Type of the Paper (Article)

Enhancing Student Employability in Cloud Computing Through Industry Collaboration: A Case Study with AWS Academy

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Abstract: The continuous increase in tuition fees in university education in many countries requires justification by the university authorities through improved learning resources that can guarantee employment opportunities for the students through hands-on industry training. This paper describes the design of curriculum of cloud computing module in collaboration with Amazon Web Services (AWS) Academy to include industry-based practical hands-on labs in the curriculum to improve the employability of Internet of Things (IoT) engineering students. This study introduces industry best practices and hands-on labs in cloud computing and discovered that students' understanding and learning experience in the subject increase when exposed to real-life applications. The study blends academic theories in cloud computing with their applications as obtained in industry to enable students to have both the theoretical and practical skills that will prepare them for careers in cloud computing. To achieve this, cloud computing lecturers were trained by AWS Academy as a prerequisite to ensure that the tutors themselves acquire hands-on proficiency in cloud computing technologies. The study finds that students tend to be more engaged and learn better when academic theories and concepts are combined with real-world applications as obtained in the industry.

Keywords: Amazon Web Services Academy; Cloud computing; Employability.

1. Introduction

The investments in education by governments, parents and the industry keep increasing to ensure that high quality education is given to students. This effort is more visible in disruptive and fast changing engineering and science disciplines [1-3]. Cloud computing, Internet of Things (IoT) and telecommunication technologies are some key disciplines that are witnessing substantial interest in investments due to their economic potentials. Thus, encouraging universities to include in their curriculums knowledge that offers skills that improve employability of students after graduation [4][5][6]. A pedagogical approach that links knowledge with practical competence is what employers are looking for in graduates of universities [7]. This is more so in technologically disruptive disciplines such as cloud computing and IoT as the curriculum needs to be constantly updated to meet current engineering and technological requirements of the industry [5]. The author collaborated with AWS Academy to design the curriculum of cloud computing module that incorporates latest cloud technologies lecture materials and labs [8]. In most science and engineering disciplines, it is important to blend face-to-face classroom lectures with digital interactions to improve the digital skills of the students as they embark on real-world work experiences [9][10]. For example, in cloud computing work place, almost 70% of the skills required in technical areas are based on virtual resources that have to deal with purely digital interfaces [10][11][12][13]. Engineering and technology related subjects are better learned with greater results in terms of knowledge and application of the knowledge in real-life situations through creating and making artefacts and prototypes during the learning and teaching process [14]. AWS Academy provides

e-learning resources in the form of lecture materials, videos, labs and assessments in their learning management system (LMS) that is used in cloud computing industry [8][15-18][20-21].

The success of including industry hands-on skills in any university curriculum depends on how well defined the skills set requirements are generated and the sources from which they emerged [22-26].

2. Materials and Methods

In designing the curriculum of a module of a degree program, it is important to consult the vision and mission statements of the university in addition to the core topics that are taught in similar modules by other universities. In this study, Queen Mary University of London (QMUL) has an established Teaching Excellence Framework (TEF) and strategic aims [27]. There are six main aims under the QMUL strategy namely people, research, education, international, public engagement and sustainability. Of these six strategic aims, the ones that fit into QMUL's collaboration with AWS Academy are people, education, public engagement and sustainability. QMUL's aim for people means recruiting staff and students with great talents and potentials and nurturing these talents for greater and successful careers. This paper concentrated on identifying the talents and potentials of students and using the AWS Academy to nurture their future careers through hands-on practical skills that will make them readily employable. To provide quality education, state-of-the-art technology in cloud computing are adopted using the AWS Academy LMS, which is the most widely used cloud platform and largest cloud provider in the world [21]. There are three labs designed to test students' understanding of virtualization, scalability, availability, big data, data analytics and monitoring systems in cloud computing environments. These labs bring the theoretical classroom lectures to hands-on practical implementation and enable students to better understand the theoretical concepts as applied in real-life. The labs and the test on the labs constitute 25% of the total exam marks.

On QMUL's international and public engagement, the author engaged AWS to help deliver world-class industry-based lectures using videos and assessments in a face-to-face classroom lectures as well as using AWS and QMUL's online LMS platforms. The study looked at similar curricula taught in cloud computing in other universities around the world. In most cases, there are three main areas covered in the documents the author consulted. These are core distributed topics such as scalability, computer cluster, data center design, virtualization, MapReduce/Hadoop and big data/data analytics. Figure 1 shows the key cloud computing professions linked to the skills and pre-requisites that students need to obtain to be successful in such professions. This is a concept that provided students with a roadmap in their journey towards employment after graduation. This maps each professional career path to skills requirements and how to acquire those skills. The professional career paths in cloud computing are so many that this study cannot exhaust the list in a diagrammatical form, but only presented the most popular career paths in this paper. Figure 1 shows popular professional paths in cloud computing that the study emphasized in teaching for employability [28][29][30].

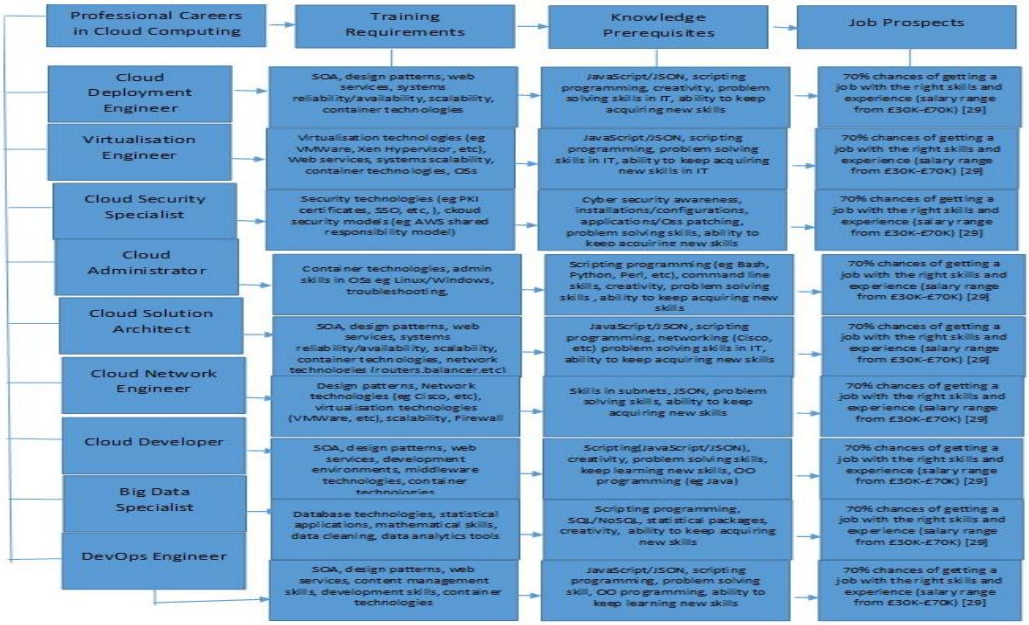

Figure 1. Career Paths and Skills Requirements in Cloud Computing.

The study observed that the common requirements for all the professional paths are creativity, problem solving skills and ability to keep acquiring new skills. These common attributes are emphasized during teaching as cloud computing is constantly evolving. By doing this, the students are already thinking of what they want to do after graduation. In addition, there is a logical justification for the increase in tuition fees as the students have a better understanding of the earnings they may expect in the future.

AWS Academy has put in place criteria for any university to use their teaching and learning materials. The first stage is the registration of the lecturer(s) into the AWS Academy Cloud Foundations (ACF) programme. The author registered for the course and spent about 12 weeks studying the lecture materials. After feeling confident with the materials and hands-on practical labs, the author registered for the AWS Certified Cloud Practitioner practice exam using AWS free voucher. In the first attempt, the author got 92% out of 100% in the practice exam. Using the 50% discount AWS voucher for the exam, the author took the exam and passed and immediately registered QMUL as an accredited AWS Academy. Having gone through the certification training themselves, lecturers not only have the confidence in delivering lectures and labs to their students, but have the confidence of their students as they display their certification qualification and logos. This is similar to the recommendation that UK university lecturers need to acquire the Fellowship of Higher Education Academy (FHEA) qualifications as an indication of their proficiency in learning and teaching. This also justifies the increase in tuition fees as it will be seen by parents and students that the university only recruits academically and professionally qualified lecturers which is an indication of the quality of education they are providing to the students.

The next stage is choosing the AWS teaching and lab materials to be included into the curriculum of cloud computing module. To do this, a survey on the most important skills that are needed in cloud computing was carried out. Based on the outcome of this survey, at least 70% of respondents said that practical hands-on implementation of cloud solutions is what industries are looking for in cloud computing graduates. These areas included administration and management of Elastic Compute Cloud (EC2) instances, cloud network skills, cloud security, scalability and load. These areas in AWS Academy were included into the lecture slides and labs and about 25% of the examination questions and coursework that final year IoT Engineering students took were taken from the AWS materials that were included into the curriculum. This proved to be effective in the examination results as there was an improvement of about 3% in the passing rate and reduction of 2% in failure rate in cloud computing exam as compared to the results of the previous year (2017/18).

The AWS Academy LMS has an area where digital certificates are stored when any student or instructor writes any of the certification exams and passed. This makes the students not only to think about the training, but also the certifications that will lead to a potential future career in cloud computing. Cloud computing module at QMUL consists of 3 labs and 1 test as part of the coursework. The coursework constitutes 25% of the total marks while the final exam is 75%.

In addition to using QMPlus, the AWS Academy LMS is used for teaching, conducting assessments and labs. Because QMUL is an accredited AWS Academy, a dedicated virtual classroom and labs have been created for QMUL lecturers and students. The lecturer, who must be an AWS Certified professional, is given administrative privileges to activate and deactivate classrooms and labs and can view the progress of students on the lecture materials, videos and labs. The students can register in a class or lab using their QMUL's email addresses only. Over 174 QMUL students were registered for the AWS Cloud Foundations course.

AWS Cloud Foundations has five modules with corresponding five labs and additional one lab with titles starting with ACF Lab 1 to ACF Lab 6 as shown in Figure 2. Each lab lasts for two hours. AWS Academy issues students with credits (valued in US dollars) that allow them to do the labs.

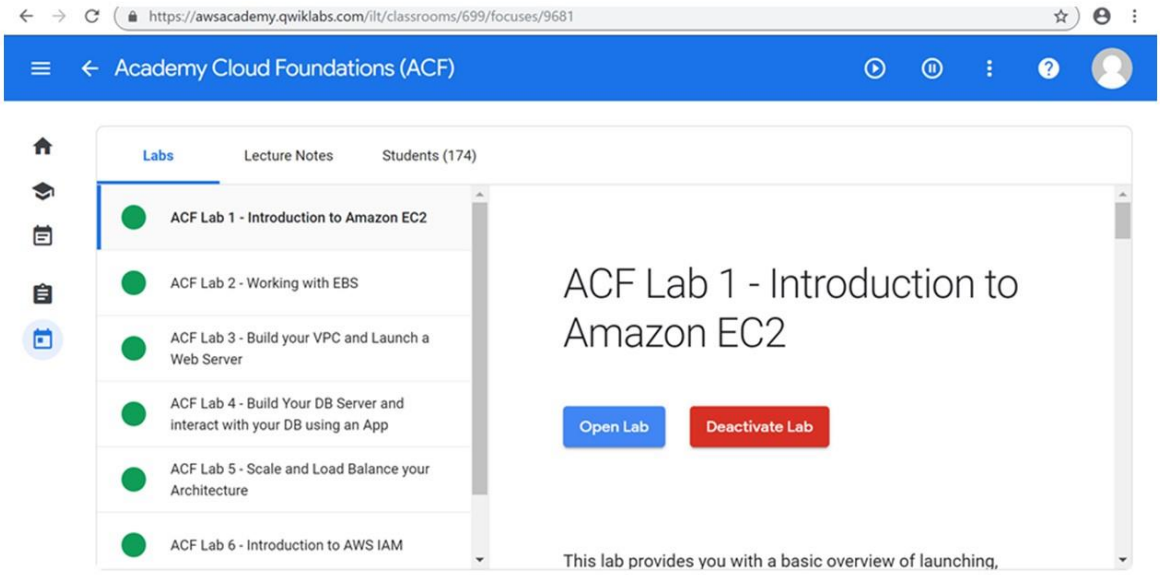

Figure 2. AWS Academy Cloud Foundations Virtual Labs for QMUL Lecturers and Students [8].

The labs are customized in a way that the instructions that the students need to follow to do the labs are presented on one tab and the actual labs in another tab that are completely on separate web pages. This makes navigating between the two web pages sometimes problematic. To get around this problem, this study developed a simple script that calls the application programming interfaces (APIs) of these two web pages and present them as one web page with the instructions on the left side and the labs on the right side, This innovation has improved the ease of use and reduce the time normally taken to finish the labs by 10%.

The cloud computing labs have been going for the past five years now. When the module was created in 2014, the lecturers were using physical servers that Teaching Assistants (TAs) need to install open source software for the students to do their labs. This usually takes long time and most of the OSSs always need upgrades. But with the adoption of the AWS ACF platform, there are no more issues with updates or upgrades of software or hardware and this has saved 50% of the time usually spent on installations and udates. In addition, students do not need to come to the physical labs to do their labs, but can do it anywhere they have access to the internet.

The idea of introducing industry hands-on practical skills and best practices of the state-of-art in cloud computing into the academic curriculum is to make students at QMUL stand out in the crowded global labor market from students that just acquire theoretical knowledge. Apart from

keeping up with the fast changing technologies, collaborating with the world's largest provider of cloud computing services and using their materials to teach students not only justifies the increase in tuition fees, but gave the students the confidence they need to go out there and start working without any experience. The first confidence boost comes from the fact that the lecturers/tutors that are teaching the students have themselves gone through training by AWS Academy. Passing the exams means the lecturers know the theories as well as the practical applications as the labs are tailored to be hands-on to complement the theoretical lectures. During lectures, the professional certification and some key professional paths as created by AWS Academy are emphasized to create that awareness of employability routes in the students' minds as shown in Figure 3.

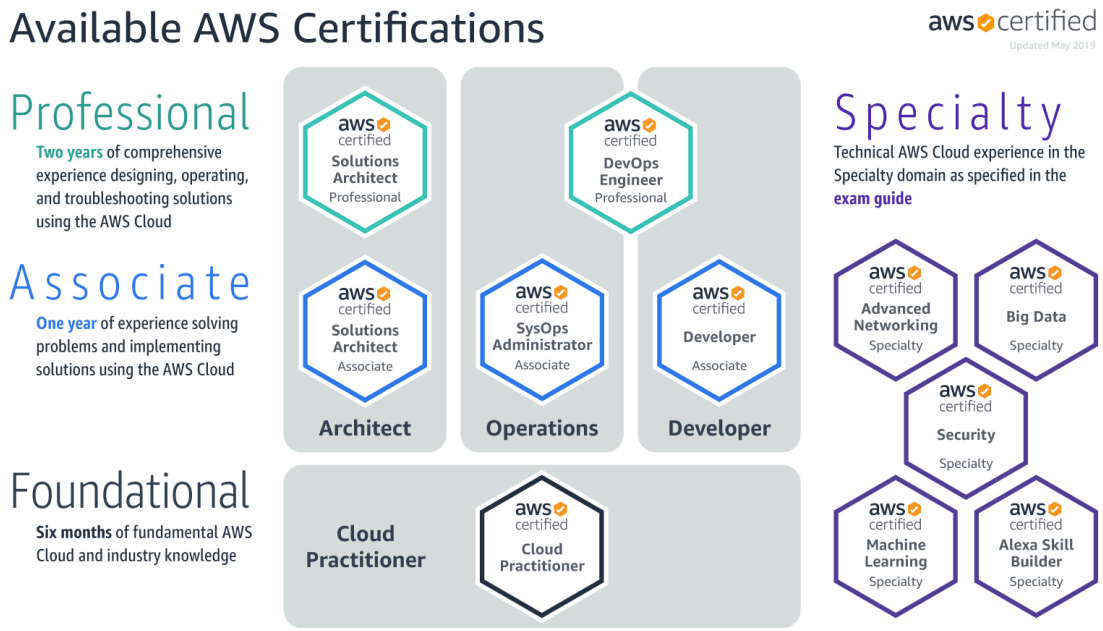

Figure 3. Amazon AWS Certification and Career Routes [8].

AWS ACF is the training that helps the students prepare to take the AWS Certified Cloud Practitioner examination. This is the foundational certification that serves as the prerequisite for other higher certifications. The other certifications after passing this foundational exam as shown in Figure 4 are the associate level AWS Certified Solution Architect, AWS Certified Developer and AWS Certified SysOps Administrator certifications. At the professional level, there are the AWS Certified DevOps Engineer and AWS Certified Solutions Architect certifications. Others at the specialty level include AWS certifications in Advanced Networking, Big Data, Security, Machine Learning and Alexa Skill Builder. These certification routes are emphasized to the students and the skills required with incentives and remunerations enjoyed by these professionals that work for AWS and other companies. The idea is to prepare and stimulate the students' ambitions towards getting those jobs of their dreams by combining both academic and professional qualifications. With the inclusion of 25% of the lecture materials and two out of the six labs of AWS ACF into the cloud computing curriculum, the students already have about 25% of training in the AWS Certified Cloud Practitioner exam materials. However, this is not sufficient enough for the students to pass this exam. To ensure that the students are trained to the level that they can obtain the certificate of course completion as well as to be able to confidently sit for the AWS Certified Cloud Practitioner exam, the author arranged extra training sessions for the students, which is completely outside the normal teaching and learning requirements of the university. This is necessary if students must acquire both academic and professional knowledge and skills in technology-driven qualifications that will earn them certifications in different professional paths. The extra time put in paid off as the students appreciated it and this effort endeared the lecturer to the students as they have more confidence in him.

When students complete the AWS ACF training, they automatically receive electronic certificates of completion sent to them in the transcript area of AWS LMS. The satisfaction of getting a certificate from the biggest cloud services provider in the world gave the students additional satisfaction and the urge to go ahead and write the practice and final exams. At the end of the training, about 18% (30 out of 163) of the students registered their interest to be given the free AWS Academy vouchers to write the AWS Certified Cloud Practitioner practice exam. All the 20 students that wrote this exam passed. This performance further justifies the efforts put into the training and goes a long way in making the students to appreciate the increase in tuition fees. This gave the lecturer the confidence to recommend the students for internship positions with Alibaba Cloud and other tech companies. The recommendation for the internship is meant to give the students the opportunity to put into practice the skills they have acquired and also to prepare them for real-life professional careers in the future.

3. Results

The inclusion of AWS Academy Cloud Foundations in the curriculum of Cloud Computing module had a positive impact in the performance of the students as shown in the results of the examination. The final marks for the exam consists of three parts-the examination, labs and class test. The examination constitutes 75% and the labs and test constitute 25%. A total of 166 students wrote the exam and 90.80% passed the exam and only 9.20% failed. Of this result, 42.94% got distinctions (A grades). Because this is the first time that AWS materials were introduced into the cloud computing curriculum, this study conducted a comparative analysis of the performance with the two previous years' results. Fig. 4 shows the results of this comparison. From Fig. 4, more students (42.94%) got grades A (distinctions) in 2018/19 academic year than the two previous academic years 2017/18 (32,32%) and 2016/17 (7.4%) respectively. The results also showed that the failure rate in 2018/19 reduced to 9.20% compared to the two previous years which had 11.59% and 18.60% failure rates for 2017/18 and 2016/17 academic years respectively. The improvement in performance and reduction in the rate of failure in the module is attributed to the fact that the students now have both the theoretical and hands-on practical real-life applications. This study and other studies show that students can easily relate exam questions to what they have done in the labs and the real-life scenarios and can easily remember the answers in an examination situation [31.

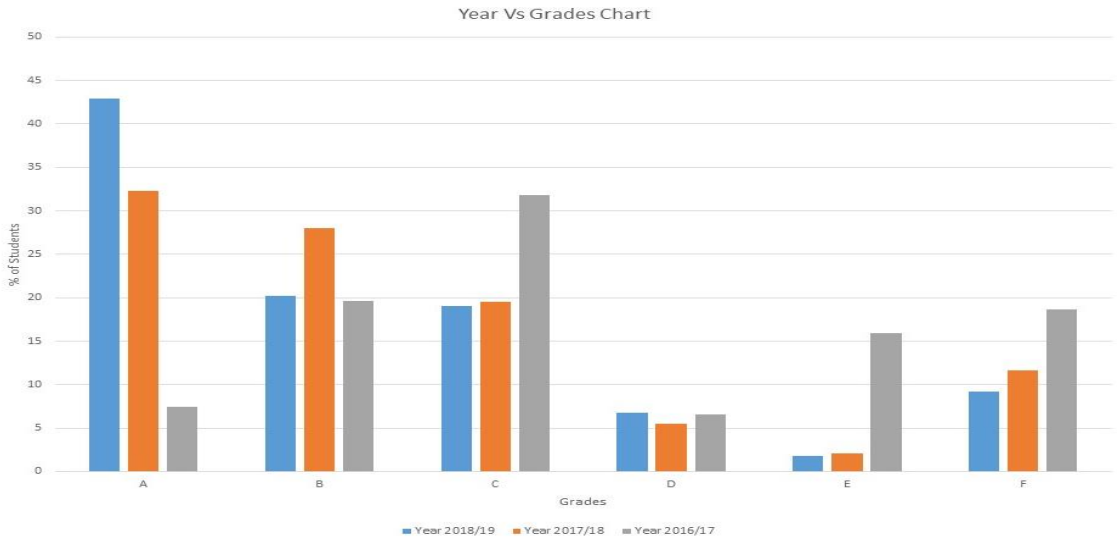

Figure 4. A Comparison Chart of 3 Years Results of Cloud Computing Module.

Two questionnaires were administered to students when the AWS Academy Cloud Foundations was introduced in the 2018/19 academic year. The first was issued to students using the SurveyMonkey online questionnaire platform and the other was a manual paper type of

questionnaire. The first questionnaire was designed and issued immediately after the lectures and labs in cloud computing module. This questionnaire aims at finding the opinions of students on the inclusion of the AWS course into the cloud computing curriculum and whether the students will be interested in completing all the course materials so that it can enable them to prepare and write the AWS Certified Cloud Practitioner exam. Out of the 166 students that were sent the survey via their email addresses, 58% responded to the questionnaire. This is quite good, but it took time to achieve this through constant reminder to the students to complete the questionnaire. From the respondents, 83% of the students think that the inclusion of AWS course into the curriculum of cloud computing has increased their learning experience and also enhanced their understanding of the module while 45% said that they now know the career paths to take in cloud computing. 72% of the students want more of the AWS contents included in the cloud computing module and because of this 43% said that they will like to attend the additional AWS lectures and labs after their exams so that they will be able to prepare for the AWS Certified Cloud Practitioner exam. Because AWS Academy has offered 100% discount to all the students that want to take the practice exam (not the actual final exam), 38% of the students said they want to write the practice certification examination.

The second questionnaire was administered after the students have written their cloud computing module exam. After the exam, the remainder of the AWS materials that were not included in the cloud computing curriculum and were not taught to the students were delivered to students that opted to attend all AWS lectures so that they can acquire the knowledge that will enable them to write the AWS Certified Cloud Practitioner exam. This questionnaire as stated earlier was a manual paper-based format and administered to only the 30 students that attended the extra AWS Academy Cloud Foundations lectures. As expected, there was 100% response as the questionnaires were distributed immediately on the last day of the one week (5 days) extra lectures. The students filled in the questionnaires and submitted to the tutor that same day in form of a feedback. There were also 10 questions as in the SurveyMonkey online questionnaire. 80% of the respondents said they are now more confident in using cloud computing resources and technologies after attending the all AWS lectures and another 83% said they now know more about cloud computing career paths. 90% of the respondents said they would like to write the final AWS Certified Cloud Practitioner exam if they passed the practice exam. A question on the justification of increase in tuition fees featured and 70% of the students said that if most courses can include hands-on practical and professional contents that enhances the quality of the education which improves their confidence and employability, then the increase in tuition fees is justifiable. 90% of the students said they would like to be recommended for internship where they can put what they have learnt in the AWS training into practices and 85% of them think that cloud computing has a very promising future for students that can acquire cutting edge training in cloud computing.

4. Discussion

The results as shown in the questionnaires and examination performances for three years as shown in Fig. 4, clearly demonstrated that students tend to understand science and technology courses better when they are exposed to both the theoretical and practical real-life applications of the scientific and technological theories behind the applications. In Fig. 4, the number of students that got grade A (distinction) when the AWS Academy curriculum and practical hands-on labs were introduced, increased by 10.62% and the number of students that failed the course (that got grade F), decreased by at least 2.39% compared to the two previous years (2016/17 and 2017/18 academic sessions). However, the number of students that got grade B in 2018/19 academic session decreased by 7.8% compared to the students that got B grades in 2017/18 academic year. This is because more students that could have ended up with B grades have now moved to A grades as a result of introducing industry applications to the cloud computing module. But the contradiction is that the number of students that got grade C in 2018/19 and 2017/18 are almost the same, so more efforts needs to be put in place to improve this trend in future work. Future work will include the AWS Cloud Architecting curriculum which is more advanced than the AWS Academy Cloud Foundations used in this study.

5. Conclusions

This paper explores the opportunities in collaborating with the industry to have access to cutting edge cloud computing technologies for inclusion into the cloud computing curriculum. Amazon AWS is the largest cloud provider in the world and its AWS Academy provides training to educators around the world to become certified cloud practitioners. The author had this training and registered QMUL as an accredited AWS Academy and used AWS Academy digital LMS, lecture and labs materials in teaching cloud computing module. This experiment resulted in better performance in the results of the module compared to the examination results of two previous years. Two questionnaires were conducted and the results showed that the students have more confidence in using cloud technologies and they think that the increase in tuition fees is justifiable after the inclusion of AWS Academy Cloud Foundations into the cloud computing curriculum. The students also think that the hands-on practical skills they have acquired in the AWS Academy labs has increased their employability.

This paper concludes that working with the industry to design the curriculum of cloud computing has improved the skills and confidence of the students in using cloud technologies. In addition, the students performed better in examination when exposed to the real-life practical aspect of cloud computing and now know the career paths in cloud computing when they graduate.

Funding: This research received no external funding.

Acknowledgments: The author wishes to thank the Joint Program between QMUL and BUPT for given him the opportunity to include the AWS course into the curriculum of Cloud Computing module. The author also wishes to acknowledge the huge contribution of AWS Academy in the UK for the training and support given to him which enabled QMUL to become an AWS accredited Academy. Worthy of mention are the team members at AWS namely Jenni Jones, Paul Smart and Undeleeb Din for their invaluable support throughout the program. The contribution of AWS Academy to this program runs into hundreds of thousands of pounds if quantified in monetary value.

Conflicts of Interest: The author declares no conflict of interest.

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