

Evaluating Impact of an Online Self-Service Learning Platform for Application-Inspired Cloud DevOps Curriculum

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Abstract

Learning Management Systems (LMS) have the potential to deliver learning materials in academia to teach learners about advanced cyberinfrastructure topics. It is important to develop metrics that can characterize the impact these systems have on students in terms of their learning outcomes. In this paper, we outline novel user interfaces that we have developed for LMSes that allow evaluation of the students' learning progress. Our user interface development is centered around an innovative online self-service learning platform viz., "Mizzou Cloud DevOps", which features application-inspired Cloud DevOps curriculum. We specifically discuss our auto-grading API that is developed for technical assessment of the students' taking course. Additionally, we show how we monitor and manage instructors' and students' usage of the online learning platform and curriculum content, and how we provide rewards for learning accomplishments.

Keywords: Learning Management Systems for Cyberinfrastructure, User Interface for Impact Evaluation, Learning Engagement Metrics

1 Introduction

In the rapidly evolving landscape of digital education, avenues for learning have expanded exponentially, offering diverse opportunities for individuals to enhance their skills and expertise. Industry-specific certifications, Massive Open Online Courses (MOOCs), and dedicated course curricula within educational institutions have become integral components of the modern learning experience, as evidenced by the growing body of literature in the field of eLearning [1]. The proliferation of cloud technologies and DevOps practices has transformed the way organizations operate, the need for skilled professionals in this domain is more pressing than ever before. Public cloud providers have recognized this demand and responded by offering comprehensive training and certification programs tailored to specific cloud ecosystems. Platforms like AWS [2], VMware [3], QwikLabs Essentials [4], and Azure [5] have become indispensable resources for individuals seeking expertise in Cloud and DevOps. Moreover, MOOC platforms have emerged as pivotal players in democratizing education, making DevOps training readily accessible to learners across the globe. Platforms such as LinkedIn Learning [6], Udemy [7], Udacity [8], Coursera [9], and Edx [10] have revolutionized the learning landscape, offering flexibility and convenience to those eager to enhance their capabilities.

In line with such advances of Cloud DevOps online training, we have developed the “Mizzou Cloud DevOps” (MCD) platform, an online self-service learning platform designed to equip students with in-depth knowledge about Cloud DevOps concepts, tools, and technologies. Building upon the foundational work laid out in [11], where an education catalog was developed, the MCD platform represents a significant evolution by harnessing the capabilities of LMS, telemetry for students/instructors, auto-grading API for technical assessment. The platform consolidates a wealth of educational resources for Cloud DevOps providing cohesive and interactive learning experiences equipped with user engagement through Slack, acknowledgement of achievements for students through certifications for individual courses. The platform supports the roles of students and instructor(s), and allows instructors to keep track of student learning progress, and facilitates peer-learning feedback platforms as well as acknowledges learning achievements via digital badges and LinkedIn certificates. In this paper, we describe the various metrics that are relevant to characterize the impact of the MCD platform, and showcase the user interfaces to allow evaluate the students’ learning progress.

2 LMS Evaluation Features

We discuss various evaluation features for LMS basing our evaluation on the MCD platform. Figure 1 discusses basic user steps in performing learning modules in MCD. After students are able to perform these steps to complete labs, our module offers various components outlined in this section to evaluate their progress including the auto-grading API, telemetry and management, and the digitally verifiable credentials.

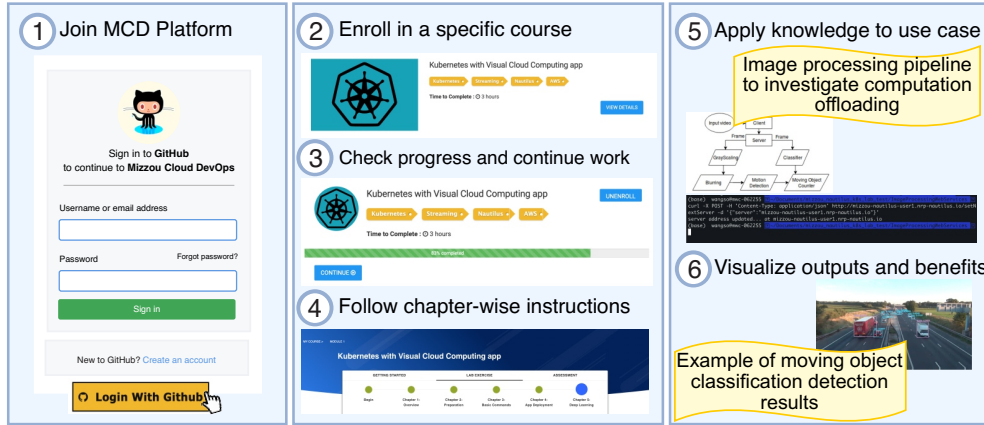


Fig. 1 Illustration of user steps for completing lab exercise in MCD.

2.1 Auto-grading API

We have integrated a set of Learning Evaluation APIs for auto-grading into the core of the MCD platform to enhance the assessment and grading process for students. These APIs enable students to submit their technical assessments, which are automatically graded. Additionally, the system assigns knowledge level medals (as shown in Figure 2) based on individual performance. Within the *submitEvaluation* API, we’ve developed an auto-grading feature capable of evaluating responses to questions, each with varying levels of complexity. These questions primarily consist of multiple-choice items related to different lab exercises, ensuring a diverse range of assessments. After the evaluation, the *submitEvaluation* API not only determines knowledge levels but also bestows corresponding medals and ranks students in relation to their peers. Students can easily access their personal rankings and medals and also view the rankings of their fellow students through the *getStudentRank* API. Medals are awarded based on the ”Knowledge Dimension” concepts derived from Bloom’s Taxonomy [12], with

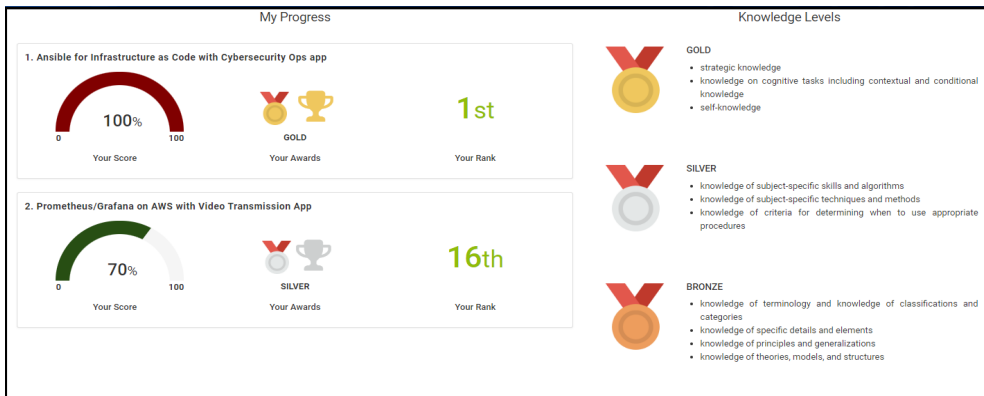


Fig. 2 Different knowledge levels associated to the students based on their assessment for lab exercises and their ranks.

varying weights assigned to questions based on their complexity. These REST APIs have been meticulously implemented using *Spring Boot*[13], a well-established Java Web Framework. This offers students practical learning exercises mirroring real-world application workflows. Each exercise is thoughtfully accompanied by comprehensive instruction manuals, introducing essential technologies such as container orchestration for video processing, cloud networking for cyber defense, edge/cloud federation for trusted computing, data pipeline automation for knowledge discovery, and more. The web portal, adopting a wiki-based format, provides invaluable guidance to help learners enhance their Cloud DevOps skills.

2.2 Platform monitoring and management

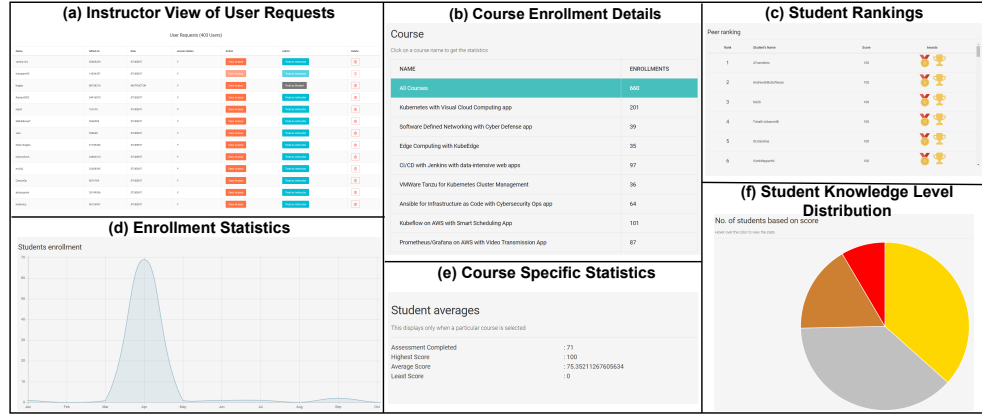


Fig. 3 Different monitoring and management pages for Instructors to gain insights on the platform usage and student data

Instructors are empowered by the MCD platform to gain insights into students' progress, utilizing data accumulated throughout students' interactions with the learning modules. The platform offers interactive graphical representations, including timelines of various activities within the MCD web portal. These visualizations encompass elements such as student ranking, enrollment statistics, and score analytics, facilitating data-driven assessments of student accomplishments and informing refinements to course content to enhance the overall student learning experience. Figure 3 showcases different pages that are available to the Instructors to visualize the outcomes in the platform. This provides details of each and every students and then also general statistics along with statistics specific to different modules. In the Figure 3, we have, (a) view of users requesting access to the portal, (b) enrollment information for courses, (c) ranking of students for specified course, (d) overall enrollment statistics, (e) course-specific statistics, and (f) student rank distribution.



Fig. 4 Certification for completion of learning modules catalog.

2.3 Digitally Verifiable Credentials

We have integrated the MCD platform with the LinkedIn API to grant learners (virtual) certificates/badges that recognize their achievements and help them showcase their skills to their professional profiles. This MCD platform component is designed to motivate students by granting them certificates (digitally verifiable credentials) for individual courses or for completing the entire MCD learning modules catalog as shown in Figure 4. The learners will be able to directly share the credentials to LinkedIn from the MCD platform in two ways: (i) open credential without verification ID, and (ii) credential with verification ID.

3 Conclusion

In this paper, we introduced the “Mizzou Cloud DevOps” (MCD) platform, a cutting-edge Learning Management System (LMS) that focuses on Cloud DevOps training and showcased the impact of its self-service learning capabilities. We presented the learning outcome evaluation features that can help Instructors to evaluate student progress using auto-grading of students’ technical assessments, as well as student engagement management and monitoring services. Lastly, we described how we recognize student accomplishments through digitally verifiable credentials such as badges and LinkedIn certificates. Our work thus provides insights on methods to not only assess students’ progress comprehensively in online cyberinfrastructure learning platforms, but also provide instructors with valuable data on curriculum effectiveness and learning platform usability/engagement.

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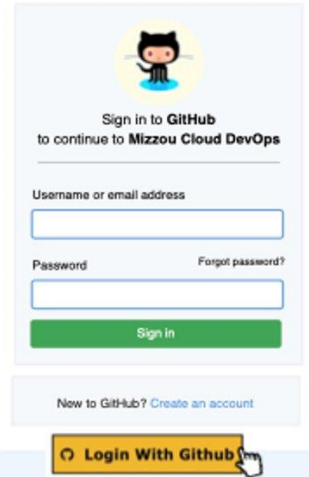
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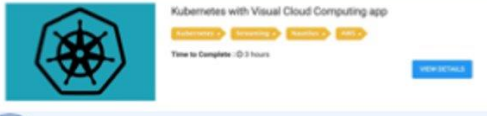
The Platform Overview

1. Join the platform through your GitHub account.
2. Learners can choose from a set of courses.
3. Learners can check progress of their work and return to their last progress.
4. The modules follow a progression of starting from introductions and basics for these technologies
5. Learners are able to implement a use case scenario.

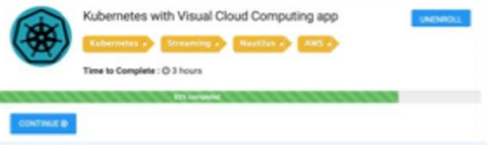
1 Join MCD Platform




2 Enroll in a specific course



3 Check progress and continue work




4 Follow chapter-wise instructions




5 Apply knowledge to use case

Image processing pipeline to investigate computation offloading



6 Visualize outputs and benefits

Example of moving object classification detection results



Instructors view of user access request









1. The instructors are able to view the list of students that are requesting access and grant them.
2. Description about the users are shown in the user requests panel
3. There are options for admin privileges or assigning roles.
4. Instructors can view the students accessing a course and have the option to remove a request.

neupaner@missouri.edu

Change Email

Email used for getting notified by users requesting access. Please enable access to mizzouclouddevops@gmail.com mail account for sending mails. [Click here to give access for Gmail](#)

User Requests (402 Users)

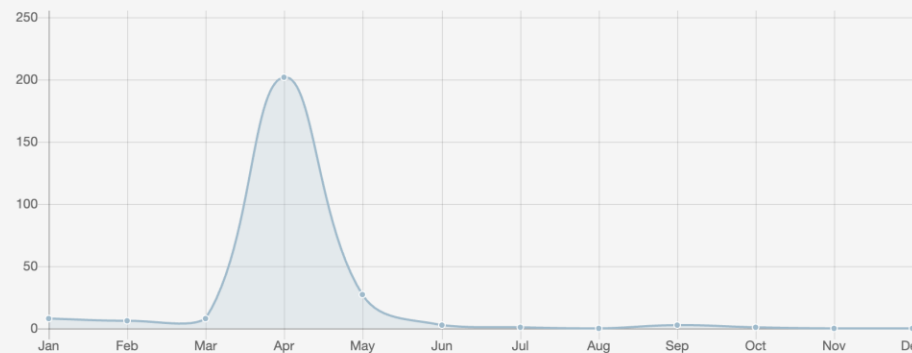
Name	Github Id	Role	Access Status	Action	Admin	Delete
varsha124	55065229	STUDENT	Y	Deny Access	Treat as Instructor	
rneupane93	14354357	STUDENT	Y	Deny Access	Treat as Instructor	
kngbq	88738210	INSTRUCTOR	Y	Deny Access	Treat as Student	
Ramya2902	54416870	STUDENT	Y	Deny Access	Treat as Instructor	
okjed	151675	STUDENT	Y	Deny Access	Treat as Instructor	
MiddelkoopT	5560008	STUDENT	Y	Deny Access	Treat as Instructor	
vasv	538648	STUDENT	Y	Deny Access	Treat as Instructor	
Neal-Hodges	91756360	STUDENT	Y	Deny Access	Treat as Instructor	

Descriptive statistics on the student enrollments – Instructor view

1. The status of student enrollment is shown.
2. Instructors can filter the visualization with the courses available and check the enrollment status.

Statistics For All Courses

Students enrollment



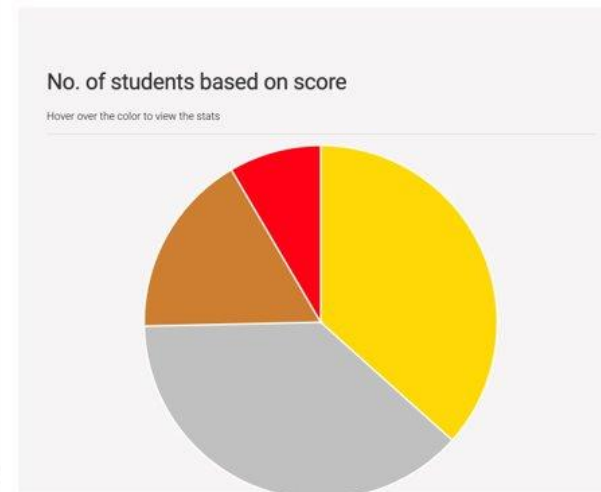
Course

Click on a course name to get the statistics













NAME	ENROLLMENTS
All Courses	660
Kubernetes with Visual Cloud Computing app	201
Software Defined Networking with Cyber Defense app	39
Edge Computing with KubeEdge	35
CI/CD with Jenkins with data-intensive web apps	97
VMWare Tanzu for Kubernetes Cluster Management	36
Ansible for Infrastructure as Code with Cybersecurity Ops app	64
Kubeflow on AWS with Smart	101

Knowledge Levels and Peer Ranking – Instructor view

1. Assessments are shown based on the class scores, student rankings.
2. Student averages for the assessments, their min-max and average
3. Student rankings are sorted through scores and there are awards assigned based on the Knowledge Growth Study



Peer ranking

Rank	Student's Name	Score	Awards
1	47carolines	100	 
2	AndrewGillisSoftware	100	 
3	Six2h	100	 
4	Trinath-Adusumilli	100	 
5	Itz-Darahas	100	 
6	Vivekthiparthi	100	 

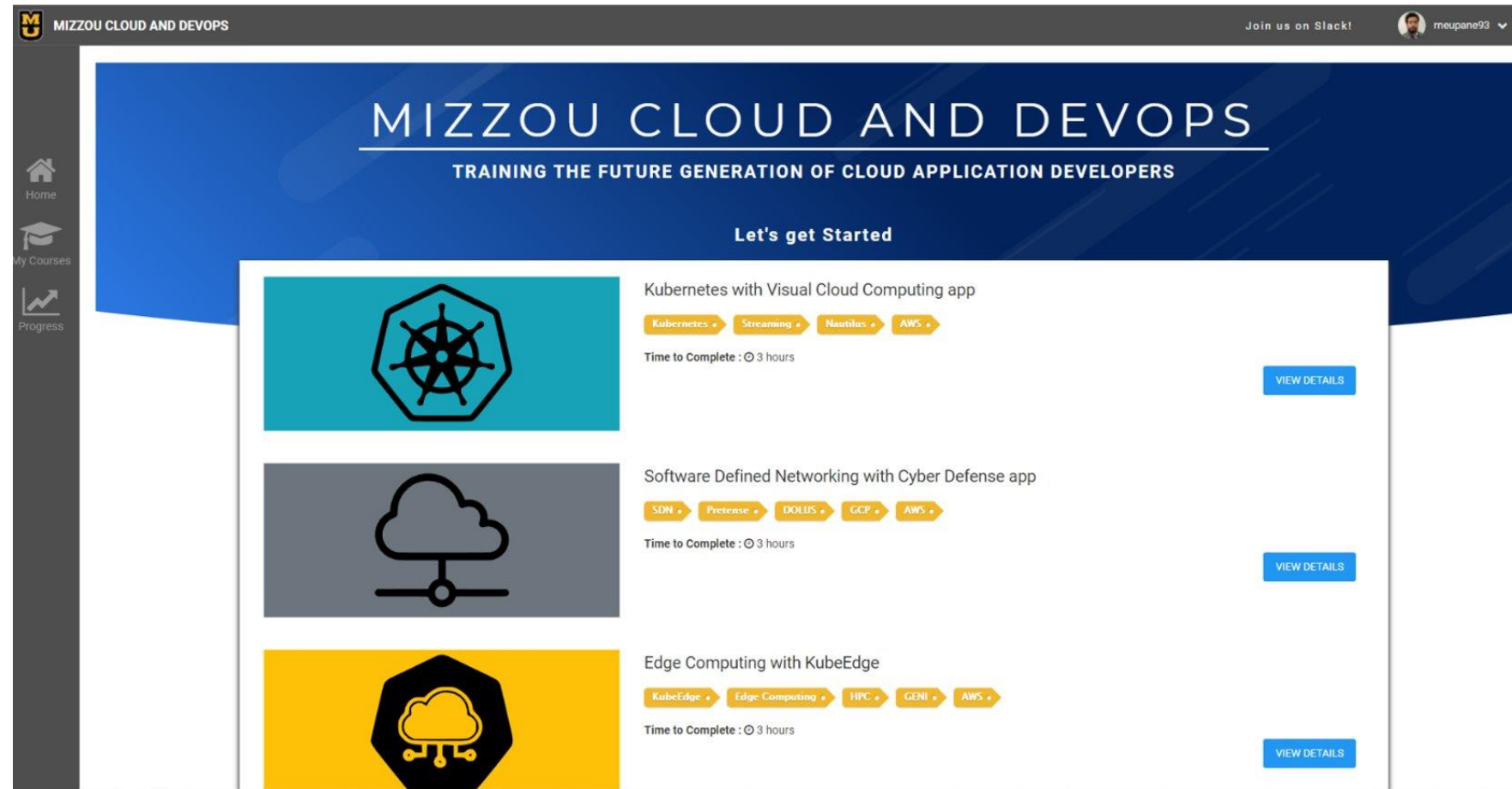
Student averages

This displays only when a particular course is selected

Assessment Completed	: 71
Highest Score	: 100
Average Score	: 75.35211267605634
Least Score	: 0

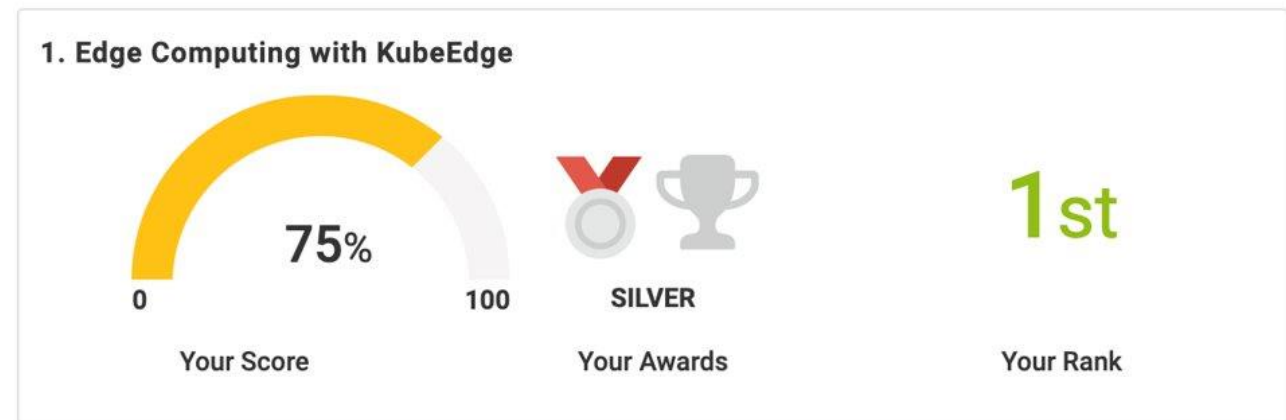
Student Home Page

1. Learners land into the listing page for the courses available in the LMS system.
2. There are diverse cloud and devops tools listed with Keywords that emphasize the learning outcomes.
3. Student can view details of the course that lands them in the upcoming page.



Student View - Course Catalogue

1. After the completion of the course, students can view their final scores in the 'Progress' page.
2. Their scores are shared as a percentile with Awards such as gold, silver, bronze assigning the Knowledge level and assessing Knowledge Growth.
3. Also, the individual rank is shown to the student only without publicizing.



Knowledge Levels – Student View

1. The gold standard mentions strategic knowledge about the course with contextual and conditional knowledge.
2. The silver standard mentions subject-specific skills and algorithms knowledge and ability to determine when to use appropriate procedures.
3. The bronze acknowledges the terminology, details and elements, principles and generalizations of theories, models, structures.



GOLD

- strategic knowledge
- knowledge on cognitive tasks including contextual and conditional knowledge
- self-knowledge



SILVER

- knowledge of subject-specific skills and algorithms
- knowledge of subject-specific techniques and methods
- knowledge of criteria for determining when to use appropriate procedures



BRONZE

- knowledge of terminology and knowledge of classifications and categories
- knowledge of specific details and elements
- knowledge of principles and generalizations
- knowledge of theories, models, and structures

Student Progress

1. Description about the Progress is shown in all the courses.
2. Learners can also assess their Knowledge Levels looking at the tiers that they are assigned.
3. These help assess the Knowledge Growth in students and provides directives for improvement.



Student assessment

1. Learners/Students complete the course and are directed to this assessment page.
2. The assessment consists of 3 pre-survey questions and 10 post-survey questions for determining the knowledge levels.

The screenshot shows a web interface for a course titled "MIZZOU CLOUD AND DEVOPS". The user is logged in as "kngbq". The course is "MODULE 5" and the current page is the "ASSESSMENT" for "VMWare Tanzu for Kubernetes Cluster Management". The assessment progress bar shows 10 questions, with the first question selected. The question is: "1. What command can be used to gather your management cluster status and information?". The options are:
☐ tanzu management-cluster list
☐ tanzu management-cluster load
☐ tanzu management-cluster info
☐ tanzu management-cluster get
A "NEXT" button is visible at the bottom right of the question area.

MIZZOU CLOUD AND DEVOPS

MY COURSE > MODULE 5

VMWare Tanzu for Kubernetes Cluster Management

GETTING STARTED LAB EXERCISE ASSESSMENT

1 2 3 4 5 6 7 8 9 10

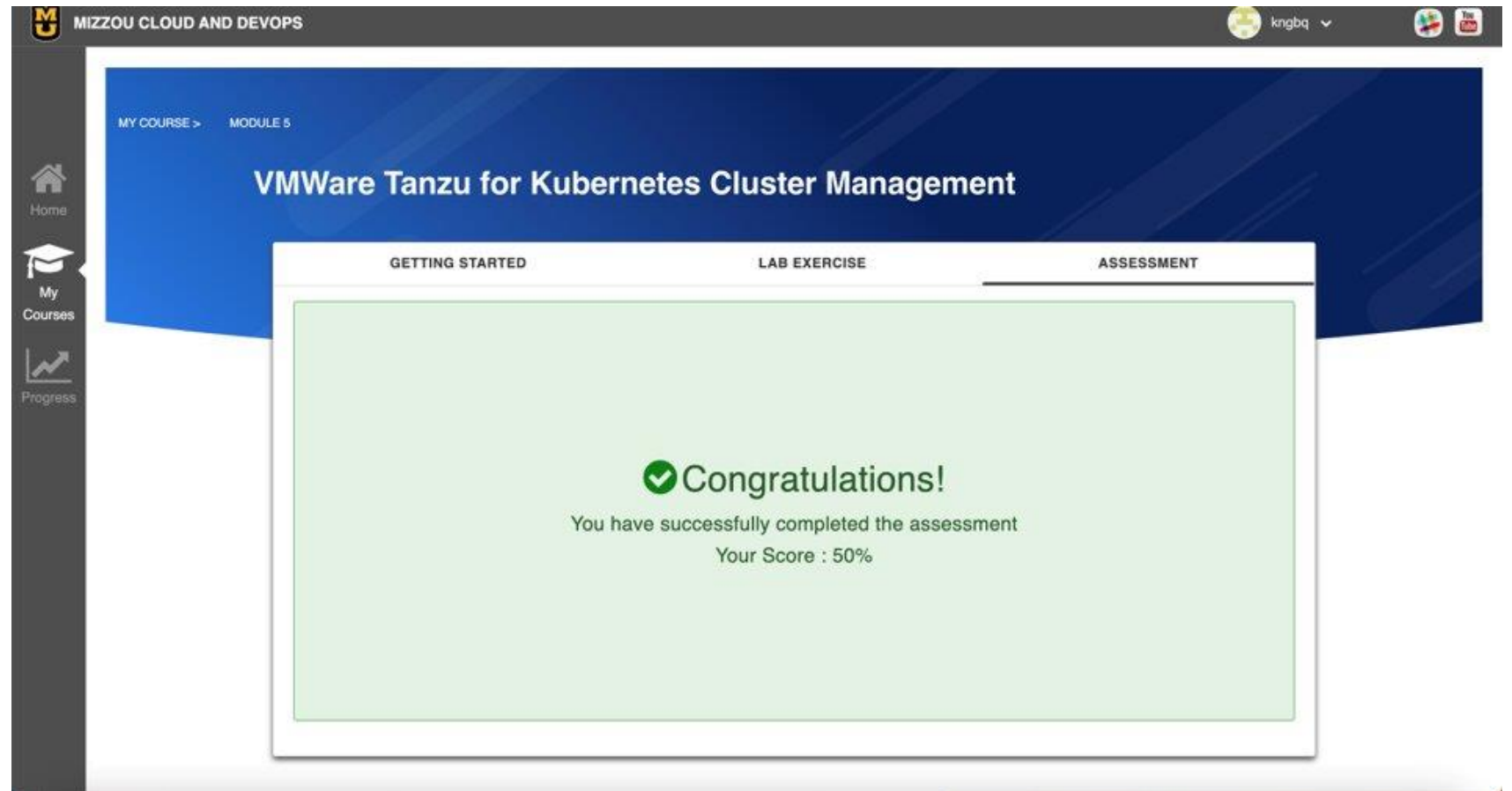
1. What command can be used to gather your management cluster status and information?

- ☐ tanzu management-cluster list
- ☐ tanzu management-cluster load
- ☐ tanzu management-cluster info
- ☐ tanzu management-cluster get

NEXT

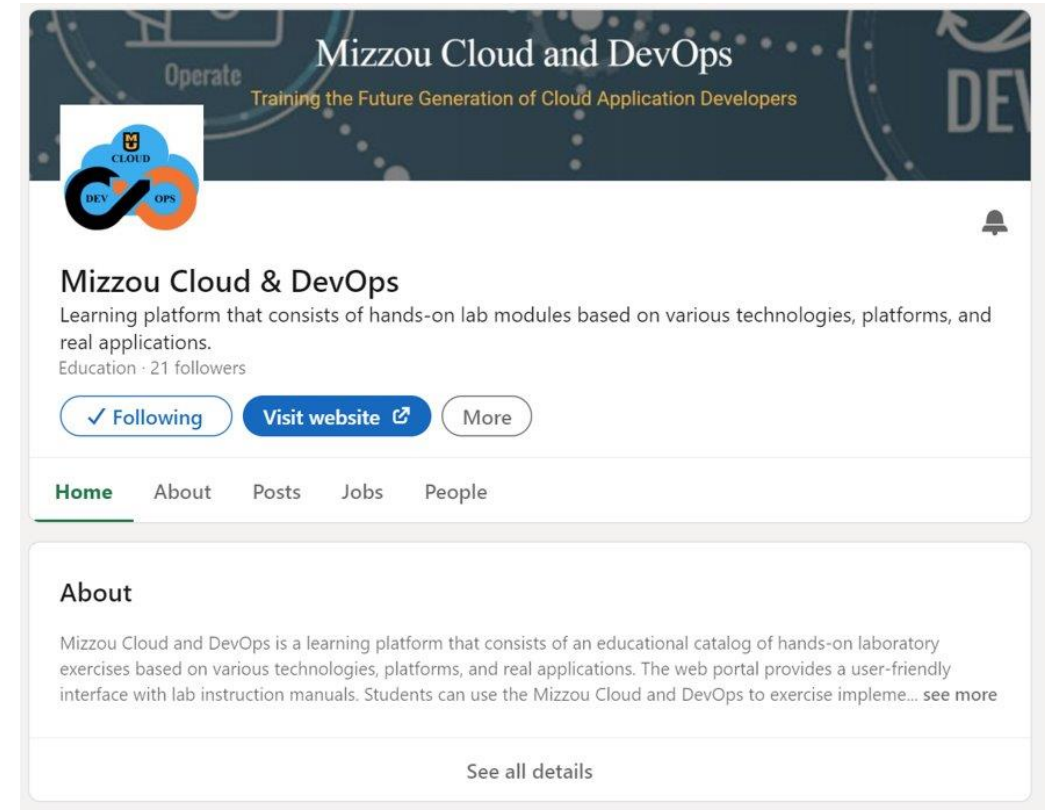
Student Course Completion

1. Students see the completion of the course after their post lab assessment is complete.
2. There are options for multiple enrollments in the same class or a different one.
3. Students can see their progress in the 'Progress' icon at the left vertical bar.



LinkedIn Integrations

- We have newly created a dedicated LinkedIn site for Mizzou Cloud & DevOps for improving the learner outreach
- We have integrated with LinkedIn for providing students credentials (certificates/badges) based on their lab completion using the portal
- Student can directly share the credentials to LinkedIn from the portal using the link given to post the credentials in 2 ways: (a) Open credential without verification id, and (b) Credential with verification id



Certification of Course Completion

Please enter the validation code found at the bottom right of the AWS certificate. Click submit to verify the certification. Verification information is displayed above this text. After viewing the verification information, you may continue to use this form to verify additional certificates as needed.

Validation Number

SBZW4

Type the code from the image

Submit

Example to show Certificate Validation by
CERI Center (similar to how AWS does)

