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The Value of Knowledge Transfer on the Development of EdTech Ventures

1. Overall Abstract

The topic of this paper is to study "The Value of Knowledge Transfer on the Development of Educational Technology Ventures". It aims to investigate: How can entrepreneurs empower themselves by engaging in the knowledge transfer activities of universities for the development of educational technology business in Hong Kong? What does knowledge transfer mean to local educational technology firms on their start-up journey? How do the firms experience a knowledge transfer collaboration? The study will conceptualise the University-startups co-development framework for the evolution of educational technology start-ups. The study will cover the transfer of value across disciplines to illustrate how education innovations, technology inventions and incubation activities can be converted into internal capital of an educational technology start-up to foster their evolution along the start-up life cycle. It will provide guidelines for entrepreneurs to leverage universities knowledge and expertise on the development of educational technology business, which will do good for the students and educators and do well for the entrepreneurs.

1.1 Problem under investigation

The annual spending on research and development is approximately USD 2 billion in Hong Kong. With the government as the driver, more and more funding from the public money, charity, and industries will be invested in developing innovation and technology. Universities, research institutes, and tertiary education establishments are dedicated to enhancing the research and development funding return on investment. They are responsible for developing original knowledge and technological advancement to drive the tendency of economic growth of the city while benefiting the wider community. Knowledge transfer, as the third common mission of universities and institutes in Hong Kong, is the process to convert knowledge and technological advancement into business and daily life application, which generates an income of over USD12.5 million in 2019 (Lap-chee Tsui *et al.* 2020). On top of the traditional topics of medicine, science, engineering, information and communications, Educational Technology or commonly called "EdTech" is a new keyword of the innovation and technology industry. University knowledge can upgrade the entrepreneurs' capability in terms of both technology and education.

By nature, EdTech business consists of three disciplines, namely, straightforward education, technology and business. These are independent aspects that a single entrepreneur team can hardly with competencies covering all three. In fact, education, as a core element creates, conflicts on both the left-hand side and right-hand side. Scholars, educators, and technologists have entered the debate of whether educational technology should be education- or technology-driven. The education is still doubtful on the real educational value and practical feasibility of integrating technology into teaching and learning (Cuban, Kirkpatrick & Peck, 2001; Selwyn, 2015; Luckin and Cukurova, 2019). On the other hand, the discussions on the question "should the enrollees of an academic program be students or customers?" never stops (S. Trachtenberg *et al.* 2010; Vijay Govindarajan and Jatin Desai, 2013). Here, this study will exemplify the framework for EdTech start-ups to figure out their necessary support from universities to form the right mix of education, technology and business to realise their development.

1.2 Participant information

The study will result as empirical evidence advising the education, technology and business value entrepreneur teams can capture in their collaborative partnership with universities in knowledge transfer, after a multiple case study and analysis of 30 educational technology start-ups in Hong Kong. These participants will be mostly incubating start-ups under the Hong Kong Science Park or the Hong Kong Cyberport, which are also supported by the entrepreneurship development schemes of local universities. Each start-up must be active for at least two years and be in business operation in 2021. Founders and top management of the firms, who has followed the start-up's development since the idea generation stage, will be invited to the research interviews and meetings. So the pool of respondents will have a comparable professional background and knowledge level. We can then illustrate how educational theories, technology know-how and business incubation resources contribute to the firms' sustainable evolution in forms of business and innovation.

1.3 Study design, approach and method

The ground of the analysis is on a literature review in the field to synthesise the development models of technology start-ups and education start-ups, covering (i) the stage of start-up development and required factors to support the firms' evolution; (ii) meetings and individual interviews with stakeholders in the EdTech business (e.g. venture capitalists, administrator of incubation programmes, educators, scholars, etc.) to integrate the technology start-ups and education start-ups models into a development model specific for EdTech start-ups; (iii) personal expertise and experience as the administrator of knowledge transfer unit and entrepreneurship development programmes in universities to outline the resources and supports from the academic organisations; and (iv) a multiple

case study based on the 30 EdTech start-ups to illustrate how the universities' supports can be converted to the firm's internal value to tackle their needs in different stages of development.

The first half of this study will be an inductive approach for gathering information from literature, industry experts, and personal experience as a stakeholder in the field to propose the university-startup co-development framework and shape the instrument for guiding the multiple case studies. The findings will be presented as models of EdTech start-up development and corresponding resource support available via knowledge transfer with universities. Then these resulting models will be adopted to guide the semi-structured interviews with individual EdTech start-ups to verify the coherence of the models and make the necessary modifications. This stage is a deductive multiple case studies. For each case to study, we will (i) describe the development path of the firm; (ii) illustrate the technology, education and business development resources the firm leveraged from universities via knowledge transfer; (iii) carry out the cross-case analysis to study the similarities and differences in between; (iv) continuously use the results from the collected information to modify and enhance the theoretical framework developed.

Keywords: start-up; EdTech; knowledge transfer; innovation management; education ventures; social innovation; Hong Kong

2. Evaluation of a current research article

Luckin, R. & Cukurova, M., 2019. Designing educational technologies in the age of AI: A learning sciences-driven approach. *British journal of educational technology*, 50(6), pp.2824–2838.

This section illustrates a review and critique of the article entitled "Designing Educational Technologies in the age of AI: A learning sciences-driven approach" authored by Professor Rosemary Luckin at University College London's Institute of Education-Learner-Centred Design and Dr Mutlu Cukurova in Digital Technologies of the same institute. The article was published in the *British Journal of Educational Technology* in the Year 2019.

2.1 Introduction

The authors in the article described the value of learning sciences research in supporting the adoption of Artificial Intelligence (AI) algorithms and technology in creating new educational experiences. The article used three case studies to illustrate how research in the field of learning sciences supplies training materials and rules for the AI systems in the forms of informed analysis and a validated pool of data. The authors discussed how research in learning sciences is important for the design and evaluation of AI application in education, with the support of empirical case studies. The discussion

echoed the authors' key argument that the learning sciences provide crucial evidence-based back-up in the design of educational AI by providing theories on making the educational technologies operable and advance-able practically and continuously.

The three case studies in this article covered inter-stakeholder, inter-disciplinary partnerships. The first case study was on how learning sciences research contributes to educational AI development in system design and implementation. The second case study was an integration of a concept-proven learning sciences theory with a commercial AI system to illustrate to the Education sector the possibility of educational AI. The latest case study was a successful upgrade of a face-to-face education programme to a scalable online platform empowered by AI. By using these case studies as the ground, the authors proposed a co-creation framework for developing AI systems for education and training. This theoretical framework supported another key argument that cross-sector, cross-disciplinary collaboration can connect educators, learning scientists and technologists to develop technologically innovative, scientifically valuable and educationally practical AI solutions for education and training. The researchers claimed that the framework was validated by the business performance of some 200 educational technology start-ups and small and medium enterprises participating in the EDUCATE scheme in the University College London's Institute of Education in 2018-2019.

We saw some underlying propositions of the authors, which came from the literature of EdTech development, personal, professional experience in education practice, and generalisations based on the empirical case studies and EDUCATE scheme. Technology is the key for supporting and scaffolding individuals and groups to engage in productive learning activities (Sommerhoff *et al.*, 2018). The authors foresaw "AI" and "Data" as the two keywords for the upcoming education evolution. Under structured inter-stakeholder, inter-disciplinary partnerships, new educational AI solutions would promise a further positive impact on education and training in parallel would enable data-driven analysis and understanding of teaching and learning processes.

The authors adopted the multiple case studies qualitative research method in their study to demonstrate and analyse cross disciplinary findings. It is the right choice of methodology because multiple case studies enable the researchers to explore differences within and between cases (Yin *et al.*, 2003), which was the core of this research. The three case studies were well picked that there were similarities in between, while heterogeneous factors were also measured. Each case consisted of a different combination of stakeholders, covered different stages of education technology development, and illustrated various methods of integration of learning sciences and technology. This provided a broad spectrum of contexts coverage in the study. The authors concluded the common

replicating finding across the cases that learning sciences research was vital in educational AI's system design. This literal replication provided the ground to support the proposed co-creation framework for developing AI systems for education and training.

Although the three case studies cover a wide spectrum of educational AI development stages and interdisciplinary collaborations, the cases were in unequal or even contrasting contexts. There would be common questions around the sampling, like "would the selected cases be representable among the similar contexts?" and "how would be the level of validity, repeatability and reliability?" The authors did not describe much on these issues in the article. Besides, the article lacked a "methodology" section to explain the data collection procedures, analysis approach, and interpretation in the case studies. The authors mentioned the proposed framework of co-developing AI systems for education and training was validated by the performance of the 200+ companies under the EDUCATE scheme. However, the article did not cover details about the implementation of the framework in the EDUCATE scheme. Readers could hardly picture the benefits the companies received and lacked direct evidence on the effectiveness of the framework. Moreover, the performance of the EdTech companies might be affected by the background social and economic eco-system or any major event of the industry. The discussion of these issues was absent in this article.

2.2 Summary Paragraph

The researchers investigated three cases about the inter-stakeholders, inter-disciplinary co-design practices bringing together researchers in learning sciences, education practitioners and AI technologists. The study aimed to answer the research questions (i) how does learning sciences research influence the development of education-driven AI solutions? (ii) what are the factors for building a strong connection between education practices and AI technology? The researchers used multiple case studies to illustrate the effectiveness of learning sciences research on empowering educational AI technology with its validated, empirical and multimodal data. The case studies grounded a co-design framework for educational AI development, which reinforce the stands: (i) AI solutions for education and training should be pedagogically and technologically valuable, and (ii) educators should develop their understanding of AI technology, in parallel, (iii) technologists should understand teachers' and learners' perspectives. The article outlined the guidelines to deliver core aims for educational AI solutions: (i) prioritising non-computerised-able human intelligence, (ii) tackling advancing delivery and receipt of education, and (iii) popularise the understanding and use of AI safety and effectively.

2.3 Strengths of the Article

2.3.1 Selection of Case Study Qualitative Research Methodology

This study aimed to review and discuss the inter-stakeholders, inter-disciplinary practices of educational AI development. In many other contexts, researchers have the option to do a holistic case study with an embedded unit. For instance, there is Tesla in the electric-vehicles industry, Microsoft in the software industry, Apple in the smart-device industry, Nintendo in the computer games industry, Caterpillar in the heavy machinery industry, InterContinental Hotel Group in the hospitality industry, Johnson & Johnson in the pharmaceutical industry, Chanel in the fashion and luxury goods industry, Procter & Gamble in the fast moving consumer goods industry, and even in the academic research world, there is Stanford University in technology transfer. Unfortunately, the EdTech field's factual situation is that there is not a single dominating company in EdTech and educational AI solution development around the world. The big names, like Microsoft, Google, Apple, HP and Oracle, are engaging in the EdTech market with one of their sub-branches only (Grand View Research 2021, Markets and Markets 2020, Holon IQ, Aug 2021). Researchers can hardly find the representing case for a holistic case study with embedded units to explore the sub-units, sub-processes or sub-events. Multiple case studies can understand the similarities and variations within and between the three selected cases and analyse cross disciplinary findings (Baxter P. & Jack S. 2015, Yin, et al. 2003). Therefore, the authors' choice of using the multiple case studies qualitative research method in conducting this study is correct.

2.3.2 Selection of Cases

The case study methodology is a common and appropriate research tool for education and technology development studies (Passaro R. *et al.* 2020, Corcoran P.B. *et al.* 2004). This article is about the cross-disciplinary research and analysis across both education pedagogies and AI technology. The cases should be carefully and precisely selected to cover all the elements and inter-connections. Case studies should provide a comprehensive review and discussion of practice(s). The conclusion, i.e. the results, should be illustrated as transformative value for readers and well documented (Corcoran P.B. *et al.* 2004). This kind of qualitative research represents a method of learning about a complex instance through the description and contextual analysis (Yin, 2003). The three case studies were well picked. They enabled the researchers to go deep to study and analyse the real situations of inter-stakeholder, inter-disciplinary co-development partnership in educational AI. There were both homogeneous and heterogeneous factors in between the cases, illustrating the flexible and adaptive nature of the typology. The mix of stakeholders varied in each individual case in this study and covered different stages of education technology development. This allowed the authors to explain different models of integration of pedagogical practices and AI technology, including the integration

of learning sciences experts in AI development, the integration of a validated pedagogical theory into an AI system, and the application of pedagogical practice data into AI machine learning. The authors reported the three cases in a story-telling way that the complex situations behind the cases were well presented to readers.

Grounded with these cases, the authors concluded that learning sciences research is important in educational AI's system design is the common replicating finding. This literal replication provided the ground to support the framework of co-creation for developing AI systems for education and training. Afterwards, the researchers intended to testify and validate the framework of EdTech co-creation, as the foundation of the scheme's design concept, with the 200+ participating firms in the EDUCATE Scheme at the University College London. This intended to describe the tension between the contextual and universal to address how practice and learning from the three particular cases could become transformative beyond the context in which the case was developed (Corcoran P.B. *et al.* 2004). As the enrollment eligibility requirements of the EDUCATE, these some 200 firms were at a certain level of knowledge, under a similar economic and social background, and with comparable economic dimensions. This placed a reasonable boundary for the study.

2.4 Weaknesses of the Articles

2.4.1 Reporting the Case Studies

In the first part of the research, the researchers used three cases to illustrate the importance of learning sciences research in educational AI. The three case studies were comprehensively reported that could get the engagement of readers. As the reader, I had sufficient information to understand the details and background of the cases and was able to put myself into the angle of the researchers to consider that perhaps I could apply the findings into my daily work of facilitating technology transfer in educational fields. However, there lacked an explanation of selecting the cases to study. When reading the article, I had questions around the sampling, like "Would the selected cases be representable among the similar contexts?" and "How would be the level of validity, repeatability and reliability?" (Corcoran P.B. *et al.* 2004). The authors did not report much on their sampling strategies in the article.

Besides, the authors included two large tables in the second case study, which intend to explain the framework to assist the reporting of the case. However, the explanations of these two tables were so simple that readers would have difficulty seeing how the tables tell the story of the case study to reinforce the authors' arguments. Actually, the reporting patterns of the case studies lacked similarities which would be difficult for the readers to follow. A better practice would follow a

standard way covering (i) background description of the case's stakeholders, (ii) the challenge faced, (iii) history of the challenge, (iv) solution used to tackle the challenge, and (v) conditions for others to replicate the solution in the future (Corcoran P.B. *et al.* 2004). Moreover, the article did not describe any strategies the authors taken to assure the trustworthiness of their case study research. The authors could quote secondary data about the case studies.

2.4.2 Research Methodology

Besides, the article lacked a "methodology" section to explain the procedures for conducting the data collection, analysis approach and interpretation in the case studies. Readers would query the role of the authors in the case studies, especially the author use "we" as the subject in the first and third case study but use a third person reporting tone in the second case. The stories of the three case studies were comprehensively told in the article to assure credibility. However, it would be much better to mention the method of data collection, the instrument for collecting data, and the qualitative data analysis. Additional words on the causal analysis and explanation would make the study amenable and admissible to the standard of the scientific research methods (B. Pula, 2020). It would enhance the confirmability and overall trustworthiness of the study. The absence of research methodology made an article look like a newsletter and not a research journal.

In the second part of the study, the authors proposed the framework of co-developing AI systems for education and training and quoted the EDUCATE Scheme's 200+ start-ups and SME were the validations of the framework. However, the article mention deficient details about the level of adoption of the framework in designing and implementing the EDUCATE scheme. Readers could hardly picture the benefits the companies received and lacked direct evidence on the effectiveness of the framework. The author described the performance of the EDUCATE scheme's firms, in terms of substantial rate, size of in-house research and development team, uptake of research outcome into their company, were evidence to testify the framework. However, there was a deficiency of support for these performance indicators. Many researchers had published their framework in measuring start-up and SMEs performance, e.g. Passaro, R *et al.* 2020, IBIS Capital and EdTech Global Limited, 2019, J. Sekliuckiene, *et al.* and 2018, Khalil T.M. 2000, etc. Some of them were particularly for EdTech businesses. The author could refer to these empirical models. Moreover, the performance of the EdTech companies might be affected by the background social and economic eco-system or any major event of the industry. The article should spend a part to describe these issues.

2.5 Conclusion

The article explained the researchers' multiple case studies to enrich the understanding of inter-stakeholder, inter-disciplinary partnerships among learning sciences researchers, educational practitioners and technology developers. It generalised the good practice models to influence the reasoning and performance of other players in other companies, institutions and countries. The universal challenge of collaboration of educators and technologists in EdTech development made this study to be transformative. The authors selected the appropriate approach in their study. A framework was theorised from multiple case studies of actual practices and was then testified in a scheme of over 200 participating firms. However, some details were not clarified in the article, which affected the trustworthiness of the studies. I would say multiple case studies qualitative research can effectively bring out the necessary changes if it could be better theorised and documented. Adding sections of “Methodology” and “Limitation” would help clarify further details and set the boundaries for setting readers’ perspective in reading the article.

3. Research Proposal

3.1 Introduction

The literature increasingly describes university-industry technology transfer and knowledge exchange collaboration is considered as a crucial locomotive of the society's economy and innovation growth (de Wit-de Vries, E. *et al.* 2009; Passaro R. *et al.* 2020; Cheng, E.C.K. 2021). Academics benefit from close communication and interactions with the industry to generate new research ideas with guaranteed funding opportunities and application values. Globally, the universities created a high growth rate in business development and employment in their surrounding regions' clusters of high technology businesses (Lambert, 2003; Decter, M. *et al.* 2007; Lap-chee Tsui *et al.* 2020).

The education technology business is a market of trillion dollars. The IBIS Capital's measured the global market for educational technology products and platform services valued at USD228 billion in 2019. Without considering the boosting effects of the COVID 19 pandemic (Osorio-Saez, et al. 2021), the market's growth rate was projected to be at least 15% each year. Moreover, there were no traditional big names in this market dominating the technology development and business model trends (IBIS capital *et al.*, 2019). Start-ups are the primary driving force. There will be ample space for development for university knowledge to contribute to the EdTech businesses' growth, technologically and educationally. Therefore, we will carry out this case study to describe the value of knowledge transfer for EdTech companies during their start-up life cycles as Hong Kong-based businesses. At this research, the rendering of university knowledge and resources (evidence-based technology invention, intervention innovation and incubation support of university) into business

values of entrepreneur teams will be generally defined as a university-company development framework for EdTech start-ups.

3.2 Theoretical Background

3.2.1 Knowledge Transfer in University

Knowledge transfer, which is also commonly called technology transfer or knowledge exchange, is the process of translation and evolution of innovation and technology from the place of its original research and development to the marketplace as products, services or daily routine practices. Knowledge transfer activities enable universities to increase their positive impact on society by pursuing their entrepreneurial mission in several ways occurring through market transactions, strategic alliances, joint ventures, licensing or else (Grosse 1996; Baglieri, D. *et al.* 2018). There still lacks any universal models of knowledge transfer because of contextual varieties in research natures, economic dimensions, policies, business environment and internal performance indicators. Universities usually adopt flexible strategies of leveraging emergent or planned organisational processes to find balanced, feasible collaboration models between multiple stakeholders while influencing their span of control over economic impact. Business models that emphasise high-quality research and start-up creation are associated with higher financial performance (Baglieri, D. *et al.*, 2018).

Under the obligation of their third mission in addition to teaching and research, universities are committed to transferring their research outcome, which means innovations and technologies, into practical businesses and daily life applications. All the eight government funded universities in Hong Kong set up designated units under the research and development branches, which are usually named Knowledge Transfer Offices or Entrepreneurship Centers, to facilitate and foster internal academics' participations in knowledge implementation via commercial licensing or entrepreneurship development activities (Lap-chee Tsui *et al.* 2020; Cheng, E.C.K. 2021). The knowledge transfer offices are platforms designed to bridge the interactions and collaborations between universities, researchers and industries (Brennenraedtset et al., 2006; Sharifiet et al., 2014; O'Reillyet et al., 2019). Their activities create new values and parameters in the fields of intellectual property, technology development and practical innovations (Beltran-Morales et al., 2020) to nurture companies to be innovative with the research and development findings of universities. In the recent decade, the local universities in Hong Kong were catching up the global trend and increasingly profoundly committed to the interactions with and enhancements of the industry, in terms of their innovation and technology capabilities, and cultivation of creation to accomplish their third mission (Lap-chee Tsui *et al.* 2020;

Huyghe et al., 2014; Etzkowitz 2003; Rasmussen et al., 2006). Knowledge transfer is also a channel to boost start-up activities. The ecosystem of early-stage investments is yet to mature. Some success stories will help inject a sense of confidence into young people and nurture social attitudes and support towards entrepreneurship (Lap-chee Tsui et al., 2020).

3.2.2 The EdTech Industry

The Association for Educational Communications and Technology suggested educational technology is the study and ethical practice of facilitating teaching and learning and improving performance by creating, using and managing appropriate technological processes and resources (Januszewski, A. *et al.* 2013). Adopting technology in education is neither as simple as the introduction of usage of computer equipment in teaching and learning nor bringing electronic devices to school and home. There is a more complex and ambitious achievement of seamless implementation of technology as a catalyst for a shift toward new learning models in remote and hybrid settings (Osorio-Saez *et al.*, 2021).

Educational Technology is the fusion of two elements, practical educational pedagogies and technological inventions. It is about improving the education system, pedagogies and lesson contents, which are enabled by technology empowered new formats of education. EdTech business adds further the commercial point of consideration. In addition to the class contents, EdTech creates blended learning platforms and mobile learning platforms for more efficient, interactive ways of teaching and learning. More importantly, it boosts up the market development of community learning and employability platforms (Ramiel, H *et al.*, 2019; IBIS Capital *et al.*, 2019)

Both academic and business studies agreed there is a hundred billion global education technology market, whose growth is non-stoppable, especially under the boosting of the COVID19 pandemics. The market is expected to witness a compound annual growth rate of 19.9% from 2021 to 2028 (Grand View Research 2021; Markets and Markets 2020; Holon IQ, Aug 2021; Renz, A., 2020). EdTech is not only limited to e-learning materials and smart classroom equipment. The development in new technologies in parallel evolves the advancement of the frontier of EdTech possibilities. The Multiple Reality, Internet of Things, plus the new ABCD "Artificial Intelligence, Blockchain, Cloud Computing and big Data," are new carriers realising people's imagination on delivery of teaching and learning. Nowadays, EdTech covers front end teaching and learning tools to back end education management systems, for instance, interactive displays for replacing blackboard, learning management systems, student record systems, mobile team project systems, AI-assisted assessment systems, personalised learning platforms, job-talent pool matching systems, employability advisory

platforms, as well as learning-gamifying, experience simulation and edutainment solutions. Digital technologies are making access to education cheaper, easier and faster than ever before. Learners are more willing to shift towards electronic books without the boundaries of time and locations. The digitalisation of educational materials also reduced the difficulties in translation, not only on written words but also on those with physical disabilities who can listen to the educational content in an audio format. As of August 2021, the market is enormous that there are 30 EdTech start-up Unicorns with a valuation of USD1 billion or above. (Grand View Research 2021, Markets and Markets 2020, Holon IQ, Aug 2021).

EdTech is an expanding market. IBIS Capital's measured the EdTech expenditure valued at USD228 billion in the global market in 2019 and will increase by no less than 15% per year. Meanwhile, the global education expenditure reached USD5 trillion in 2019, eight times the software market and three times the media and entertainment market. However, education was only 2% digitised (IBIS capital *et al.*, 2019). This means there is a 98% blue ocean for new forms of EdTech, for instance, gamification of learning and edutainment development. An analysis forecast that the digitisation of education is changing fast, which is projected to grow to USD404 billion by 2025. The impact of COVID-19 can boost up the market with the transformation of education models (Holon IQ, 2021).

Most of the academic studies on educational technology are about the operational and ethical practice of adopting the new technological solutions in teaching and learning, i.e. from the perspective of educators. On the business side, the studies focus on market size and technology development trends. Meanwhile, there are studies on commercial and incubation activities of technology firms from university technology transfer and knowledge exchange. However, the theoretical models and frameworks for hard-core technology companies may not be applicable to educational technology, where the education value has been taken into consideration. This study will fill the research gap to illustrate all the education, technology, and business values that an EdTech start-up can empower via a collaboration with the universities.

3.3 Methodology

3.3.1 Research Questions

Given the business developments and models of university-company collaboration vary, the general phenomena are under-researched. This research will adopt a qualitative methodology to study: (i) How entrepreneurs can empower themselves by engaging in the knowledge transfer activities of universities for the development of educational technology business in Hong Kong? (ii) What does knowledge transfer mean to local educational technology firms on their start-up journey? (iii) How do the firms experience a knowledge transfer collaboration? The study will illustrate how the

universities' supports can be converted to the firm's internal value to tackle their needs in different stages of development.

3.3.2 Research Method and Design

Qualitative case study methodology are tools enable researchers to review and illustrate complex phenomena within their contexts. An appropriate qualitative case study approach here allows the development of theoretical frameworks, evaluation of university-company collaboration programmes and development of initiatives. This research will be multiple case studies of EdTech start-ups under the incubation programmes in prominent platforms in Hong Kong, for instance, the Hong Kong Science Park or the Hong Kong Cyberport. The start-ups under study are also supported under the entrepreneurship development schemes of local universities and in business operation in the year 2021 with at least two years of history. This qualitative research method would enable the exploration of differences within and between cases and eventually generalise the transformative similarities across cases (Yin, 2003; Baxter P. and Jack S, 2015). As discussed in the previous paragraph, each university-company collaboration can contextually vary. Neither a single case study nor a holistic case study with embedded units would fit this study's setting. The meta-analysis of multiple case studies will open the windows to look for trends, patterns and heuristics that are shared and emerge in different contexts (Corcoran P.B. *et al.*, 2004).

This research will adopt a triangulation research approach to propose and validate the university-startup co-development framework. Triangulation of data sources, data types or researchers is a primary strategy to view and explore the phenomena from multiple points of view to support the replicating findings and cross-case contrasts in case studies. The collection and comparison of this data enhance data quality based on the principles of idea convergence and the confirmation of results (Knafl & Breitmayer, 1989; Baxter P. and Jack S, 2015). At the beginning of the study, the framework would be created with an inductive approach that information will be gathered from literature, industry executives, and personal experience as a stakeholder in the field. Then a set of interviews with experts in the related fields will be conducted to verify further and modify the framework. The panel of experts will consist of at least two directors/founders from EdTech start-ups, two representatives from venture capitalist/angel investors, two incubator managers and two academics. The interviews will be individual, last for approximately one hour each. Their primary focus will be to validate the coherence of the framework base on their daily practice and experience. The intermediately validated framework will be used to shape the instrument for guiding the case study interviews.

3.3.3 Case Study – Data Collection

Then, we will use the developed framework and instrument to carry out multiple case studies. We expect to conduct semi-structured interviews with 30 EdTech start-ups' founders or top management, who has followed the start-up's development since the idea generation stage. The pool of respondents will have a comparable professional background and knowledge level. Each interview will be approximately 90 minutes long. This will enable the analysis of university-startup knowledge transfer co-development from various standpoints. It is considered a justifiable approach for gathering information for an in-depth understanding of the evolution of start-ups (Passaro R. *et al.* 2020; Eisenhardt *et al.* 2007).

With the assist of the semi-structured interview instrument developed from the literature and expert panel, each of the case studies will: (i) describe the development path of the firm; (ii) illustrate the technology, education and business development resources the firm leveraged from universities via knowledge transfer; (iii) carry out the cross-case analysis to study the similarities and differences in between; (iv) continuously use the results from the collected information to modify and enhance the theoretical framework developed. Follow up interviews will be arranged to ensure every respondent respond to all the questions. After all data collection, we will cross-check respondents' responses with secondary information available, for instance, company reports, websites, platforms' reports, media interviews, and any other possible sources to ensure the highest possible level of validation.

3.3.4 Research Ethical Issues

In prior to the start of the research, we will submit an application for research ethical approval to the Ethics Committee of the University of Wales Trinity Saint David. The application will clearly state the information of the researcher, details of the research activities, scope of research activities, group and size of intended participants, data handling and storage, etc. The research will follow the University's guidelines and regulations on information for participants, consent and confidentiality, and data protection and storage. All interviews and data collections will only be conducted after the university's approval of the research ethical application. All interviewees/respondents participate in the expert panel, and multiple case studies will join on a voluntary basis and sign the consent form for participation. They will be well informed about their rights to withdraw at any time for any reason during the research. Post-research debriefing and reports will be provided to all participants upon request. At the end of the article, I will print the statement:

"The data of the cases' companies and projects that are reported here are available on request from the authors in an anonymised format and within the constraints of data privacy policies in the University of Wales Trinity Saint David and roles in Hong Kong. All empirical research reported

here has been conducted within the ethical regulations in place at the University of Wales Trinity Saint David, and ethical approval has been granted by the relevant ethics committee of the University."

3.3.5 Data Analysis Procedures

This study will be an exploratory multiple case study analysing the interviewed EdTech start-ups, which vary in organisational structure, company size and market segments (Urbinati, A. et al. 2020; Passaro R. *et al.* 2020). Mostly, "how" and "what" questions will be asked to carry out a cross-case comparison (Vittorio Chiesa *et al.*, 2007). The case studies will be reported in a comprehensive and uniform manner. The paper will provide a brief profile of each company on their core technology and knowledge, product and services, incubation platform, type of technology transfer/knowledge exchange/incubation activities of university they engaged, region of key operation outside Hong Kong, founder(s)' profile, and description of development milestones. Dimensional data of the companies, such as the evolution of annual turnover and number of employees, will also be collected during the interview to illustrate the development patterns. The companies studied will cover the heterogeneous factors of turnover, company size, market segment and company history to illustrate the differences among start-ups' growth and how the conceptional contexts outlined in the university-startup co-development framework influences their development path; homogeneous factors that they gain from collaborations with universities to support their development of business, education and technology values.

3.4 Implications and Limitations

3.4.1 Expectation on the Research Outcome

This study's key idea will be to investigate how successful educational technology start-ups empower themselves via knowledge transfer engagement with universities to surf along their entrepreneurship journeys. Technologies are there in the university research which will have an increasingly positive impact on the design and implementation of EdTech solutions. Data-driven pedagogies and learning sciences research will provide validated initiatives in teaching and learning. Brands and business networks of universities will be valuable assets for start-ups to leverage at the beginning stage of their firms. An inter-stakeholder, inter-disciplinary collaboration will shape the optimal max and match. We foresee the results will support the main idea that start-ups can gain education, technology and business value from their engagements in knowledge transfer activities of universities, which can be reflected in terms of product value, services value, market sharing, turnover and company size.

Being proposed and verified with the triangulation research approach, the university-startup co-development framework developed in this study will be a tool supporting entrepreneur teams'

decision making and resources sourcing. It can be a set of guidelines for start-ups to review their company strengths and weaknesses, plan their development path, and acquire suitable competencies and partnerships. From the university perspective, the framework will be a tool to feed appropriate resources to their incubating companies and match research teams with fitting commercial partners.

From the academic point of view, this framework will intend to contribute to the understanding of features and behaviours of EdTech start-ups, which can be different from technology start-ups and education services start-ups. Moreover, it will provide a ground for a holistic analysis of the educational technology business in terms of business value, education value and technology value.

3.4.2 Significance of the Research

We foresee this study will implicate that EdTech start-ups lack either technical competencies or educational competencies, which can be advanced by university knowledge. The low market and technology visibility and limited internal resources create a product innovation bottleneck for EdTech ventures; meanwhile, the low educational visibility and ambit create a market innovation bottleneck for EdTech ventures. This study will provide the framework for EdTech start-ups to self-review their internal limitation and guide them to identify the practical support they should gain by forming knowledge transfer partnerships with universities.

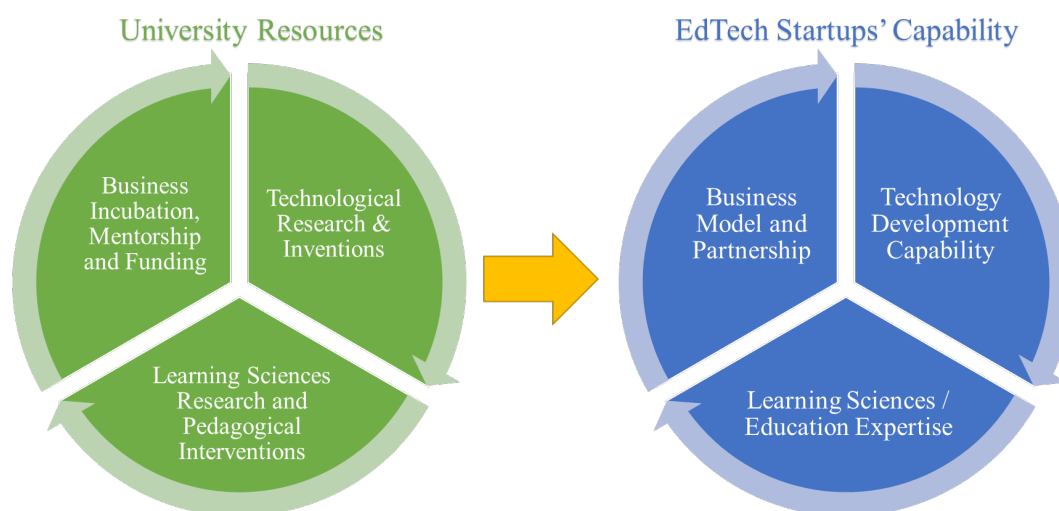


Figure 1 – Illustration of the Expected Impact of University-Company Knowledge Transfer Collaborations

Figure 1 illustrate the expected impact of university resources on the development of EdTech startups under a knowledge transfer collaboration. Universities conduct various types of research and development. Technology invention provides new technology as the media to deliver educational value to the learners. Intervention innovations are learning sciences, including novel pedagogies and

new practices that create new educational value to the learners. They can create different values in different aspects of an EdTech start-up. The composition of an EdTech start-up team creates a different profile of knowledge capital. The needs for a technology-based entrepreneur team and those for an education-based team are different. The effects of different types of university knowledge can bring contrasting effects on EdTech start-ups. A model guiding the mix-and-match can practically benefit the EdTech start-ups, the success of which will bring new educational experience to learners and trainers meanwhile build up a new driver of the economy and society development.

The Start-up life cycle of EdTech company is a complex system which various stakeholders and stages. The analysis should cover points of view from business, education and technology. Qualitative research of multiple case studies will allow an effective investigation of such a complex, unexplored topic, where "how" and "what" questions about the entrepreneur teams' experience can be well addressed. Adopting a multiple case study will allow cross-case comparisons for the identification of heterogeneous and homogeneous factors of the topic. These characteristics of the qualitative research of multiple case studies make this methodology practical and appropriate for this study.

3.4.3 Limitations

There will be some predicted limitations in this study. Firstly, this study will investigate only a snapshot of the market at a particular time-point. Secondly, the respondents' opinions can be subjective, that administration management and technical management can have a different view on product and market strategies while technology experts and education experts can conflict on business model directions. Thirdly, its explorative approach has limitations on the scalability and generalizability of the research results depending on the sample size. Fourthly, this study will not consider any unexpected events that would create a significant negative impact on the development of the start-ups. For instance, Chinese regulators barred tutoring companies from making profits in July 2021. Some of China's biggest publicly listed education companies lost significant chunks of their value as investors ditched them after the announcement of rules that require all companies that offer curriculum tutoring to register as nonprofit institutions. New investments on educational ventures would also be restricted or even prohibited under this new move (A. Stevenson, 2021). The policy change on education ventures in the Chinese mainland would make a massive impact on the related businesses in the Greater Bay Area.

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