Study TOUR for Computer Science Students

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Abstract — This paper presents a general framework of an innovative TOUR model with four interrelated elements: Transformation, Outreach, Unification and Reinforcement, enhancing the learning experiences of computer science students via a study tour. We brought our students on an overseas trip as an integral part of an academic course. The immediate goal of the study tour was to gear the students toward the program learning outcomes. Another goal was to take a first step in supporting the TOUR model, to immerse students within these four interrelated important learning and self-improvement elements, and to support each student in becoming a better person. The study tour comprises six core learning activities aligned with the TOUR elements. Evaluations were conducted based on a student survey and self-reflection. The results provide valuable insights into the design of the computer science student study tour, as well as the potential value of the TOUR model.

Keywords — study tour, experiential learning, self-improvement

I. INTRODUCTION

Study tour is an experiential learning activity, seeking to facilitate students to learn outside of the classroom. A wide range of study tours have been studied before for different purposes. Many of them have been designed with a global outlook objective. For example, in [1], a computing-related study tour was organized with the aim of transforming students into global citizens. The study tour was designed based on both Bloom's taxonomy [6] and Kolb's cycle of learning. In [2], an international study tour was organized for business students with the aim of evaluating two hypotheses based on a student survey. The results or findings confirmed the benefits and values of the study tour, in particular for cultural connectivity and professional development. Another study tour was organized for marketing students in [3]. The program comprised pre-lectures (before the study tour), lectures (during the study tour), company visits, guest talks and projects. Unlike the aforementioned study tours, a short study tour was organized in [4] with the focus on cultural aspects. In [5], a student survey was conducted to evaluate student perceptions and preferences for a short-term study tour. The results confirm the value of a short study tour. It was found that cost and visiting countries are students' major concerns.

We have been offering a seminar course for Computer Science freshmen for many years. It is a fundamental course with the following objectives (www.comp.polyu.edu.hk):

a. Educate and inspire students on different aspects of Information Technology and its applications.
b. Cultivate students' global outlook through the local and international social impact of Information Technology.
c. Cultivate and develop students' creative thinking, computational problem-solving and logical reasoning skills.
d. Educate students on different aspects of entrepreneurship and the process of creating new ventures in the information technology industry.
e. Engage students in desirable forms of learning at university, including self-regulation, autonomous learning and deep understanding.

In the past, the seminar course was mainly taught through lectures, seminars and workshops, i.e., almost completely classroom based. To complement traditional classroom teaching, we initiated a pilot study tour in November 2018 to broaden student horizons within our ever-changing world, with its increasing degree of internationalization and globalization. It is important for students to become global citizens to enhance their competitive edge. The ability to program is simply not enough when STEM and IT education permeates into high school. Our plan is to integrate the study tour with the seminar course on a larger scale to benefit these young students. We believe that it can complement classroom teaching/learning, in particular for the objectives (a), (b) and (d) and the following course learning outcomes:

- Demonstrate an understanding of and enthusiasm for the different types of computer science disciplines.
- Develop problem-solving skills and apply basic computational thinking skills to solving simple problems.
- Understand business models, aspects and the role of entrepreneurship in the computing industry.

Besides sharing our experience and findings on the study tour, we propose the overarching TOUR model that would have been aligned with the design and execution of the study tour. Our experience accumulated will be valuable in enhancing the TOUR model, as well as in articulating the various components and activities comprising a future study tour. The remainer of this paper are outlined as follows. Section II presents the TOUR model and its goals and spirit. Section III is dedicated to the design of the study trip, echoing the alignment within the TOUR framework. Section IV and Section V contain the qualitative and quantitative evaluation results, as well as discussion and insight. Finally, Section VI provides a conclusion with our future work.

II. THE TOUR MODEL

This section presents the TOUR (**T**ransformation, **O**utreach, **U**nification and **R**einforcement) model for student learning and self-improvement. As a general framework, the TOUR model would be applicable in the context of student learning and self-improvement in different aspects. In this paper, we are interested in one particular facet of the TOUR model, i.e., its manifestation in a student study tour and how the four key elements align with the activities and objectives of the study tour. Fig. 1 depicts the TOUR model with four interrelated key elements:

- **Transformation** – transforming students in various areas, such as knowledge, attitudes and beliefs;
- **Outreach** – outreach to places, people and information;
- **Unification** – unifying theory/concept and practice;
- **Reinforcement** – reinforcing knowledge and belief.

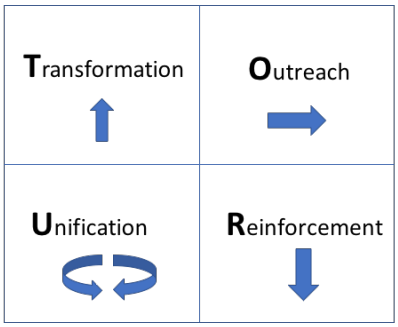

Figure 1. The TOUR model

In Fig. 1, the four elements can be represented by four meaningful symbols to illustrate their symbolic meanings. **Transformation** seeks to create high-level changes in students, hence the symbol pointing upwards, i.e., a student should attain a higher level of achievement. **Outreach** seeks to extend conventional teaching/learning, which is the major aim of a study tour to complement classroom learning in traditional courses. The horizontal pointing arrow implies the movement of attention of focus from internal to external, i.e., reaching out. **Unification** points to the act of unifying classroom theory/concept with practice, creating synergy to enhance student learning, as illustrated by the consolidation-like symbol implying findings and knowledge consolidation and assimilation. **Reinforcement** aims to help students reinforce their acquired knowledge in order to internalize it, as well as strengthen the foundation on which new knowledge can be built. It is presented by the downward arrow to imply its "more down to the earth" nature.

There are three types of transformation: addition (e.g., a student learns a new concept), deletion (e.g., a student removes a negative attitude) and modification (e.g., a student changes an attitude or a belief). It is generally believed that transformation can be facilitated more effectively in a new environment when there is a form of "cultural shock" that encourages the student to undertake a deeper introspection. University students have already encountered a major change in their environment, namely, when entering university. Students from all over the world would join together to start a new chapter in a foreign environment. It is not uncommon to witness a good proportion of international student population coming to university in the fall semester. The Hong Kong Polytechnic University has a comparatively smaller percentage of international students. So we believe that a study tour could be even more effective at bringing in the cultural shock. Transformation is a long-term ongoing process, and we believe that our study tour can only serve as an ignition for the process. It is also part of the higher education goal of transformative learning [7], which is defined as "*the process of becoming critically aware of how we perceive, understand, and feel about our world; of reformulating these assumptions to permit a more inclusive, discriminating, permeable, and integrative perspective.*" Transformative learning is usually carried out in a project-based setting [9], due to its rich room for introspection.

Apart from the obvious semantics of outreach to indicate reaching out to different places, as exemplified by the study tour setting, there are two other less explicit dimensions of outreach: outreach to people and outreach to information. It is worth pointing out that these two dimensions are of equal importance to student development. Physically interacting with foreign persons would exert a different impact on a student, compared to interacting virtually over the Internet via email or online chatting. It is a three-dimensional experience for a student to interact with someone from another country, seeing the background when the interaction takes place, with information embedded in the proper context. For instance, a company visit provides a venue in which certain activities are actually carried out with a hands-on view or experience of the product and setting. Outreach is closely related to the transformation element. It has also been pointed out that transformative learning is different from informational learning, one of the three dimensions implied by the outreach element. Informational learning is "*to extend already established cognitive capacities into new terrain*", but both kinds of learning are valuable and desirable [8].

Unification implies consolidation and assimilation. It is important for students to build up the connection between an abstract concept or a piece of factual knowledge, as told with the solution manifested or product reality as observed. For example, a student may learn the concept of cloud computing in the classroom. But through a company visit, he/she will learn about how cloud computing is applied in practice, seeing the servers connected with network cables with different monitoring screens capable of tracing packets flowing around, as well as the concentration and nature of packets geographically, not to mention task allocation and resource utilization information. Students could also be introduced to the new dimension of knowledge of network traffic monitoring, especially today with the presence of malicious packets for various types of attacks. Without seeing the actual setting, students may not believe that monitoring is equally important, if not more important, than job submission in cloud computing. Unlike transformation and outreach, unification focuses more on the student's knowledge and ability.

Reinforcement is one of the goals in a common classroom setting. It is best exemplified by hands-on work on exercises and projects through collaborative effort. It is

well known that students will be able to recap and internalize their knowledge better through practice. It would be more effective when this is carried out in a collaborative mode, in which each member makes a contribution. This is particularly relevant in the context of a creative entrepreneurship project, where everyone knows a piece but no one knows the whole. Learning from one another will help reinforce existing knowledge. Besides the more obvious connotation of reinforcing knowledge, this element also embodies the reinforcement of belief, unless that belief has been challenged to lead to transformation. Again, taking the company visit as an example, a student will be impressed by the dream company that he/she had been longing to see, thereby reinforcing what he/she believes about the company as an industry giant, thanks to more concrete first-hand-experience.

Structurally, outreach would form the backbone of the TOUR model to emphasize the value of learning beyond the border, be it the classroom, the city, or the country. It carries a strong geographical meaning. This is reflected in Fig. 1, where outreach defines the horizontal dimension (for longitudinal values) and supports the attainment of the other three elements, arranged in the vertical dimension (attaining different latitudes). The ultimate goal of TOUR is transformation, which looks for self-improvement in different aspects. Transformation can only be attained through a complicated process with combined contributions from reinforcement and unification in the context of knowledge, as well as seeing and feeling through outreach to new places. We envision that for most students, reinforcement would take place first, by strengthening their knowledge with positive feedback examples via seeing. Accumulation of reinforced and validated knowledge would lead to their knowledge being connected, structured, and internalized in a process of unification. It could well be anticipated that more students attain reinforcement with a higher degree, fewer attain unification with a lower degree, and yet even fewer attain transformation in the smallest degree. However, we believe that the overall value brought by the study tour will be significant, especially given the relatively short period of time in building this up.

In summary, the TOUR model covers the four key elements in student learning and self-improvement. Transformation is more focused on student self-improvement, which is the highest goal of education in the long run. Outreach is relevant to extrapolation and extension, covering both self-improvement as well as knowledge acquisition, although the focus is more on the former. Unification requires the consolidation and assimilation of knowledge and is more relevant for knowledge accumulation to prepare students for new knowledge learning or even creation, i.e., moving from *connect* to *create* in Bloom's taxonomy. Finally, reinforcement is also relevant to knowledge accumulation, but more to build a strong foundation to prepare for new knowledge. We believe the TOUR model is a very useful student learning and self-improvement model that can also be extended or applied to other academic activities, as well as to other disciplines.

III. Designing the Study Tour

Based on our TOUR student learning and self-improvement model, we present in this section the design of the study tour and key learning activities. Table 1 gives an overview of key learning activities, particularly from the perspectives of learning inside/outside the classroom.

TABLE I. Key learning activities

Learning inside classroom	Learning outside classroom
Attend lectures in a familiar environment with familiar students	Attend lectures in a new environment with unfamiliar students
Learn from information from the Internet	Learn from seeing things and meeting with people
Learn from lecture slides and notes	Learn from visiting places and seeing things
Study entrepreneurship theory	Discuss entrepreneurship practice and experience with startups
Study companies by reading their websites	Study companies by visiting them and seeing demos

We designed our study tour with an alignment to the TOUR model, comprising six core learning activities. Besides being aligned to the TOUR model, the learning activities are also designed in a way to cover the course learning outcomes, as required by the university to be ABET-compliant and aligning to the graduate attributes required by the Seoul Accord.

Figure 2. Study tour to Singapore

The first important decision for the study tour is the destination. A second important decision is the length of the tour. We selected Singapore, as shown in Fig. 2, with a study tour of five days. (Note: In this paper, student faces in the photos are blurred for privacy reasons.) Singapore was selected due to its high similarities with and its distinctive differences from Hong Kong. We cannot afford a very long tour without generating much impact on regular teaching and learning activities for our students, since they also need to take other courses in the meantime. Making use of the lecture day (Wednesdays) and Saturday and Sunday, we made use of five full days, with an extremely early flight to Singapore and a late flight back to Hong Kong, with minimal

disruption to our students' normal studies. It was a tiring yet rewarding journey, as most students stated in their own reflections on the study tour.

We designed the study tour around six major types of activities: (*a*) visits to universities, (*b*) attending lectures and workshops, (*c*) interacting with local students, (*d*) visiting companies, (*e*) hands-on working on projects, and (*f*) cultural visits. There are sufficient varieties in the key types of activities. To be more precise, during the university visits, we received a warm welcome from Singapore Management University (SMU), Singapore Institute of Technology (SIT), and Nanyang Technological University (NTU), three different types of universities with different focuses. At SIT, our students attended a standard lecture on web programming by SIT professors, as well as an interactive workshop on entrepreneurship projects taught by our own faculty member. Our students mingled with SIT students during a buffet lunch and interacted with them in various aspects. We visited Microsoft, Kaspersky Lab, and a Singaporean startup company. Students were asked to work in groups on an entrepreneurship project and report back on their findings, with an emphasis on the "value" of their "product" under the business plan model. Finally, the tour concluded with a series of cultural visits on the last day at popular and representative spots in Singapore. Needless to say, outreach was the key theme throughout the study tour, since our students were exposed to a foreign environment with many differences to learn about and explore. The ultimate goal is really to initiate the transformation process for self-improvement.

A. University Visits

University visits were designed primarily for unification and reinforcement. Students have recently started their university studies at our university. Through visits to other universities, they can compare and draw similarities and differences between them, building up the correspondence required in unification of knowledge, as well as their general concept of university life and studying. They will also reinforce a rough concept of what university life is all about. Perhaps it is still a bit premature for freshmen to be exposed to research, a key activity supported by universities, but the students seemed to be amused at what research could bring us. As faculty members, we would convey messages to them that they would be able to attain a similar status if they proceed with their studies seriously.

On the first day, a visit was arranged for students to visit the Singapore Management University (SMU). The visit to SMU was mostly general, taking a walking tour around the campus to take in its beauty, as well as its facilities, such as its court for law school, and the School of Information Science and its programs. Apart from seeing the traditional facilities, students visited an inspiring student learning space (see Fig. 3). The learning space is an open environment with interesting and entertaining facilities to cultivate creativity. This is unlike traditional teaching/learning environments. Students found it inspiring, and this outreach activity has transformed many students' view on the learning environment (e.g., to view learning from a new perspective). Besides amused by the innovative learning space, they were also surprised to learn about the doubling of intake quota in computer science in the year to come. They got the feeling that the Singaporean government is very assertive about Singapore's education and human resources needs. This feeling was reinforced when they saw the ERP (Electronic Road Pricing) system for toll fee collection, later extended to parking fee collection, and the Marina Barrage being built in an effective manner for long-term striving of the country. The Singapore International Airport also served as a positive example to our students.

Figure 3. Visiting an inspiring learning space at SMU

On the second day, we visited the Singapore Institute of Technology (SIT) and Nanyang Technological University (NTU). While we spent a good amount of time in SIT for the other activities, we visited NTU after a long day at SIT. The visit to NTU was very focused, namely, visiting the research lab and facilities. Our students were interested in the research findings and raised interesting questions on the "how" aspect of the traffic monitoring system based on image and video analysis, under the infrastructure of the Internet of Things.

We believe that we struck a good balance with proper arrangements to best utilize the limited amount of time we had in Singapore: we visited NTU for its top-notch research, SIT for our experiencing and actually carrying out teaching and student interactions, SMU for its innovative way of teaching and learning, making the best out of the three universities, as well as capitalizing on their relative strengths.

B. Workshop and Lecture

Lectures were designed with the key objective of unification and reinforcement. Students should be given the opportunity to learn, and also from observing how others learn. The joint lecture with Singaporean students brought us some pleasant surprises: introspection. Not only did our students attain some form of knowledge reinforcement and unification, but some also saw and felt how Singaporean students learnt during the lecture, with their positive and attentive attitude. This inspired some of our students into introspection about their own study attitudes back at our university, thereby achieving the high goal of transformation.

On the second day of our study tour, we visited SIT for almost the entire day. In the opening session, we were welcomed by the SIT program director, who highlighted SIT

and its missions. Our students then attended an interactive workshop on entrepreneurship conducted by our own faculty members (see Fig. 4). This corresponds to a lecture in a foreign place, although the same content would also be delivered to our remaining students taking the same course not joining this study tour. The core content of the workshop is to introduce students to the concept and tool of a Business Model Canvas model, which is very useful for connecting brainstormed ideas to potential realization. To enhance the student learning experience, our students were invited to attend a lecture with Singapore students. The workshop was intended to prepare them to do a group project on entrepreneurship (activity *e*) and to visit some companies and startups (i.e., seeking to unify concept/theory and practice, activity *d*). The lecture was an outreach activity, allowing them to learn in an unfamiliar environment with unfamiliar students. This has transformed some students' learning attitudes, because they found that Singaporean students are more active in learning (see the student reflection).

Figure 4. Entrepreneurship workshop

C. Mingling with Singaporean Students

Outreach can lead to valuable benefits when interactions across different cultures is fully leveraged. We designed an interactive activity with Singaporean students by adopting outreach as the central theme, so that our students could freely mingle with them in exchanges of any form. We did not anticipate too much in terms of unification and reinforcement with this activity, though the students may have been able to reinforce some old concepts in their mind, or overturn something they had known for a long time.

Figure 5. Mingling with Singaporean students

To allow students more interaction with the Singaporean students, a lunch buffet was arranged so that they could talk freely in a relaxed environment (see Fig. 5). We did not impose any conditions or constraints on their interaction, so that they could share whatever they liked. This outreach activity has further transformed the attitudes of some students and reinforced their understanding about Singapore through the discussions with Singaporean students. A side effect was that some of them became friends and they have continued to maintain their ties after the visit.

D. Company Visits

Company visits were beneficial towards reinforcement, besides the more obvious outreach element in the TOUR student learning and self-improvement model.

On the third day, three company visits, namely, Microsoft, Kaspersky Lab and a cluster of local startups, were arranged. These outreach activities seek to unify concept and practice, allowing students to see how computing technologies are developed and used in real life from different perspectives. Furthermore, they reinforce students' understanding of the importance of information technology in our society. Visits to large companies would be helpful in reinforcing what our students already know, as well as opening their eyes to upcoming technologies, forcing the better students to move towards unification of their existing knowledge. For instance, they found the Microsoft product to support an effective office very attractive. Some students were also keen to compare Microsoft with Kaspersky Lab. Visits to startups would provide them with a contrasting view of how companies work (see Fig. 6). More importantly, the founders of the startups we visited were quite young, which strongly attracted our students. Some were excited that they could also become startup founders in the future, while others were simply admiring.

Figure 6. Visiting startups

Last but not least, it is to our enlightenment that the company visits have also transformed some students' views on the development of information technology. Students had a very fruitful discussion session with the founders of three startups, learning about how they had succeeded, the path they had taken, and their desire for better products that drove them forward. We have to concur that the conversation with the startups' founders has been most influential on our

students, in particular the transformation element, although the number of students transformed is small.

E. Working on Entrepreneurship Project

As part of the study tour and also the course project, students were required to complete an entrepreneurship project by proposing an IT-related business idea with some technical elements. This is the key activity that must be carried out in order to justify a study tour that was heavily sponsored by the university. We expect to instill unification and reinforcement elements through this activity.

In the project work, the first part of fundamental knowledge had been covered in the workshop held at SIT (see Section III-B). Students would be reinforcing their learning from the workshop, as well as exercising unification on their observations and know-how from company visits, and applying them to the execution of the project.

Students need to work in groups to apply what they had learnt in the entrepreneurship project on an IT-related business idea with a viable plan. A pre-announced presentation and discussion session was arranged at the hotel on the second last day (see Fig. 7), due to the fact that Saturday is a holiday in Singapore and university campuses are not open. Students were reminded of the importance of this activity and were encouraged to work on the project during their free time well before the working session and the presentation. This activity aims at unifying classroom theory and real-life practice. The aforementioned company visits can inspire students to create more innovative and practical ideas. They have also reinforced students' understanding of entrepreneurship.

Figure 7. Presenting entrepreneurship project findings

F. Cultural Visits

Our last activities were more relaxing, namely, cultural visits to sights of interest in Singapore. Of course, the key theme is definitely outreach, but we do hope that reinforcement might still occur behind the scene when students built up their observations and reinforced their original beliefs, more in the non-academic context. There may also be some transformation occurring when the amount of reinforcement reaches a critical point.

On the last day, cultural visits were arranged to complement the aforementioned technical and academic activities. We planned some common points of interest to be visited and still remained open to suggestions. These outreach activities seek to facilitate learning from other perspectives. Apart from reinforcing students on the importance of cultural development and history in Singapore, these outreach activities have also transformed some students' views about this Asian country (e.g., their multicultural development).

Figure 8. Cultural visits

Not originally on the itinerary, some students suggested visiting the Marina Barrage. The rationale is that it is a key infrastructure built by the Singapore government for the long-term benefit of the people. This was seconded by other students. We therefore altered our itinerary slightly to accommodate this visit. This indirectly indicates that our students are not simply going for fun, but actually are going to learn, since that is not a common tourist destination nor a cultural point of interest, but offers more of an educational mission and value. This was also a pleasant surprise to us that our students are motivated, although still green.

IV. QUALITATIVE EVALUATION

We evaluated the success of our study trip based on student reflection reports and a survey providing both qualitative and quantitative analysis. In this section, we focus on the qualitative evaluation. We required each student to submit to us a reflection report on the insights and findings from the Singapore study trip. For the reflection report, we deliberately provided no specific guidelines as to its length and content. There are a couple of reports with just one or two short paragraphs, whereas most reports run two pages, with a few even longer. The distribution of the activities that they report on in the reflection provides a good indication of the relative importance or degree of impression on them, which also translates into potential gain in the TOUR elements. Nevertheless, the reflection reports provide more information about the qualitative aspects of the study tour.

Let us review some student reflections. The study tour has transformed student attitudes in learning and studying to a certain degree. This is expected to exert a positive impact on their future studies. To make the presentation more logical, we grouped the reflections according to the six core activities and highlight those being relevant to some of the TOUR elements. After performing the categorization, we discovered that most students wrote substantial content about the university visits and the company visits. It is expected that students generally feel that activity **E** on project work is

more a burden than fun, so there is very little reflection content mentioning this. It is a bit surprising to notice that there is also comparatively little reflection content addressing activity **F** about the cultural visits. Nevertheless, students seemed to enjoy themselves more when spending time on their own visiting various places in Singapore (which took place on the Saturday afternoon, after they had finished the project presentation and before the final day of cultural visits and the return flight). There was more reflection about their own visits. All of the combined experience leads to certain write-ups in the reflection that cannot be allotted to any of these six but as an overall attainment leaning toward transformation. We therefore include some student reflections about the university visits (inclusive of student interaction and lectures), company visits, and the rest.

A. University Visits

The most common reflections were about the beauty of the SMU and NTU campuses, the good facilities, but also very importantly, the student study attitudes (mostly from SIT). Some of our students actually felt a bit ashamed, which could perhaps provide a driving force for them to do better in the future.

"*The most memorable scene is that during the lecture, everyone is so focused on the lesson without doing anything not related. I think that we have to learn their learning attitude*." [**Outreach** with potential **transformation**: seeing something new and would like to change.]

"*I was also amazed by the students, by their attitude toward academics. The students showed a concentrated mind toward their studies: they listened carefully to their professor during the lecture without anyone using a mobile device to do anything else not related to their project. In the university hallway, we could see some students sitting around a table near the edge of the corridor we were walking in, and they were discussing some issue about their group work assignment. Each was listening carefully to the speeches from their groupmates, absorbing others' opinions, and sharing their own*." [**Outreach** with potential **transformation**: seeing something new leading to introspection and would like to change.]

"I still remember what they talked with us about during lunch, they said they are 'SAS', which is Sleep At School. Facing the projects and work they need to finish, they can study that way, which is quite inspirational for me." [**Outreach** with potential **transformation** of learning attitude.]

"I will try to force myself to make more time to learn and learn more about different aspects, not just focus on the subjects that were assigned." [**Transformation**: determining to change.]

"NTU is one of Singapore's universities with the longest history. The research on transportation is also very interesting. It can monitor traffic conditions and provide the most updated road information to nearby drivers. In addition, all vehicles in Singapore have installed an auto payment system, which I think it is quite convenient for drivers and smart, since it reduces the time for paying fees. In terms of this, I think [our place] may also try to implement this kind of system for vehicles. It may reduce the time needed for drivers to pay for parking or even charging significantly, and it may be useful in alleviating traffic congestion." [**Reinforcement** of useful technical concepts and **unification** in bringing ideas back to local setting.]

"*I met one student at SIT who I think is versatile. He can speak Mandarin, Cantonese, English, Japanese and also Korean. Having the ability to speak at least three languages seems to be normal for them.*" [**Reinforcement** on the importance of language ability and communication skills.]

"*When communicating with them, I really realized the importance of language. There was one student who is Japanese. However, he can speak four languages, English, Mandarin, Japanese and Korean. With so many language skills, he can travel across Asia without a language obstacle. Such a cool thing!*" [**Reinforcement** of the importance of language ability and communication skills.]

"Furthermore, the country's diversity reminded me of my own homeland. The citizens of Singapore are from different ethnicities and they seemed to get along perfectly, which is somewhat of a contrast from where I come from, since they are still a lot of inequalities in [my country]." [**Outreach** to see the difference between own country for introspection and potential change.]

"In the morning, we had a workshop on entrepreneurship. One thing he said that stuck with me and inspires me to this day, is to learn by doing or working. I have already spoken about it in my reflections on the last day, but I want to emphasize its importance to me. It gives me hope that no matter what happens next in my life, I can also find a way to build something for myself." [**Reinforcement** on self with introspection, with potential **transformation** for change.]

"From the Entrepreneurship Workshop, I found the ways of coming up with ideas very helpful and Business Model Canvas. I am motivated to have my own startup after this semester's exams." [**Unification** with past knowledge and aspiration with **transformation** to put that into reality.]

B. Company Visits

Students generally enjoyed the visit to Microsoft the most, which has been one of their dream companies for a long time. The office setting and wide range of productivity-enhancing products was eye-opening for them. Some are also attracted to the startups, especially their success stories and the challenges they went through. Kaspersky Lab was comparatively remote for most students, who were a bit too young to appreciate the topic of cybersecurity, and one of the sessions was quite technical in nature.

"*It was really captivating to hear what each company/organization had to share. The visit to Kaspersky Lab allowed me to ask certain questions I've always wanted to ask big tech security companies about "0 Day" vulnerabilities.*" [**Unification** on classroom learning with real-life experience, prompting students to ask questions based on their previous learning experience, with **reinforcement** of their existing understanding of IT.]

"*Visiting Kaspersky and Pixel gave me an opportunity to more deeply understand the current IT market and all of the tendencies in very different aspects. The Kaspersky visit made me understand the huge importance of cybersecurity in today's world. I really enjoyed the story of the young cybersecurity specialist working for Kaspersky. His career story was really impressive*." [**Unification** on classroom learning with real-life experience, prompting students to ask questions based on their previous learning experience, with **reinforcement** of their existing understanding of IT.]

"The Microsoft visit inspired me a lot. Their office is a totally open space, which means they do not have a specific room or places for workers, who can sit anywhere they like. It means that workers can meet new friends and get new ideas from colleagues. I recognize that we need to step out of our comfort zone and break the chains of our mind in order to come up with more creative ideas, just like what Microsoft has done to their office." [**Unification** on classroom learning with real-life experience, with a trigger for introspection and potentially **transformation**.]

"Pixel Studio also gave me a lot of inspiration. By sharing three speakers, I am more interested in creating games and learning programming. I envy their courage to develop their own company. This is also on my wish list." [**Unification** on classroom learning with real-life experience, with a trigger for **transformation**.]

"What is inspirational as well, is the three guys at Pixel Studio. In my opinion, their age is probably not that much older than ours, but what they have done is absolutely bigger than us. They are trying to tell us their stories, they are trying to tell us the skills, the knowledge that we should know to do what we want, they are trying to tell us not to give up your dream. They explained the difference between making a game and running a business, and at that time, I could feel what they have chosen. To be honest, studying at university is a challenge for me, I do not know how it is for others, but for me, it is not easy to adapt. Just like the assignments and projects and the peers who are smarter and more confident than me, I always feel tired when I compare myself with them. Luckily, after listening to their experience, I can encourage myself and push myself to keep going." [**Outreach** with **reinforcement** in knowledge with self-introspection, possibly leading to future **transformation** in their studies and future career.]

C. Miscellaneous

Students generally provided a log about their tour, with self-reflection on various aspects of the tour. Some students compared different aspects of Singapore to their home town. Most acknowledged that this had been an eye-opening tour that highlighted many things they had previously not thought about. The feedback was generally highly positive. It also gave us the momentum to make plans to hold the tour again, on a larger scale and with more carefully thought-out components.

"And I think Singapore's government did a good job of combining those ethnicities. Singapore's citizens are willing to accept other cultures and respect them. There are also many places that represent different ethnicities, like Little India and Chinatown. And tourists can go there and understand more. I went to a mosque and spoke with the clergy there; it changed the image of Muslims in my mind. And Singapore keeps a great balance between culture and innovation. There are many new ideas and the city changes fast, while Singapore still maintains some traditional buildings and culture." [**Outreach** with introspection and **reinforcement** of existing beliefs].

"In these five days, what I have learned is not only how global companies operate, but also how the world works. It is always true that travelling can expand one's horizons and can benefit one greatly. In the future, I would definitely take part if similar trips are held!" [**Outreach** with introspection and **reinforcement** of existing beliefs, such as the benefits of an exchange study, potentially **transforming** global viewpoint].

V. QUANTITATIVE EVALUATION

We also conducted a quantitative evaluation. After the study tour, we conducted a student survey (with a rating of 1-10) to evaluate the following aspects, which are relevant to the program learning outcomes:

- Communication: Communicate effectively in English at a level sufficient for project and system presentation and documentation. This corresponds to Seoul Accord graduate attribute 7 and ABET Computer Science attribute f.
- Global outlook: Demonstrate a global outlook on factors that can affect the way computing systems are developed and used. This is somewhat relevant to Seoul Accord graduate attribute 5, but with a strong correspondence to ABET Computer Science attribute g.
- Lifelong learning: Be responsive to and closely follow advancements in information technology and their impact on the industrial need for information technology, with an attitude of continuous and lifelong learning. This corresponds to Seoul Accord graduate attribute 10 and ABET Computer Science attribute h.
- Teamwork: Work together as a team in project design and development, while exhibiting leadership in a group or team whenever designated or necessary. This corresponds to Seoul Accord graduate attribute 6 and ABET Computer Science attribute d.
- Ethics: Understand and value ethical issues in the design and development of computing systems, in safeguarding information therein and in developing dependable systems as computing professionals and engineers. This corresponds to Seoul Accord graduate attribute 9 and ABET Computer Science attribute e.

Other program learning outcomes are more relevant to technical knowledge and problem solving and hence are not of particular importance to this first seminar course intended for freshmen. The specific survey question is:

> Please indicate whether this study tour has fulfilled the following program learning outcomes (Yes (Y) / No (N)). If you think that a learning outcome is not

relevant, please enter NA. For each relevant learning outcome, please provide a satisfaction score to indicate how well the study tour has fulfilled the learning outcome (1-10, where 9-10 indicates "fully fulfilled", 7-8 "well fulfilled", 5-6 "fulfilled", 3-4 "barely fulfilled", 1-2 "not really fulfilled").

The following table summarizes the mean scores (in descending order of scores to indicate their relative importance) (see Fig. 9):

TABLE II. MEAN SCORE FOR PROGRAM OUTCOME

Program outcome	Mean score	Standard deviation
Teamwork	7.96	1.28
Global outlook	7.81	1.55
Lifelong learning	7.73	1.40
Communication	7.62	1.33
Ethics	7.19	1.62

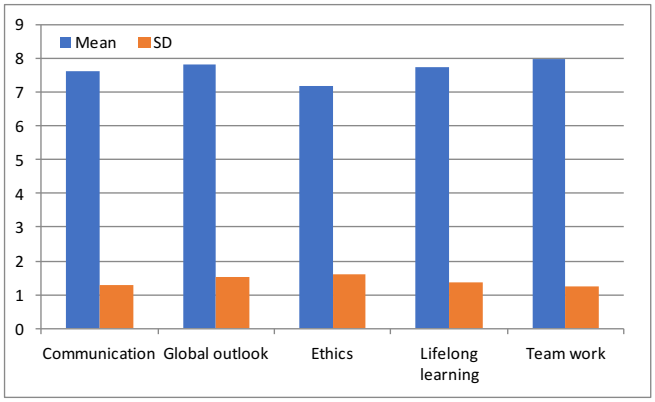

Figure 9. Survey results for program learning outcomes

The result indicates that students are the most satisfied with the learning outcome on teamwork. The standard deviation is the lowest as well. During the study tour, students were assigned into groups. Throughout the whole trip, they helped and supported one another. The study tour should have reinforced their understanding of the importance of teamwork in general. As expected, global outlook is another highly satisfactory learning outcome. However, the standard deviation is slightly higher. As the student trip was short, some students might think that the international exposures were still limited. While the satisfaction scores are slightly lower for lifelong learning and communication, they are still high, indicating their importance.

It can be noticed that most scores are over 7.5. In the survey scale, the scores of 7 and 8 represent well-fulfilled. It means that any score of 7.5 or above basically implies that students in general feel the activity fulfills their needs well, very much over the passing mark of "fulfill" at 5.5.

The lowest scores accompanied the ethical elements, something that is not as explicit to freshmen. At any rate, the score is still over 7.0, meaning that students feel that they also attained this, perhaps partially influenced by the visit to Kaspersky Lab on information security, the traffic accident detection system at NTU, as well as the hardworking attributes of Singaporean students.

We conducted *t*-test on the attainment of outcomes and see no significant differences between the first pack of four. However, the difference of attainment to the outcomes is statistically significant at a 95% confidence interval between Ethics and the others. The difference between attainment in Ethics and Communication is more marginal. The difference is only significant with 1-tailed test (i.e. Communications was attained better than Ethics) but not significant with a 2-tailed test.

In the student survey, we also asked the students to rate the core learning activities. The specific question is:

For the following activities during the study tour, please indicate a satisfaction score (1-10 where 10 indicates "very satisfied").

The following table summarizes the mean scores (in descending order of scores to indicate the relative perceived degree of success by students) (see Fig. 10):

TABLE III. MEAN SCORE FOR LEARNING ACTIVITY

Learning activity	Mean score	Standard deviation
Company visit	8.54	1.86
Interacting with Singaporean students	8.08	1.38
Cultural visit	7.88	1.97
Lecture /workshop	7.85	1.26
Project discussion	7.65	1.47
University visit	7.50	1.94

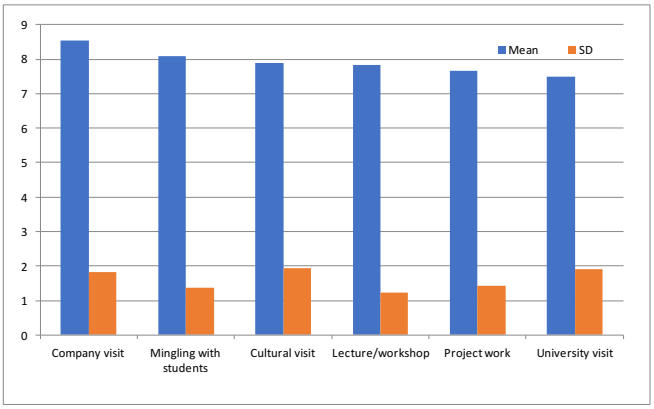

Figure 10. Survey results for various learning activities

It can be noticed that all of the scores are over 7.5. In the survey scale, the scores of 7 and 8 represent well-fulfilled. It means that any score of 7.5 or above basically implies that students in general feel the outcomes are well-fulfilled, very much over the passing mark of "fulfill" at 5.5. Of course, there are a few entries giving a high score of 9 or 10.

The first three items have one common characteristic – they cannot easily be replicated in our own location. In other words, students are more interested in new learning activities of a genuinely international nature. Although the lecture and project discussion were conducted in a different

environment, their nature was still similar. However, this is in contrast with the qualitative evaluation results. Very few students mentioned the project work, but since they really achieved something en route in the creation and completion of the semester project, that could have been useful in contributing to their satisfaction with the outcomes, although they do not think it is worth reporting in the reflection journal. In any case, all of the mean scores are still quite high, indicating that students were well satisfied with the study tour (i.e., the core learning activities) in general.

We also conducted *t*-test on whether there is any significant difference on the level of attainment among those six activities. It is clear that company visits are considered the most valuable. It can also be shown that at 95% confidence, the differences between company visits and the others are all statistically significant, under 2-tailed test. On the contrary, university visits are considered to be of relatively least value. The difference with student interaction activities is also statistically significant. Students in general enjoy the interaction activities more. That also leads us into planning more interaction activities in the future, perhaps with more students from more universities.

It may be worth noticing the existence of a few low scoring instances. There were three students who gave a score of below 5 to the university visits, perhaps due to the fact they were already familiar with university life, and other universities look similar to them, and they were thus not excited. There was also one student who did not enjoy the company visit and one student who did not enjoy interacting with the Singaporean students. These two are probably more like outliers. Actually, in the reflection reports, one student particularly mentioned that she did not like Singapore at all after our visit. One unfortunate event is that she hated smoking very much, but smoking is relatively common in Singapore. We are glad that our students do not attempt to hide their feelings in their reports.

VI. Conclusion and Future Work

In conclusion, we have presented an innovative TOUR (Transformation, Outreach, Unification and Reinforcement) model as an overarching framework for student learning and self-improvement. Based on this framework, we organized a study tour with six core learning activities for computing students. From the student reflection reports we collected after the tour, there is evidence that the study tour has transformed some students in various aspects. One major transformation is the fundamental change in student learning attitudes (i.e., the need to study harder, as inspired by the Singaporean students). Based on the student reflections, visiting companies is students' preferred outreach activity. Company visits also facilitate the unification of classroom theory/concept and real-life practice, because seeing is believing. Last but not least, the study tour reinforced student understanding/belief in the importance of information technology in our society, not to mention the reinforcement of knowledge in the application of the broad IT area. Furthermore, it has also reinforced the importance of languages and communication in their computing career. All of this has been achieved through the extensive outreach activities and student interactions with Singaporean students, professors and company representatives and founders.

In the future, we would like to do more quantitative studies based on the TOUR model and the impact of a study tour on student general learning and attainment in the long run. A form of longitutual study would have been useful, although more time consuming, in tracking through students. It is equally important to follow through on the cohort for performance and development differences across the group of students joining the tour and others. In another vein, we would like to pursue more in the TOUR to enrich and refine its elements, to make it a better and more comprehensive model when designing and evaluating similar activities.

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