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Report

**Successes and lessons from a trial of the three-way university-
enterprise cooperation program on data science and big data
processing technology in China**

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Abstract: Work integrated learning (WIL), most in the form of co-operative (co-op) partnerships or workplace placements/internships, has been incorporated into many undergraduate programs in universities around the world. In this express report, we share a recent trial of a new WIL model for a bachelor's IT degree in data science and big data processing technology experimented at our University (Inner Mongolia Agricultural University, IMAU) in China. This new model involves three entities, an institution as IMAU (Part A), an industry-certification training agency (Part B), and a cloud computing enterprise (Part C). Our experiment was initiated in September 2018 with the first intake of about 120 undergraduate students and completed in July 2022 over four years of full-time study. The initial results show that the three-way WIL initiative produced more than 60 employment-ready and industry-certified professionals for ICT enterprises and service providers specialized in data science and big data processing technology. The industry-standard certification training and the four-month industry placement in a top 500 ICT enterprise in the world significantly improved both the hands-on skills required by the ICT industry and the employment opportunities for the graduates.

Keywords: work integrated learning (WIL), three-way university-enterprise cooperation program (3UECP), employment-ready ICT graduates, IT industry-standard certification

1. Introduction

In the recent decades, more governments and industries have called for the tertiary institutions to

focus on producing work-ready or employment-ready graduates to meet the current and future needs of industry and workforce skills. Such demands require universities adopt the work integrated learning (WIL) strategy, mostly in the form of co-operative (co-op) partnerships or workplace placements/internships, in various educational programs to expand the theoretical concepts acquired from academic studies to real-life contexts in a relevant profession. For example, in Asian-Pacific region, Australia leads the WIL initiation and inclusion in many programs either implemented by individual institutions [1–5], or promoted by government agencies [6] and the university association [7]. Co-op partnerships have been experimented in United Arab Emirates [8], China [9], and Saudi Arabia [10]. The leading form of WIL strategy in North American universities has been the co-op partnerships with a long history [11–15]. Co-op partnerships and other WIL practices have been reported in studies from Europe or EU or many European nations [16–22].

Studies have showed that various forms of WIL have produced positive outcomes for all stakeholders, including students, universities, enterprises (i.e., industries and businesses), organizations (i.e., non-profit or governmental agencies), or service providers (i.e., public and private hospitals and schools). However, most WIL models reported, such as co-op partnerships, workplace placements and work-based internships, are based on the cooperation between two parties: an academic entity (or institution) and a non-academic entity (or industry). This express report shares a new model of WIL for a bachelor's degree in data science and big data processing technology experimented at our university (Inner Mongolia Agricultural University, IMAU) in China. This new model involves three entities, a university as IMAU (Part A), an industry-certification training organization (Part B), and a cloud computing enterprise (Part C). The inclusion of an industry-certification training organization (Part B) into this program was motivated by the increasing trend in ICT recruitments which indicates that many ICT industries would prefer to hire ICT professionals with both a formal ICT degree and related ICT industry certificates [23]. This experiment was initiated in September 2018 with the first intake of about 120 undergraduate students and completed in July 2022 over four years of full-time study.

In the rest of the report, Section 2 provides the background and structure of this three-way university-enterprise cooperation program (3UECP). Section 3 presents the program outcomes for the group of pioneer students, successes in and lessons from this three-way university-enterprise cooperation program. A brief conclusion is drawn in Section 4.

2. The three-way university-enterprise cooperation program (3UECP)

2.1. Background information about the 3UECP initiative

To explore new ways of training employment-ready graduates in data science and big data processing technology demanded by the ICT industry for the most recent decade, as a new initiative to implement the university's WIL strategies, our college proposed a new university-enterprise cooperative undergraduate program on data science and big data processing technology with two majors in Network Engineering (NE) and Information Management and Information System (IMIS) in 2018. Initially, 120 undergraduate students were enrolled to this program in September 2018, 60 each in NE and IMIS. After four-year full-time study, 117 students out of the 120 successfully graduated from this program by July 2022, with more than 85% of the students being offered a full-time job by graduation, much higher than the recent national average rate of undergraduate graduate employment just below 50% [24]. Hence, this experiment was successful and most importantly very

encouraging to the further refinement of this university-enterprise cooperative initiative in the near future.

For the ICT industry, any existing WIL model, either work-based placements or paid/no-paid internships with industry partners, would not fully serve both the students and the ICT industry partners or ICT service providers well. This is because the students only possess the theoretical knowledge and limited laboratory hands-on experience in ICT before starting their industry placement or internship. In contrast, the ICT industry provides services or produce ICT products to consumers according to the current ICT industry standards certified by the ICT industry regulatory bodies. There exists a large gap between the skill sets of the students obtained mainly from the classroom/laboratory and the industry certified standards adopted by the ICT industry. Such gap should be properly fixed before the industry placement takes place. Hence, the three-way university-enterprise cooperation program (3UECP) emerged as an alternative solution to WIL for ICT students.

Three entities were involved in the 3UECP initiative: the university (Part A), the industry certification training provider (Part B), and the ICT industry (Part C). Part A mainly takes responsibilities for program approval and certification, student recruitment, administration, management, and revenue collection and redistribution, industry liaison and resolution, student's foundation education, academic assessments and assurance for the services provided by both Part B and Part C. Part A also provides industry-standard training ICT facilities within the university, and the degree certification for all eligible students from the university. Part B prepares and provides all industry-standard training materials and qualified instructors to teach all industry certification subjects to the students and the university teachers who are involved in 3UECP. To save the costs for students, all industry certification subjects are delivered face-to-face at the laboratories within the university, which were established with the industry standards guided by Part B. Part A and Part B share the tuition collected from all the industry certification subjects delivered by Part B with a mutually agreed ratio. Part C provides placement for each of the eligible students in their relevant departments for a duration of four months in the final (4th) year of the program. The placement at Part C should not only cover the technical aspects of the industry activities, but also the enterprise culture, teamwork, organizational structure and workflow, communication strategies including customer services, and career opportunities. Part C also involves in co-supervision of student's final project should the project closely connects to Part C. Similar to the arrangement with Part B, Part A and Part C share the tuition collected during the placement at Part C with a mutually agreed ratio.

2.2. Academic structure of 3UECP on data science and big data processing technology

The 3UECP is delivered in eight semesters over four years, the same timeframe as a regular four-year bachelor's program in China. The distinctive feature of this program is a total of 16 big-data related training units (or subjects) delivered by Part B in the second and third years or from the 4th semester to the 6th semester out of the eight semesters (Figure 1). By successfully completing all these industry-certification units, students receive a big-data specialized certificate issued by the industry regulatory body through Part B.

The foundation units are delivered in the first three semesters by Part A as usual university studies on campus. This includes 12 ICT core units in total, plus other non-ICT units required by completing a formal bachelor's degree in China. After completing all the core and industry units in the first three years, students are expected to take the industry placement at Part C in the 7th semester, usually during September to December in the 4th academic year. During the placement, in addition to

the rotation of working at different ICT departments, students are also provided with opportunities to visit other non-ICT departments, and participate in industry-sponsored competitions and conferences. After the placement, some students may be able to further develop what they had started during the placement into their formal graduate (final) project in the 8th semester (the final semester of the program) back to the university. If such a project is approved, a joint team from Part A and Part C will co-supervise the student towards the completion of the industry-oriented project.

Semester	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
Unit	4 core	4 core	4 core	4 industry	6 industry	6 industry	Placement	Final project
Party	A	A	A	B	B	B	C	A+C

Figure 1. Overall structure of 3UECP

3. Successes and lessons from the first graduates of 3UECP

3.1. Summary of the first graduates from 3UECP

By the end of the 8th semester in July 2022, 117 students, less the three students who withdrew from the program, completed and thus graduated from the inaugural 3UECP trial, with a successful rate of 97.5%. As the ultimate goal of 3UECP is to provide employment-ready graduates to ICT industries and service providers, the destinations or employment status of these 117 graduates at the time they graduated are summarized in Table 1. Excluding the 7 graduates who were qualified and accepted for postgraduate studies, an overall employment rate of 87% was achieved by the students at the time of their graduation. Among the 14 graduates who were not linked with any employers at the time, some wanted to have a break from full-time study after a non-stopping journey of education for 16 years since their primary schools. Thirty-three graduates (or 30% of the graduates) accepted offers from government agencies, state-owned or private enterprises that do not offer ICT products or services.

Table 1. Summary of the graduates from 3UECP and employment statistics (by July 2022)

Major	ICT Employment	Other Employment	Not Employed	Total	Employment Rate	Postgraduate Study
NE	32	18	8	58	86%	1
IMIS	31	15	6	52	88%	6
Total	63	33	14	110	87%	7

Note: Three students withdrew from 3UECP at different stages during the program.

Overall, 63 out of the 110 graduates (or 57% of the total graduates) received offers from ICT industries or service providers by the time of graduation. By looking into the two majors in big data individually, it was almost an even split between NE (32) and IMIS (31). Among the 63 job offers, a significant portion was from the industry partner (Part C) and its subsidiaries as this is one of the top 500 enterprises in the world. This also indicates that many graduates from this 3UECP initiative are the industry sought skillful junior ICT professionals, given the fact that the industry partner can recommend potential career opportunities, but does not have any obligation to provide employment opportunities to the graduates.

3.2. Successes in the inaugural 3UECP trial

3.2.1. Employment-ready graduates

The joint efforts by the academic institution (Par A) for foundation education, the registered training provider (Part B) for industry-standard certification, and the large ICT enterprise for industry placements through the 3UECP initiative successfully prepared most students to employment-ready ICT professionals after completing this four-year program. Compared to the graduates from the traditional undergraduate ICT degree programs who are more academically oriented, the graduates from 3UECP have abundant hands-on skills and experiences in carrying out real projects on big data or data analysis with the latest industry platforms. They had the first-hand experience in the culture, organization, operations, processes of industry quality assurance, strategies for communication and customer services in real-world ICT industries. They also had a better understanding of the current and future advancements in data science and big data processing technology. Hence, they are ready to take employment opportunities offered to them from ICT industries.

3.2.2. Industry certification and prestigious experience in work placement

During our program, once completed the industry training units provided by Part B and passed the regulatory body's professional tests, all graduates would receive a certificate as an industry certified professional in the training specialty, either in NE or IMIS for the inaugural graduates. This additional certificate was the necessary step towards the industry placement. The four-month placement in a top 500 enterprise in the world was not only a real-world ICT industry experience, but also a privilege highly regarded by other ICT enterprises and non-ICT organizations in China. The combination of a formal ICT degree from the university, the industry certification, and the experience in working with a top 500 enterprise in the world widened job opportunities for the graduates both in the ICT industry and in other non-ICT organizations. This combination not only led the 63 graduates to securing their first job in the ICT industry, but also helped many of the 33 graduates in securing jobs in non-ICT organizations as many would be working in data analysis and reporting, or internet, network, and system data processing for government agencies, state-owned or private organizations who offered them the employment.

3.2.3. A central point of coordination and communication

During our program, the students mostly contacted the program coordinator and the support team from Part A who acted as the official counsellor for all the students during the program. This is the normal administrative arrangement for all undergraduate students in Chinese institutions. This arrangement was not only accepted by both the students and their parents who pay for their children's tertiary education as 'studying in a standard university environment', but also the most effective way to reduce potential hassle, misunderstanding, frustration, and even harassment raised in improper communications between students and Part B or Part C during the project. The program coordinator from Part A acted like a central point of communication for all stakeholders, and each stakeholder just needed to focus on the matters they should be responsible for. Any matter needing interactions between two or more parties would be handled by the program coordinator.

For example, if many students felt the instructor from Part B (the training agency) could not

deliver the training units up to the required quality standards, instead of complaining to the instructor directly by individual students, the program coordinator would receive students' feedback and take the matter to the instructor and/or Part B on behalf of Part A for resolution according to the mutual agreement. This approach not only ensured the quality of education, but also protected students' privacy and provided students with a safety net for their study. The other example was that the overall schedule for the industry placement, and student travel and accommodation were all centrally arranged by the coordinator and the support team from Part A, after countless negotiations and communications with Part C, travel agencies, and accommodation providers etc. It would be seemingly endless tasks for individual students to arrange own journey.

3.2.4. Industry training on the university campus

The industry-certification training could be conducted at the venue of the training agency but it would have several potential disadvantages for the students and Part A. Firstly, the safety of the students was a major concern as the training agency opens for the general public and focuses on offering paid professional training only. Individual's safety outside of the venue of the training agency would not be the duty of the agency. However, the university takes the full responsibility of its students' safety during their study (including the approved training outside of the institution). Therefore, Part A and Part B agreed to provide the training at the specially established industry-standard ICT laboratories at Part A guided by Part B. It turned out that the special ICT laboratories at Part A was superior to the training facilities at Part B where the facilities were mainly for the training purposes. The university invested beyond the minimum standard for the facility to support potential big-data research for both undergraduate and postgraduate students for years to come.

Hosting the training at Part A brought the maximum flexibility in accommodating changes due to unexpected circumstances. For example, if the instructor from Part B experienced unexpected delay in conducting the training units at Part A, the students could be rearranged to take other required learning and practices. Other potential benefits to host the training at Part A include reducing costs for students as staying outside of the university would be more expensive, avoiding extra charges that Part B might impose on the students during training at Part B for various excuses, for instance, extra charge for accessing specially licensed software packages or new materials.

3.2.5. University staff-led industry placement

As an extension of the central point of communication through the program coordinator from Part A, during the four-month industry placement, the students were accompanied by university staff who served as the point of communications with the hierarchy of Part C for common issues raised during the placement. This also provided an additional measure for students' safety while staying far away from the university.

3.3. Lessons learned from the first completion of 3UECP

3.3.1. Quality of instructors from the training partner (Part B)

As the business operation of Part B is to offer paid industry certification training for the general public hosted in Part B, its main focus is to conduct training for registered individuals as a batch in

the laboratories at Part B by the permanent trainers. There are many such batches organized with regular sequences on a rolling basis at Part B annually. However, for training the students in 3UECP at Part A located in a different city from Part B, Part B was agreed to send qualified trainers to Part A and stay in Part A for the duration of the training course. This created a potential problem with students' learning and training as the assigned trainer may not have had experience in handling training in a formal university learning environment that is more open and interactive than the straightforward and constrained environment at Part B. The tertiary students are more likely to ask the trainer questions beyond the training activities. For example, the training is to guide the trainees on 'how to get a task done', but the students may also want to know 'why the task should be done in such a way?' Of course, in the initial agreement, it was not clearly written that the trainers would be responsible to answer all the question asked by the students during training. In reality, more experienced and knowledgeable trainers would be able to handle the learning and training for the students in 3UECP more satisfactorily.

Hence, identifying more appropriate trainers to deliver quality teaching and training for the students at Part A is a key issue to be addressed, subject to the mutual agreement by Part A and Part B in the future.

3.3.2. High workload for the program coordinator and the supporting team

As more than 100 students were enrolled in 3UECP with three formal partners and many other entities associated with various activities at different times during the program, e.g., travel agencies, hotels, internal and external financial institutions, health and medical authorities, etc., program coordination and support became a huge workload far beyond the initial expectation, even not including the workload in academics carried out by academic staff during the program. This should be adequately addressed as a priority sooner rather than later.

3.3.3. Student's enthusiasm for ICT employment

As 3UECP is an ICT industry employment-ready program paid mainly by the students (actually their wealthy families), some students lacked a desire and passion to become an ICT professional after graduation because their families may have arranged other non-ICT employment opportunities for them well before the program completion. The degree and training certificates were the passport for them to take up the non-ICT offers. Therefore, a significant portion of the students only made the minimum effort to pass the program, while not always try their best during the study and training. It is actually a waste of resources of the program.

4. Conclusions

Despite the issues encountered during the inaugural 3UECP trial with about 120 students, this three-way WIL initiative was a success overall. It produced more than 60 employment-ready and industry-certified professionals, about 60% of all graduates, for ICT enterprises and service providers specialized in data science and big data processing technology. Among the graduates employed by non-ICT organizations, their duty was closely related to data processing and analysis. There is no doubt that the industry-standard certification training and the four-month industry placement with a top 500 ICT enterprise in the world significantly improved both the hands-on skills required by ICT

industry and the employment opportunities for the graduates.

The experiment also indicated that conducting the industry-standard certification training in the high-quality special-purpose laboratories at the university can not only provide students with a safe and cost-effective learning environment, but also ensure that the industry-standard training delivered by the trainers from Part B is up to the required quality. The accompany of university-staff during the industry placement ensured effective communication with Part C and the personal safety of the students during the placement, which could be a concern raised in previous study [13].

Modification and refinement should be considered to address some key issues emerging from the initial trial. Internally, a modified model for the program coordination and support must be a priority to reduce the huge workload for the program coordinator and support team for sustainable management of the program. Mutually, the host university (Part A) and the industry training provider (Part B) must come up with a detailed agreement to regulate the selection and performance of the trainers to ensure the quality.

To motivate more graduates moving into the ICT industry, career perspective should be more frequently promoted to the future students in 3UECP. Nevertheless, professional choice in essence is a matter to individuals. As long as the graduates believed they have got what they wanted from the program, any knowledge and every skill acquired during the program would be beneficial to the graduate, regardless of their career choice.

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