Implementing the AWS Academy curriculum into a cloud computing course

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Abstract: *Companies are moving towards the cloud more than ever, and startups are getting full support from cloud providers in terms of consulting and credits, with developers adopting new programming models shifting further away from traditional technologies. However, teaching cloud computing is still a major undertaking, as it is still difficult choosing the right tools, learning platforms, and creating curriculums to cover such a wide body of knowledge. One of the newest additions to teaching cloud is the AWS Academy curriculum and learner labs and long-running labs. In this paper, the results of implementing the AWS Academy with a hybrid model at Faculty of Technical Sciences are observed. Post-semester evaluation showed up that use of this initiative's resources can fully support an introductory course in cloud computing. However the proper adaptation is needed to fully utilise the platform and achieve the learning goals.*

Keywords: *AWS Academy; cloud computing; e-learning; teaching cloud*

1. INTRODUCTION

Cloud computing is a paradigm with significant impact on today's global market. Grand View Research published that "the global cloud computing market size was valued at USD 368.97 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 15.7% from 2022 to 2030. [1]". The need for scalable, robust and measurable service and rise of machine learning and artificial intelligence has led to increased interest in cloud models. This trend is further coupled with the urge for skilled work-force and therefore for education in the field.

A decade ago it was argued that cloud computing should be taught on a graduate level [X], but having the cloud concept intertwined with basically all other information technology features (databases, security, Internet of Things), "descended" cloud computing to undergraduate level.

A major education tool for teaching cloud computing is - the cloud platform itself. Providing a platform where the concepts can be implemented and tested is of essential importance. Moreover, having hands-on experience on a specific platform can be a solid ground for future jobs, such as DevOps and in the software industry in general. Major cloud players provide various ways of cooperation with the academy. It is also in their interest to help in training for their platform. Therefore, various academic initiatives emerged, such as Microsoft Learn for Educators [2], Google Cloud Career Readiness Program [3] and AWS Academy [4]. These programs provide educators and students with teaching resources, including the access to cloud platforms and a number of its services.

This paper deals with use of the AWS Academy platform in an undergraduate cloud computing course at Faculty of Technical Sciences Čačak. The faculty became a member of AWS Academy initiative and incorporated the AWS Academy platform and its resources into the cloud computing course. More specifically, the online course "Cloud fundamentals", which corresponds to the AWS Practitioner certificate, is positioned as a core hands-on course segment. The goal of the paper is to examine how the AWS Academy platform and its online resources were used during the course, from the student's perspective and to evaluate if this hybrid approach has helped in achieving learning goals and outcomes.

The structure of the paper is as follows. The related work is analysed, then the methodology is presented, the data is analysed and the results are shown. The conclusion and recommendations are closing the paper.

2. RELATED WORK

Introduction of cloud computing into undergraduate courses was discussed by Sommervile [5]. Author argued that the practical work should be focused on PaaS.

Authors stated project-work, using available cloud platforms as a core component in [6]. However, they emphasised the importance of keeping general concepts, which are independent from specific platforms.

Authors in [7] expressed the concern for hands-on, lab activities, as the cloud providers offered a modest capacity for education use. They proposed a multi-cloud syllabus, involving various commercial cloud platforms, and also OpenStack.

Authors described a design and pilot implementation of the DevOps and Cloud based Software Development curricula for Computer Science and Software Engineering masters [8]. They emphasised the need for qualified students in this area who are familiar with major cloud platforms.

Use of Amazon's AWS Educate in cloud computing courses is analysed in [9]. This research showed up that this concept of cloud resources provisioning was an effective resource in developing an environment to teach cloud computing for most labs.

3. COURSE DESIGN

The subject Cloud computing at Faculty of Technical Sciences in Čačak is an elective subject for undergraduate students of the IT study program. It is set with a workload of 6 ECTS. Students are introduced with theoretical concepts of cloud computing from two points: mostly as a cloud service user (IaaS, PaaS, SaaS model), but also as a cloud provider (data centre design, virtualization, cloud-native paradigms). The first point presumes introduction with commercial platforms. Although various platforms are mentioned and referred to, the focus is on AWS, for multiple reasons. First of all, AWS is a dominant cloud platform and familiarity with its services can provide benefits to the future students' professional development. Also, the academic support for AWS turned out to be very rich, equipping students and teachers with learning resources and, most importantly, with cloud services' access. Certainly, the students are aware of other options, such as Microsoft Azure or Google Cloud and of specific features these providers give.

3.1. AWS Academy

Amazon has a certain tradition in supporting academia. AWS Educate was an initiative providing academia with online access to a subset of AWS services. Students of registered education institutions got 100$ of credit by default, for free. This facilitated the way students could previously use AWS resources, when a credit card was required to claim for free credit (and would get charged eventually, after the limit is reached). This creates issues with students forgetting to terminate their cloud resources. Students would either exceed the "free tier" limitations and get charged or would leave resources in a running state and once the free tier expires, one year after the account creation, the students would get billed. In most cases, AWS drops these charges after contacting their support

and explaining how the charges were incurred. AWS Educate eliminates part of this problem as charges on this platform can't occur, however, it does not solve the issue of students leaving resources in a running state or overprovisioning certain resources and burning through the assigned credit limit. AWS Educate is now open for students outside of academia as well, to individuals, no matter where they are in their education, technical experience, or career journey.

AWS academy is the next step in the evolution of Amazon-academia collaboration. An educational institution applies for the AWS academy status and goes through an interview and onboarding process. Then it is possible to use AWS resources for teaching. AWS provides access to their Academy (Canvas) platform and a set of courses with a complete curriculum, course outline, instructor guideline, videos, student guides, labs, knowledge checks, and a sandbox environment for experimenting. Labs are time limited and have predefined instructions for each lab depending on the course module that the lab is in. There are also long-running labs provided in a special Academy Learner Lab where students can experiment and create environments using cloud resources without the standard 3-hour sandbox environment limit. Instructors can get AWS badges for their qualifications and complete AWS Educator training. This includes students as well, when they successfully complete all knowledge checks, they will get an AWS badge and a significant discount on their next AWS certification exam. Courses are frequently updated by AWS to keep up with the changes with services, as well as UI changes. AWS organises live events and webinars aimed at Educators and helping them teach AWS. Each course has an educator version that aims to help educators prepare to teach those courses. There is a wide variety of courses available, from introductory to more advanced ones:

- Cloud Foundations,
- Cloud Operations,
- Cloud Developing,
- Cloud Architecting,
- Data Analytics,
- Machine Learning Foundations,
- Learner lab - Foundational services,
- Learner lab - Associate services.

AWS Academy supports several languages, but not Serbian. This poses an additional challenge for teaching, as students have to consume materials presented in English. Certain materials prepared by the teaching staff were available in Serbian, however, translating the entire available teaching material would consume too much time and would be difficult to keep up to date over time.

Having experience with both AWS Academy and AWS Educate, in an academic setting, proves AWS Academy as a suitable environment for teaching

students. While some labs may be considered too simple, custom labs can always be implemented using the sandbox environment and additional work can be assigned to students. AWS predefined labs save time by creating and setting up an environment for that module specifically, leaving out the manual initial setup of the environment and getting straight to the point.

Depending on the students' backgrounds, some written materials provided by AWS Academy may require further clarification or a stronger background in the subject at hand. This is where the hybrid model comes in, allowing the implementation of exercises and materials outside of the scope of AWS Academy, covering the prerequisites and providing further insight into certain modules.

For example, the security module demonstrates AWS Identity Access Management and explains the Shared Responsibility Model, focusing on securing the AWS side of the environment. It should be expanded into general security guidance for operating systems, firewalls, applications, etc. in order to create a complete picture and a security conscience.

4. DATA COLLECTING AND ANALYSIS

The data was collected using a questionnaire tool, implemented in the Moodle course. It is noted that the students in general do not like taking part in surveys, therefore we kept the questionnaire brief. There were 5 items with Likert 5-points scale for gathering feedback on use of AWS Academy in context of the course and its learning goals, one item (same Likert scale) related to the use of specific resources, two multiple choice items regarding certification and DevOps profession and one optional open-ended question. The full questionnaire is given in the Appendix. Total of 14 students responded, that is virtually all students active in the course.

The feedback was collected after the semester was over, from 7th June 2022 until 20th June 2022.

The descriptive statistics for the first 5 questions are presented in Table 1.

Questionnaire

1. AWS Academy enabled access to cloud computing services helped me to understand theory concepts of cloud computing.
2. Tests provided in the AWS Academy course helped me in consolidating learning.
3. Practical assignments on AWS Academy platform are on the appropriate level of difficulty
4. I did not have technical problems with AWS services available through AWS Academy.
5. Experience of working with cloud services available via AWS Academy, will help me in professional work.

6. Please indicate the level of use of particular resources (assigning 1-5)
   a. Video-clips
   b. Lab-assignments
   c. Test
   d. Pdf materials
   e. Sandbox environment
7. Do you plan to apply for a certification exam (AWS Cloud Practitioner)? (yes/no/note sure)
8. DevOps and Cloud engineer are vocations I am interested in. (yes/no/not sure)
9. Enter your observations regarding the AWS Academy platform: what suits you best, what could be improved with the platform and its use (optional, open question).

Table 1. *Statistics for leading 5 questions*

	Q1	Q2	Q3	Q4	Q5
Mean	4,571	3,714	4,643	4,214	4
St. Error	0,173	0,339	0,133	0,214	0,234
Median	5	4	5	4	4
Mode	5	4	5	5	5
Std. Dev.	0,646	1,267	0,497	0,802	0,877
Sam. var.	0,418	1,604	0,248	0,643	0,769
Kurtosis	0,951	1,725	-1,84	-1,23	-1,77
Skewness	-1,30	-1,49	-0,67	-0,44	0

This first group of items is directly related to the potential benefits of using AWS Academy. Tests (knowledge checks) are found to be least useful. These are available on the AWS platform (Canvas) for each unit and students are directed to solve these in order to assess their own knowledge and prepare for certificates. The least interest in tests is confirmed in the next item, where students indicated which resources, they found most useful. Video-lessons and the sandbox environment are indicated as most useful. Pdf-materials are also found as not very interesting for students.

The results for the 6th item are shown in Table 2.

These answers fit the model of the course, as in this hybrid setting, resources are provided beside the platform and the most useful (and necessary) feature is access to the very AWS platform and services. The resources given on the AWS academy course are tailored to match the requirements for achieving a certificate, therefore if the students' focus is on the course Cloud computing, they might neglect specific details related to the certification.

Table 2. *Questionnaire results for the 6th item*

Answers	1	2	3	4	5
Video lessons	14%	14%	29%	7%	36%
Lab-assignments	7%	14%	14%	50%	14%
Test	14%	57%	29%	0%	0%
pdf	36%	7%	21%	21%	14%
Sandbox	29%	7%	7%	21%	36%

Students get a 50% discount for first level certificates (AWS Cloud Practitioner). It is a great opportunity to gain added value from this course. However, out of 14 respondents, 4 (29%) are planning to apply for the Practitioner certificate, one does not and 9 (64%) are not sure yet. This data is fully aligned with the previous discussion on students' focus.

The last mandatory item was related to the profession plans. Even 71% (10 students) are not sure if they want to work as a DevOps/Cloud engineer and 3 students responded they see themselves in this position.

The last item was open-ended and optional and served as a qualitative input for improvement of the subject. Total of 5 students gave their inputs here. The AWS Academy platform is labelled as well organised, with easy practical assignments, which could be leveraged to the next level of complexity.

5. CONCLUSION

Delivering a Cloud computing course is virtually impossible without wide access to the commercial providers' services. On the other hand, these providers also have interest in promoting their platforms. AWS Academy is a serious project bonding academy and AWS. Although the courses provided in AWS Academy are primarily set as preparation for the certification, these can also be incorporated in the hybrid teaching model. Also, it showed up as more efficient, flexible and overall useful than the previous initiative, called AWS Educate.

It showed up that students were mostly satisfied with the AWS Academy platform and its features.

The least used were documents and tests. Educators should pay attention to this indicator and possibly provide a separate way of knowledge check, for students' self-evaluation. On the other hand, for students interested in certification, it is important to keep up with the authentic resources available on the AWS Academy platform. Also, as the certification exam is in English, it is not suitable to translate tests and bring in the confusion related to the terms and language.

As this is the first time the AWS Academy is used in such a way (and this means also globally, since this platform is just set up this year), it can be concluded it is a good basis for cloud computing introductory courses. With the predefined lab assignments and sandbox environment it is possible to create additional lab-assignments and projects. The availability of different cloud services is sufficient to cover all important aspects of the cloud computing course and facilitate students' individual learning, but also make their way to the industry recognized certification much easier.

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