (MVP) as well as other features they wanted. Thus, I created a Product Requirement Document with the following features:

- 1) Organization Description
- 2) Problem Statement
- 3) User Studies
- 4) Features and Components
- 5) User Journey
- 6) User Journey Map
- 7) User Flow Diagram
- 8) Wireframe
- 9) Development Timeline

10) Contact Information

All these features located in a single document, which is shared among various groups, allows everyone to be on the same page in terms of necessary features, different user perspectives, and allows clear communication and ideas between everyone. This document allows Larry to specify all the features he would like in the final product and the engineers to provide feedback in terms of what can be completed within specific time frames.

As for my AWS SAP course, I planned to complete all the modules, which are the following⁴.

- 1) Organization⁴
- 2) Identity and Access Management⁴
- 3) Directory and Federation⁴
- 4) Advanced Amazon Virtual Private Cloud (VPC)⁴
- 5) Hybrid Connectivity⁴
- 6) Compute, Autoscaling, Load Balancing⁴
- 7) Storage⁴
- 8) DNS, Caching, and Performance Optimization⁴
- 9) Database⁴
- 10) Serverless Applications⁴
- 11) Docker Containers and PaaS⁴
- 12) Deployment and Management⁴
- 13) Migration⁴
- 14) Analytics Services⁴
- 15) Monitoring, Logging, and Auditing⁴

16) Security and Defense Services⁴

During the course of my project, I made sure to keep aware of certifications that AWS announced that they plan to retire³.

Implementation

AWS Architecture Analysis

Starting with an analysis of the AWS architecture, I will review the services EC2, S3, and the elastic load balancer. Beginning with EC2, I noticed that there was a very high monthly cost associated with that service. Upon further analysis, I noticed that Dataworks was utilizing on-demand instances for their main as well as non-production platforms. AWS defines an on demand instance as compute capacity utilized by the customer that they pay for per second or hour, depending on the instance type, with no long-term commitments⁸. Following the cost optimization pillar of the AWS Well-Architected framework, I suggested they convert their production instance to a reserved type rather than keeping it on demand. A reserved instance provides up to a 72% discount compared to an on-demand instance with the agreement of a one to three year commitment of consistent usage of the instance¹. This change would save Dataworks quite a bit of money as compared to keeping all on demand instances.

Keeping with the pillar of cost optimization, I noticed that S3, which is AWS' storage service, was racking up quite a fee as well. Upon discussion with Dataworks, I understood that a lot of the buckets, which is a container used to hold objects, were barely accessed as they served as a backup drive of all data. Since the buckets were barely accessed, I suggested to the team to migrate the buckets to either S3 Glacier Instant Retrieval or S3 Glacier Deep Archive. S3 Glacier Instant Retrieval² allows for extremely low cost storage for data that can be accessed within

milliseconds while S3 Glacier Deep Archive¹² also has a competitive price but data retrieval takes up to 12 hours.

I then analyzed their use of an application load balancer, where I found that two pillars required improvement. A load balancer has the ability to distribute ingress traffic across multiple targets, which in this case are EC2 instances¹⁴. In general an application load balancer¹⁴ has three layers to it.

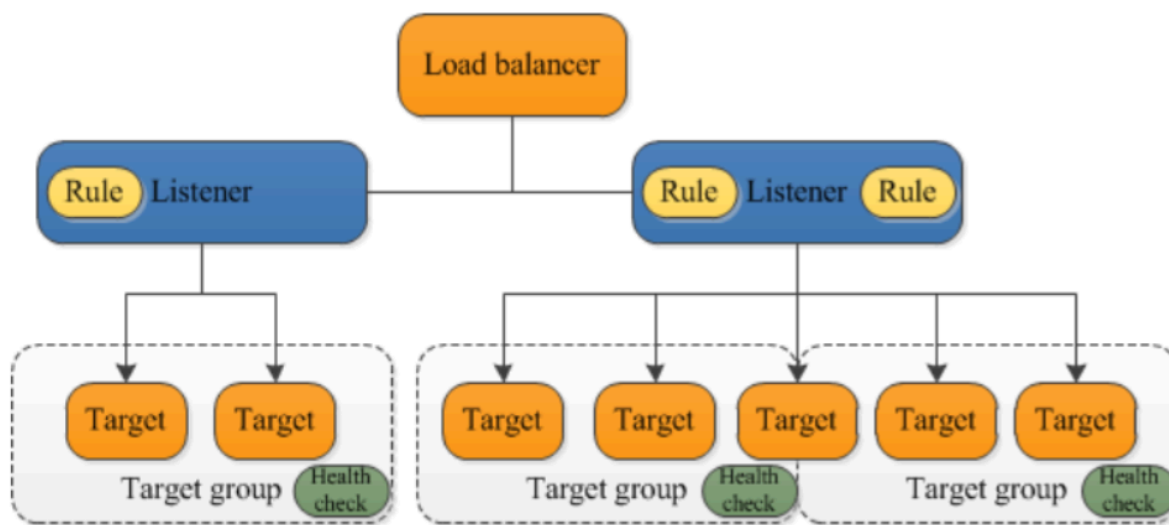


Figure 4: Diagram of an optimal load balancer¹⁴

First is the load balancer, which is the point of contact for all clients¹⁴. Next is the listener, which analyzes the connection requests from clients¹⁴. Dataworks had the load balancer listening for connections with HTTP and TCP protocols, which I found agreeable.

Protocol:Port	Instance Pr...	Security policy	Default SSL/TLS certificate	Cookie stickiness
TCP:443	TCP:443	Not applicable	Not applicable	Not applicable
HTTP:80	HTTP:80	Not applicable	Not applicable	Not applicable

Figure 5: Dataworks Listeners

The next layer are the target groups, which route requests to registered targets, such as EC2 instances, using the protocol and port number the company has specified¹⁴. The problem was here as Dataworks only had one instance defined as a target defeating the purpose of a load balancer, which is to distribute traffic across targets. A load balancer can also route traffic to a different target should an instance have issues and fail¹⁴. Thus, I suggested either to remove the load balancer to save costs and uphold the cost optimization pillar or to create another target group to uphold the performance efficiency pillar. From my studies in the AWS SAP course, these suggestions will allow for a fortified cloud architecture.

Creation of Product Requirement Document

This document is quite intensive, but I will cover the main points in this report to give a detailed overview. To complete this document, I got on a call with Larry and John Hollingsworth, the president of Dataworks, to nail down the minimum viable product so that the Chordify team can begin implementation. To begin, we identified the problem that the new EDFX software is attempting to find a solution for. The pain points identified is that students can not see the whiteboard depending on where they are sitting, and thus it hinders their interaction with the lesson. In addition, teachers do not have the awareness that a student is falling behind. Parents may struggle to advise their children, as they may not have the proper instruction to do

so. To resolve this, the EDFX software wants to enhance how students receive, store, and access information presented by the teacher.

On the note of pain points, I helped Larry and John identify four different types of users the software should account for: these are teachers, students, admin/coaches, and parents. I will include some user stories below.

- 1) *“As a student, I want to be able to see the instruction in front of me and be able to interact with it freely independent of other students seeing my work.”*
- 2) *“As a teacher, I want all my students to feel engaged. I want all my students to feel free to interact and ask questions anonymously as I project it on their devices.”*
- 3) *“As an admin, such as a coach, I want to be able to improve teaching by providing tips and strategies. I want to review any lesson and provide strategies for teachers to try.”*
- 4) *“As a parent, I want to view messages from teachers. Parents can access my child's notes and materials.”*

The above statements are some goals that should be achieved by the software depending on the user perspective.

This leads into the components that should be required for each user. All 4 users must be able to have a single sign on for all applications utilized. For administrators, such as a principal or a learning coach, be able to view all teacher's plans, provide strategies to teachers digitally, and be able to message anyone. From the teacher's perspective, they should be able to have universal access and control of all student devices, display their screen to students as well as share details, message anyone in the classroom, and other features. For a student, they should be able to message the teacher privately, take notes on their device which are saved, be able to signal to the teacher with a button if they are having trouble understanding, be able to highlight

details, and other features. For a parent, they should be able to access their child's notes and see any messages from the teacher.

To make a more clear picture, below is a user workflow between teachers and students which displays how information is sent and received between those two different users.

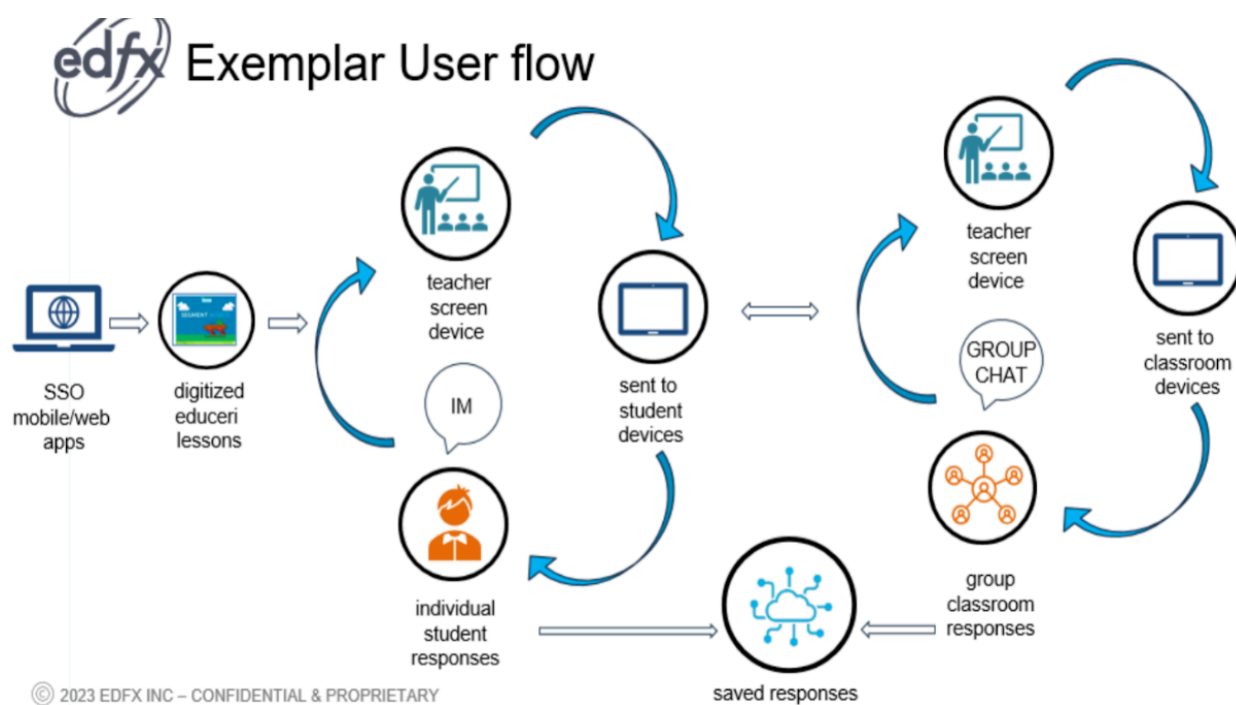


Figure 6: User Flow between teachers and students.

Chordify Solution Feedback Document

I created another document for Larry, which contained my feedback on a solution that was prepared by Chordify to implement the EDFX Solution as detailed in the PRD. This document outlined sprints for creating a solution as well as the hours and tasks in each sprint. Based on my knowledge, my main focus with the solution document was a concern about the

testing in each sprint. I emphasized that it would be good to see more testing in each sprint to address any customer concerns/feedback as well as any issues with software in the process of creation.

AWS Solutions Architecture Professional Course Overview⁴

I will give a brief overview of what I have learned in the Solutions Architect Professional Course here.

- Organizations⁴ is an account management service that allows you to create and consolidate multiple AWS accounts into a single area. This module also went into service control policies which are rules that help manage permissions in organizations for each account⁴.
- IAM⁴ stands for identity and access management. This service allows you to control access to your resources by creating roles and policies that you can attach to users in order to foster the principle of least privilege⁴. It allows everyone to have the least permission necessary to do their job while maintaining high security for resources⁴.
- Directory and Federation is next. To break this down, Directory services such as Microsoft AD allow you to use a single set of login credentials to access a multitude of resources⁴. Federation is the ability to extend this single sign on beyond your organization's network to access resources in other organizations or services⁴. This module went into the AWS options for making this possible
- Advanced Amazon VPC, which stands for Virtual Private Cloud, went into deeper concepts of networking, design, and deployment of setting up a successful cloud environment to host your instances and other resources⁴.

- Hybrid Connectivity⁴ went into how to utilize AWS to create connections between on premises and the cloud, various VPCs in different or the same regions, and virtual VPCs to on premises VPCs or resources.
- Compute, Autoscaling, Load Balancing was about managing your EC2 instances, which are virtual machines⁴. Autoscaling is the computing feature of adjusting compute resources based on workload and load balancing is distributing incoming network traffic across servers or resources⁴.
- The storage module covered Amazon S3, which is AWS' storage service and included other services such as EBS for block storage and EFS for file storage⁴. It also goes into the various features of all these services.
- In the DNS, Caching, and Performance Optimization module, it covered various services such as Route 53 for scalable DNS services, CloudFront and Elasticache for content delivery networks and caching abilities, and Global Accelerator for performance optimization on a global scale⁴.
- The Database module went into their various database options such as DynamoDB, MariaDB, RDS, Neptune, DocumentDB, and others⁴. AWS tries to be compatible with various databases to allow for easy migration.
- Serverless services in AWS include Lambda and Eventbridge. Lambda runs code without managing servers, scaling automatically and Eventbridge integrates different AWS components through event triggers⁴. The module also covers serverless architectures, which are important as they can reduce operational overhead, scale on demand, lower costs, and accelerate development⁴.

- Docker is supported through AWS in services such as ECS and EKS. ECS is a container orchestration service, while EKS allows users to manage Kubernetes for running containerized applications⁴.
- Deployment and Management goes into the AWS services that can compile, test, and transform your code⁴. There are services that can deploy software updates to various resources. On the note of management, AWS allows you to share resources with accounts and organizations through their resource manager service⁴.
- AWS Migration Services⁴ provide tools and resources for efficiently moving applications, data, and workloads to the AWS cloud, ensuring minimal downtime and optimized performance.
- Analytics services in AWS allow for real-time data processing, data warehousing that is scalable, and cost effective⁴. These services include Athena, Kinesis, and Redshift which can all analyze data as well as perform other operations⁴.
- Monitoring services include CloudWatch, which is crucial for maintaining application health, identifying issues, optimizing performance, and ensuring efficiency⁴.
- Security Services are next, and some that I covered were KMS, Config, and Shield⁴. KMS, which stands for key management service handles encryption keys for securing data, Config monitors and assess AWS resource configuration, and Shield protects against DDoS (Distributed Denial of Service) attacks⁴.

Verification

For a majority of my work, it was presented to my clients and verbal feedback was given at that time. For the review of my AWS Architecture Analysis document, I gathered the Dataworks team as well as Larry Federico onto a zoom call where I presented my findings in an

hour-long call to engineering contacts and company executives. I went through each service, answered any questions or confusion, and explained why I felt my suggestion would help the company have more performance efficiency and cost optimization. By the end of the call, the team felt the suggestions were critical and useful for improvement. The document was cleared to be sent to Bigslee, which is the company that handles the AWS architecture for Dataworks-ED.

With the PRD, that document was made with Larry and John in order to ensure clarity in the final features of the product. Before the call began, I had headers of all the details that were required, which I listed in my design section of this report. I sat down with the team for an almost two hour call of all of us sifting through fine details to figure out what the imperative components to be implemented were. Once the document was completed, Larry and John gave the document a look over and emailed me their approval after the call. I was then cleared to send the document to the Chordify team, which is the team that will be implementing the software. They also appreciated the concision and clarity of the document. The same applied to the Chordify Solution Feedback document that I created. Larry appreciated the thoughts I had on this document and kept it for his reference.

In terms of verification of my AWS SAP course, I completed all modules in the Udemy course and created quizlets based on what I have learned. The quizlets allow me to master the material that I have obtained. To truly master the skills that I need for the exam, I have been utilizing the Tutorial Dojo AWS Certified Solutions Architect Professional Practice Exams 2024¹⁶. On my first try, which was in review mode, I scored a 49%, where I reviewed all the questions I got wrong. I then completed the section based questions in the course, which are as follows:

- Design Solutions for Organizational Complexity¹⁶

- Design for New Solutions¹⁶
- Accelerate Workload Migration and Modernization¹⁶
- Continuous Improvement for Existing Solutions¹⁶

Based on the pattern of information that the questions were asking me in each section, I took time to understand the services required in each that I was lacking in. Thus, the next exam that I took, which was in regular timed mode, I got a 70.67%, and I needed a 75% to pass. Over the next few weeks, I took timed tests, and I received the following scores: 66.67%, 70.67% 54.67%, 56.25%. Noticing that my scores were going down was very frustrating for me, and while I wanted to throw in the towel, I recommitted myself to the material. I went through the section based questions again, making sure I thoroughly understood the services. I reached out to colleagues at work to discuss services that I struggled with such as Direct Connect and networking services. I watched youtube videos that broke down other concepts that I struggled with such as federation. With this effort, I retook exams and scored 84% on two practice exams that I scored the lowest in previously. I was happy with my improvement, and took the actual exam the next day. I scored a 756 on the real exam and passed (See Appendix I). While I did barely pass, I am happy that I was able to pass the exam with around 7 weeks of preparation, whereas the normal study time is 6-7 months. I put in a great deal of effort, and it paid off. I became an AWS Certified Solutions Architect Professional.

Interdisciplinary Connections

Liberal Arts Connection

This project involves communication between various teams and people with different levels of technological understanding. Some of the clients that I have worked with on this project do not have any understanding of AWS, but I have learned to break highly technical concepts

down in order to facilitate better understanding of the service. In addition to that, I have been able to apply my communication skills to sift out important details in conversations such as for developing the PRD with my clients. As I was creating the document, my clients gave me a general overview of all the features they wanted, which did not account for the technical viability of the features. I made sure to keep in mind that an engineer will have to look at my comments and think of how to create it, thus I was able to translate what the client wanted to features that a developer can build.

Engineering Connection

I have been able to learn about AWS services while also gaining some hands-on experience with it through my client's infrastructure. In addition to that, I have subsidized my engineering application through the Udemy AWS SAP course⁴, which goes over more than 200 services that are involved in creating a well built cloud system while also going over how to debug issues within the cloud. The course provides detailed information on how to prevent the collapse of a cloud system while also providing examples of best architecture practices in various situations.

Related Work

The experience gained from this project can be directly translated into the field of Solutions Architecting. *Coursera* defines that a solutions architect analyzes a client's existing environment or investigates what a client desires to build, figures out what technologies are available to implement the idea, and provides the best solution while accounting for various factors¹³. It can be similar to project management, but solutions architecture requires stellar project management skills in addition to accounting for providing various solutions. The responsibilities of a solutions architect include performing designing and debugging solutions,

documenting and sharing best practices, advocating for procedural improvements, ensuring excellent communication on development, providing exceptional technical leadership, and other duties¹³.

Future Work

If I were given more time and resources for this project, I would be working on helping the company implement the AI portion of the project, which is a feature they desired to help kids have a more custom experience with learning. A lot of this quarter was spent surveying different companies to help build this solution, which only recently got solidified, so I would be helping EDFX with building the best AI model for their solution.

Conclusion

With the current state, I am happy with the work completed. EDFX is a huge project that requires details to be narrowed down as well as architectural improvements. Their goal is to improve education for all students to enrich the learning experience. Students struggle to see the board based on where they sit or they may be nervous to ask questions due to peer pressure in the classroom. Educeri hopes to resolve these problems through their software product. Educeri also wants to have better facilitation between all parties including teachers, parents, students, and admin.

In addition, the enrichment of my work experience with the AWS SAP course and certification has been fascinating. As I learn about more specifications from the client, I am able to connect the specification with a service that will accomplish that feat. I plan to use this knowledge to help the engineering team with implementation where cloud services are required. EDFX shows promise as a wonderful teaching service to students and teachers, and I hope my efforts will further progress next quarter.

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Appendix I

Section	Score Performance		
	% of Scored Items	Needs Improvement	Meets Competencies
Domain 1: Design Solutions for Organizational Complexity	26%		
Domain 2: Design for New Solutions	29%		
Domain 3: Continuous Improvement for Existing Solutions	25%		
Domain 4: Accelerate Workload Migration and Modernization	20%		

Candidate Score: 756

Pass/Fail: PASS