CONFERENCE PROCEEDINGS

2019

Singapore Learning Design and Technology Conference

CHANITA RUKSPOLLMUANG, JEREMY PAGRAN, LEE MING TAN
Editors

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Conference Proceedings 2019- Singapore Learning Design and Technology Conference

PREFACE

Singapore Learning Design and Technology Conference 2019 (SLDT 2019), jointly organized by East Asia Research and Siam University, was held on the 1st and 2nd August 2019 in Singapore at the Grand Copthorne Waterfront.

SLDT 2020 achieved the objective of bringing together leading scholars, students and practitioners from overseas to Singapore for an academic exchange. The programme consisted of a keynote speech by Professor Emeritus Dr. Chanita Rukspollmuang, Vice President, Siam University, and a keynote speech by Dr. Jeremy Pagram, Edith Cowan University. A conference workshop on ‘Technologies in and beyond the classroom’ was conducted by Ms. Zina Cordery, Dr. Hendrati Nastiti, Dr. Barnard Clarkson and Dr. Alistair Campbell, all from the Edith Cowan University, Australia.

We have received close to 80 abstracts and accepted 16 papers to be presented at the conference. A total of 50 registered delegates from the following countries attended SLDT 2019: Australia, Czech Republic, Hong Kong, India, Indonesia, Japan, Singapore, Thailand, United Kingdom and United States of America. Participants were invited to submit papers to the present volume.

The conference will be renamed as International Conference on Technologies in STEM (ICTSTEM 2020) and will be held in Furama Riverfront, Singapore, on the 09-10 July 2020. I welcome you to this conference and look forward to your participation.

With warmest regards,

Professor Emeritus Chanita Rukspollmuang

SLDT 2019 Conference Chair

East Asia Research (EAR)

Established in Singapore in 2015, East Asia Research (EAR) envisions to be the gateway to improving lives and enhancing productivity in Asia through promoting cross-geographical exchange of ideas and knowledge in various faculties. This will be achieved through the dissemination of knowledge from the Asia-focused research conferences and publications by EAR.

EAR academic conferences provide a meaningful platform for researchers, post-graduates, academicians, and industry practitioners to share unique insights and drive innovation. This is a great opportunity for expanding contact networks beyond a singular field and kick-starting a strategic collaboration. Such partnership can bridge the resources and expertise of multiple disciplines to spearhead pioneer movements, giving rise to breakthroughs in long-standing issues.
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*East Asia Research*
ABOUT THE EDITORS

Dr. Chanita Rukspollmuang is currently the Vice President of the Siam University, Thailand. She also was a former Dean of the Faculty of Education, Chulalongkorn University. Dr. Chanita has been elected twice and served consecutive terms as the President of Comparative Education Society of Asia (CESA). Her second term just ended in 2016 but she is still a member of CESA Board of Directors. Also, she is presently Vice-President of the Thailand Comparative and International Education Society (TCIES).

At present, Dr. Chanita has been appointed in many important Thai committees. To mention a few:
• Office of the Education Council, member of the Education Committee (appointed by the Thai cabinet).
• Office of the Secretariat of the House of Representatives, member of Research and Development Committee.
• Office for National Education Standards and Quality Assessment (ONESQA), member in the Committee for Development of Assessment Systems for Higher Education.

Dr. Jeremy Pagram is a senior researcher for the School of Education in the Faculty of Education and Arts and Associate Director for the Centre for Schooling and Learning Technologies. His research interests include, e-learning in remote areas and diverse cultural contexts, digital assessment, study using technology in remote areas.

Mr. Lee-Ming Tan is the founder of East Asia Research and he obtained his Master of Applied Finance from the University of Adelaide. He is deeply interested in how humans function and react with each other. An insight into how people’s minds think and how they work together is invaluable in just about every field. Outside of work, Anthony Tan enjoys outdoor activities and occasional computer games.
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Enabling Students to Learn Hands-On Technical Skills Using Makerspace in a Higher Education Academic Library

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**Abstract.** This paper provides a snapshot of the operation, projects and offerings of an academic library Makerspace in a regional university in Queensland, Australia. It provides the value of Makerspaces in an academic library and the learning needs they achieve; and also reflects on the potential pedagogical impacts of Makerspaces on teaching and learning. In educational settings, the movement of learning through designing and sharing within collaborative settings is fundamental. Although making and creating is not new, Makerspace is a new way of saving user’s money on tooling and equipment and continues the tradition of building a circular economy for which libraries are famous. Makerspace can be used by all educators and students on any budget, and it is a creative and collaborative way to transform teaching and learning.

**Keywords:** Makerspace; Academic library; Hands-on technical skills; Higher education; Real life learning; Creative.

This paper provides a snapshot of the operation, projects and offerings of an academic library Makerspace in a regional university in Queensland, Australia. Makerspaces are areas or spaces where making and prototyping take place. Gerstein (2014, n.p.) sees a Makerspace not only as a space itself, but describes it “as a mindset that can be and should be taught”. They are physical locations that provide expensive tooling and equipment to build, make, repair and create objects. Halverson and Sheridan (2014) emphasised the emerging role of making in education. Makerspaces offer more than just an environment to create artefacts, it is rather a physical location where lecturers, researchers and students can get together “to share resources and knowledge, work on projects, network, and build” (Educause, 2013, n.p.). They are increasingly seen as new offerings for libraries to broaden their impact on knowledge sharing in the local community. Although there is a push to include Makerspaces in universities, little empirical evidence is available about the experience of establishing Makerspaces on academic campuses.

The concept of makerspaces in education is embedded in theory and research. Constructivism is the theory of “learning based on experience and observation. Through experience, and reflecting on these experiences, individuals construct their knowledge and understanding of the world” (Roffey, Sverko & Therien, 2016; Papert, 1993).
According to Roffey (2019, n.p.) these Makerspace experiences include “constructionism, the maker movement, design thinking, and media literacy, allowing a holistic approach to learning and operating within these constructs. The thinking process is the evidence of creativity, application and problem solving”. This gives learners a reason to learn more, as stated by Roffey (2019, n.p.) “…design thinking is a methodology that will encourage the solving of complex problems through ideation and iteration”.

Reading this paper, you will mainly gain three insights:
1. The value of Makerspaces in an academic library and the learning needs they achieve.
2. How Makerspaces can offer spaces of self-directed learning, providing an environment for inquiry-based learning and authorising the drive for discovery that describes the researcher and the scholar.
3. How to improve student engagement and creativity by building projects in other fields than engineering and technology.

Roffey (2019, n.p.) describes a Makerspace in an academic setting as a “collaborative digital space for educators to explore how to create and use makerspaces in their own environments and will help to transform pedagogies of individual educators through immersion in the context and the support of a community of practice”. At this university, there was a need to provide a working room, equipment and tooling in the library for technological experimentation; with the aim to increase self-directed learning to creative individuals and creative teams. Students do not just want to attend lectures, they want to work on personal projects, explore, create and enjoy time with their friends and meet new people (Dougherty, 2013). Thompson (2014) argues that Makerspaces for education focus on the benefit of engaging users in creative, higher-order problem solving thorough hands-on design, construction and iteration. Design and creativity are making their way to the forefront of educational considerations, and Makerspaces can address the needs of the future (NMC Horizon Report, 2015).

With the pace of current technologies, there is a shift in what type of skillsets have real, applicable value. Makerspaces are a great way for students to gain future skills, and project-based learning through kit workshops can catalyse student interest and allow participants to engage in hands-on learning experience. As detailed by Curry (2017), there is a heavy emphasis on the importance of experiential student-orientated learning and the division between knowledge and action in academic library Makerspaces. Furthermore, Halverson and Sheridan (2014) have found that Maker-based instruction has emerged as a largely untapped approach to promoting student learning and engagement. Blikstein and Krannich (2017) argue the case for project-based learning in Makerspaces with the statement “Digital fabrication and ‘making’ could be an unprecedented opportunity for educators to advance a progressive educational agenda in which project-based, interest-driven, student-centered learning are at the centre stage of students’ educational experiences” (p. 182).

This medium-sized regional university fosters a values driven culture - one that is built around relationships and community, mutual respect, diversity and inclusion, and a strong commitment to ethics and integrity, collaboration, creativity and innovation.
The university’s education experience plan is designed to assist the university to progress from strategic commitment to action in areas that improve the educational experience (University of Southern Queensland, 2019). The university’s academic library Makerspace is a community space for all students and staff to come together to make and create. This is the first Makerspace in the region. While many universities have engineering or product design facilities similar to Makerspaces, an academic library-based makerspace does not restrict students by discipline and can encourage cross-faculty collaboration. The Makerspace can be used for class projects, student clubs, to test an idea you might have or just for having fun. Currently, the Makerspace has a 3D Printer, a badge maker, hand tooling, a laser cutter, craft materials, consumables and much more. Within the academic library Makerspace, students can access a range of tooling and equipment from jeweler’s screwdrivers to 3d printing and 3d scanning. The space is a place for hands-on activities including coursework projects, repair and hardware entrepreneurship. In practice, a student studying human anatomy and physiology might make realistic models for hands-on learning, and an engineering student could complete the Warman challenge robotics assignment, where students are required to build a robot to undertake real world challenges. Biomedical lecturers working with the Makerspace have created ‘human tissue’ like scaffolds for seeding cells as part of simulated tissue engineering activities, and created universal microscope phone mounts for student microscopy photography.

The Makerspace has a focus on breaking down barriers to entry, including offering two free 3d prints under 300 grams to get started, offering swipe access outside of hours for students. The university also wanted to offer their mostly online students an equal experience, similar to the on-campus student experience. As part of a Student Amenity Fee-Funded grant, the maker kits project offers four different types of kits over the academic year: Arduino and sensors, wearable technology, obstacle avoiding robots and home automation. This is a great opportunity to learn essential key maker skills in electronics, microcontrollers and coding. These free kits can be mailed out to any enrolled online student residing in Australia without any charge to the student. The program has two aims:

1) To support distance education, online and on-campus students who are not able to make use of the community, equipment and learning opportunities that the Library Makerspace provides.
2) To alleviate the financial burden of purchasing kit materials for extracurricular learning opportunities.

Incurring the cost of kit-based workshops can restrict students from low socio-economic backgrounds from undertaking extracurricular professional development and recreational learning activities. As part of this program, students who receive a kit will be surveyed after each workshop. Project-based learning through kit workshops can catalyse student interest and allow participants to engage in hands-on learning experience.

The Makerspace is open for all staff and students regardless of course or study mode and can be used for course-work linked or personal projects and activities. At the moment, the aims of the Makerspace are six-fold where users:

1. learn new hands-on skills. They can master the 3D printer and attend a range of workshops to improve their skills; including coding, 3D printing, 3D
modelling, hardware entrepreneurship (including prototyping), tile painting, maker skills (including textiles and craft) and electronics. Working with tooling is often taken for granted, but it requires practice to gain experience in order to succeed. Selecting the right tool for the specific task and learning the appropriate technique is beneficial for safety purposes and productivity. Working hands-on with the tooling and equipment, and gaining experience increase the user’s independence and confidence regarding basic maintenance and repair.

2. **make study aids.** After users have attended the 3D printing workshop, they can 3D print a whole range of models freely downloadable from specific websites, for example thingiverse.com. When learning anatomy, they can print a spine as a teaching or learning aid. Makerspaces are especially helpful and financially beneficial if users do not want to buy expensive tooling for projects when they will only use them once or twice. The possibilities are endless with a 3D printer.

3. **wind down.** Users can unwind with their peers or lectures in the Makerspace after class by creating. Users can work on art projects and use the donated craft supplies by making and creating their own artifacts.

4. **start a maker project.** There are many open source projects with free instructions and resources to start with. Users can choose to build a Combat Hexapod Robot, a drawing machine, get started with home automation or collaborate on a larger project, for example a full-size humanoid robot. These projects are a great way to improve their hands-on experience. Students often build artifacts to show to potential employers.

5. **invent something.** Find a problem that needs solving, and use iterative design skills to make a prototype. Users can take their ideas with their prototype further by testing their invention and learn about entrepreneurship at the guest-hosted workshops. When users apply new digital fabrication techniques, and using 3D printing and laser cutting, anyone can be an innovator or a designer. Project-based building builds passion. Makerspace users can work towards the goal of building something for themselves or for the group.

6. **share their knowledge.** It is possible to share the newly acquired hands-on or technical based skills by hosting their own maker workshop, class or meet-up. Working with others in collaboration on a large project develops leadership skills. Large projects build leadership skills and result in inspiring, functional assets to local community. Examples of current collaborative projects include the Ikea Growroom (spherical greenhouse), 3D printed sculptures and the Boomerang Bag project (local communities challenge plastic pollution) (Piper, 2019).

Students and staff using the Makerspace are offered safety inductions and guidance on the correct usage of the 3d printers and other equipment, and they are also encouraged to use the machines independently and teach others to build competency and skills. This practice builds capacity and leadership skills in students, allowing them to be confident in using new digital technologies. Planned entrepreneurship style challenges will push these skills further, building design thinking and a mindset for innovation. Equipment such as basic hand tooling, 3d
printing and various consumables are essential in building a budding Makerspace. From there, Makerspaces grow with their local community of users and may include extra tooling and equipment to cater for specific interest groups, including soldering and electronics equipment, craft and sewing, laser cutting and more. For educators wishing to start their own makerspace on a budget, asking for donations of consumables from their local community is a great way to build up stock. However, it is best to have clear rules around what is wanted and not wanted to avoid excess donations that are not useful.

The outcomes of an on-campus Makerspace include enabling students to build competency with hands-on digital fabrication skills, troubleshooting and more. Regular 3D printing, Arduino, robotics, website building and 3d modelling courses continue to build capacity in students and staff. The following informal excerpts provides positive feedback from students and lecturers:

“The makerspace is a great place to hang out and learn new things, learning to use the 3D printers was great fun and easier than I thought it would be.” (student).

“The support from the Makerspace to build new things to support the student experience is invaluable” (lecturer).

While the makerspace is still new at this academic library, the service is already having a profound impact on student learning. Not only does the Makerspace offer a beneficial service for on-campus students, the maker kits projects are an enabler for online and distance students. One student gave the following encouraging feedback:

“Just a quick note to let you know what a difference things like this make, I have never felt so connected to my university community, and I have never even stepped foot on campus. You guys do an amazing job.”

As a Makerspace supervisor, helping students is mainly about facilitating, giving guidance in order to build user’s confidence and independence. While it is easy to step in and do the job for someone, it is better to step back and let the student or staff members gain the skills to complete it themselves next time. It is also important to set up a space that is user friendly, easy to understand and make sure that everything has an obvious, well signed home to avoid missing items and clutter in the space. At this university, the Makerspace began as an unsupervised, small space which could not offer a wide variety of tooling due to lack of supervision and associated safety issues. It has now grown into a supervised space in a larger location with a much greater variety of equipment and hand tooling available. It is recommended that starting a makerspace with the latter rather than the former to start building up users and a community from the start. Currently, the Makerspace is open five days a week with active supervision, except when the Makerspace supervisor is delivering workshops or presentations at other locations.
access is available for students to use the space outside of hours for 3D printing and hands-on work.

The researchers look forward to having a wider focus on hardware entrepreneurship in the Makerspace in the future. Hosting hackathon style competitions with prizes, battle bots and drone challenges can build skills and an energetic community. Hackathons are events focused on solving a problem over an intensive weekend or 48-hour time period in teams. Hackathons are challenge-based competitions, often with prizes, held over a weekend. They traditionally involve a ‘solution pitch’ night on a Friday evening, where teams are formed. The remainder of the weekend is spent prototyping/building a business and validating the proposed solution. On the final day, usually a Sunday, the participants deliver a presentation on their idea to a panel of judges and winners are announced. These high-pressure competition events can create great solutions for problems, and teams may continue with the idea after the weekend if they believe it could become a real product/solution. Engaging in global events such as Start-up weekends allow students to form teams and design solutions for problems in a hands-on way, and discover the ‘lean start-up’ process for starting a sustainable business around the idea over a weekend. Many of these competition style events often result in real solutions and a motivated team who is willing to build a real start-up company around it. The Makerspace will also be engaging in a variety of data collection, including surveys of makerspace user demographics including age, student/staff, study area and tool usage. This will give direction to the makerspace future plans with evidence-based practice, building a space that is defined by the community.

Data collection of new visitor and repeat visitor numbers began in 2019, where an ‘Internet of Things’ smart button by Flic was used in conjunction with the ‘If this, then that’ (IFTTT) service to log the data. When the button is pushed once, it logs a new visitor in a google sheet, and when pushed twice, it logs a repeat visitor. This data shows a dramatic rise in new visitors during orientation week, and a rising number of repeat visitors from week one of the semester. The Makerspace averaged seven new visitors and seven repeat visitors daily, with a high of 20 repeat visitors and 16 new visitors. The following graph indicates the data collection of new visitor and repeat visitor numbers collected using the smart button by Flic. Future use of this button will also involve using a Raspberry Pi (miniature computer) to connect a receipt printer to the button. When the button is pushed once to log a new visitor, the receipt printer will make a welcome note for the visitor to keep, including information on the latest events and facts about the space. Swipe access is also available for the space, and the button plays a fun air-horn sound as an incentive to log visitation when the makerspace supervisor is not present to push the button on behalf of a visitor. Logs from the swipe access reader can also be downloaded from the system to analyse the smart button data. Ideally, visitors can be responsible for logging their own visitations with just a simple button push. This makes data logging easy, rather than a full survey-style sign in/sign out sheet that can act as a deterrent if it is time consuming, especially for short visitations in between classes.
In this paper, the researchers reflect on the potential pedagogical impacts of Makerspaces on teaching and learning. According to constructionism, the best learning takes place when students are making concrete artefacts through real life learning and authentic opportunities. In educational settings, the movement of learning through designing and sharing within collaborative settings is fundamental. Although making and creating is not new, Makerspaces are a new way of saving users money on tooling and equipment and continues the tradition of building a circular economy for which libraries are famous. Makerspace can be used by all educators and students on any budget, and it is a creative and collaborative way to transform teaching and learning. Often a local community of practice with knowledge regarding hands-on and new digital skills is built around collaboration with many beneficial and positive effects for all the stakeholders.

References

Impact of Pedagogical Space Design on Collaborative Learning in Tertiary Education

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Abstract. The integration of communication and information technologies has induced pedagogical changes. Teaching methods have shifted from “passing expertise knowledge to students” to “active and collaborative learning”, which has brought about changes in learning space design. Facilities should be able to encourage learner participation through provisions, such as IT/AV enhancements. Learning space configuration should also allow flexibility in adapting to different uses. Modular furniture can facilitate quick reconfiguration to enhance group activities. The Hong Kong Polytechnic University has carried out refurbishment work on traditional classrooms and lecture theatres aiming at improving the learning environment. Conventional classrooms and lecture theatres were renovated into modern and technology-enhanced teaching rooms to facilitate active learning. Questionnaire surveys were conducted to review the performance of the renovated learning spaces. This paper summarizes the survey findings and draws conclusions on how space and furniture design can facilitate collaborative learning in tertiary education.

Keywords: Modern technologies; collaborative learning; learning space design, flexible furniture.

1. Introduction

Learning is the central activity of tertiary education and includes formal learning in classrooms/lecture theatres, and informal learning involving interaction among individuals (Oblinger, 2006). Traditional teaching is based on teacher-centered method that is primarily concerned with the one-way delivery of information to students (Jamieson, Fischer, Gilding, Taylor, & Trevitt, 2001). Learning space design in
traditional pedagogy is focused on the delivery of information from teachers to students. The teaching lectern is the focal point of the teaching space, and students are oriented towards it. Comfort and ergonomics are the main considerations in furniture design. Modern technologies have induced pedagogical changes (Cornell, 2002). Information and telecommunication technologies have become an effective tool for access to graphics, sound, presentations, and real-time interactive communications that provide a vast array of teaching opportunities for teachers (Colace, De Santo, & Vento, 2003; Fruchter, 1999). The increasing ownership of digital devices like computer notebooks has enriched learning methods (Brown & Long, 2006). The integration of communication and information technologies shift teaching from teacher-centered practices with primarily one-way delivery of knowledge to student-centered and flexible learning approaches (Jamieson, 2003). Learning becomes an active constructive process in which students become more responsible for their learning (Jamieson, 2003). Students’ active participation and interactivity, particularly in group activities, are playing important roles in university education (Brown & Long, 2006). Built pedagogy is the ability of space to define the teaching method (Oblinger, 2006). Well-designed learning space can facilitate and enhance active/collaborative learning, provide an environment to students for academic and social purposes, and promote the use of modern facilities (Lippincott, 2006). The design should be user-centered taking into consideration (a) functionality (flexibility and adaptability), (b) user-friendliness, (c) comfort, and (d) aesthetics (Cornell, 2002; Lippincott, 2006; Chism & Bickford, 2002). Classrooms should be equipped with a variety of technologies to support computer activities and designed to allow flexibility and support the multifunctionality of the learning spaces to facilitate groups of different sizes (Lippincott, 2006). Ubiquitous power sockets should be provided to support a variety of modern technologies including computers, projectors, smartboards, video editing equipment and video conferencing tools (Fruchter, 1999; Brown & Long, 2006; Lippincott, 2006). Teachers should be able to move close to students and walk freely around the classroom to engage individual students without physical obstacles (Chiu, 2016).

Modular furniture should be provided to enhance group activities in different sizes (Chiu, 2016; Ceppi & Zini, 1998). Modular tables can facilitate speedy reconfiguration (Fruchter, 1999; Chism & Bickford, 2002; Chiu, 2016; Taylor, 2009). Chairs are preferred to be designed on mobile wheels to facilitate grouping, have a flexible back, adjustable seat height, and adequate foam support for personal comfort (Cornell, 2002). Ambient lighting, good sound insulation and adjustable interior temperature can provide a comfortable environment for learning. The use of lively colors, interesting textures and patterns can further motivate learning (Lippincott, 2006; Taylor, 2009).

2. The Strategic Plan 2012-18 of The Hong Kong Polytechnic University

In view of the current developments in teaching pedagogy, The Hong Kong Polytechnic University (PolyU) has carried out a series of refurbishment work to conventional classrooms and lecture theatres under the Strategic Plan 2012-18 (The Plan). The work includes updating, upgrading and creating innovative learning spaces and facilities at
PolyU with the aim of improving the learning environment. Upgrading, refitting and revamping work on some classrooms and lecture theatres has been carried out since summer 2014. Most of the renovation work was completed in 2017. Two questionnaire surveys were conducted to collect feedback from students and teachers who had the experience of using the renovated classrooms and lecture theatres as learning spaces. The questionnaire surveys aimed to review the effectiveness of the renovations.

Traditional teaching rooms were transformed into modern and technology-enhanced teaching rooms with upgraded IT/AV facilities. Classrooms N001, 002 and 003 were combined into a large learning space. Movable glass partitions were installed to support different sizes of teaching groups (Fig. 1). Flexible furniture was provided to enhance grouping (Fig. 2). Vibrant colours, like patterned flooring (Fig. 3) were introduced to promote learning incentive. The renovation works are expected to enhance both active and conventional teaching.

*Fig. 1. Movable glass partitions in N001, 002 and 003*

*Fig. 2. Flexible furniture*
3. Questionnaire Survey

A questionnaire survey was conducted to collect student comments on the performance of the refurbished classrooms and lecture theatres as students are the major stakeholders of the learning spaces. Based on literature review and the scope of The Plan, the survey questionnaire was compiled from categorizing the renovation works of learning spaces into the four design principles: (a) application of modern technologies to facilitate collaborative learning, (b) flexibility in space design, (c) creating comfort in the learning environment, and (d) aesthetic in the learning environment. Students were asked to rate their level of agreement that the provisions have achieved their design purposes (1 = strongly agree; 2 = agree; 3 = no comment; 4 = disagree; 5 = strongly disagree). They were also asked to rank the importance of continuous assessment on the performance of learning spaces. Four rounds of the questionnaire survey were conducted in November 2017. Five hundred copies of questionnaire were distributed, and 402 completed copies were collected and scrutinized with a response rate of 80%.

4. Analysis of Questionnaire Survey

The data collected from the questionnaire survey was tabulated with the use of the Microsoft Excel 2016 software and exported into the database in the SPSS statistical software. The data was analyzed by Factor Analysis in order to reduce a set of large data into smaller sets of components for better analysis (Pallant, 2000; Pallant, 2007; Chan, Cheung, & Wong, 2015a). The relative importance of the identified impacts was analyzed with the “mean score method”. The mean scores (MS) for each variable of perceived effects were ranked in ascending order according to their relative importance from calculation based on the five-point Likert scale, where 1 = “strongly agree” to 5 = “strongly disagree”. Effect variables with a value below 3 are important. The MS were computed from formula 1 below (Chan, Cheung, & Wong, 2015b):

Fig. 3. Vibrant floor patterns
The 15 variables of design requirements/elements were examined by Factor Analysis using the extraction method of Principal Component Analysis and the rotation method of Oblimin with Kaiser Normalization converged in 10 iterations with the number of components to be extracted set to ‘6’. With reference to Table 1, the values of KMO and Sig. are 0.926 and 0.000, respectively, which support that applying Factor Analysis as the analytical tool is appropriate.

Table 1. KMO and Bartlett’s Test

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5. Findings of Analysis

Six components were identified after rotation as listed in Table 2. The rotation solution presented the pattern of loadings in a manner that was easier to interpret (Pallant, 2007). Table 3 summarized the results after factor extraction and rotation. The six components are categorized into 6 underlying factors which are (i) Modern Technologies, (ii) Facilitation for Group Discussion, (iii) Multifunction, (iv) User-friendliness, (v) Comfortability and (vi) Manageable and Pleasant Environment.

5.1. Modern technologies

Rapid developments of information technologies have a large impact on classroom design and induced pedagogical changes (Graetz & Goliber, 2002). The learning method has shifted from “passive” to “active” student-centered and flexible learning approaches (Brown & Long, 2006; Jamieson, 2003). Higher education has become reactive (Fruchter, 1999). Classrooms should be equipped with a variety of modern technologies (including computers, projectors, smartboards, video editing equipment and video conferencing tools) and flexible furniture (Brown & Long, 2006; Lippincott, 2006). Factor (i) reviews that modern and technology-enhanced teaching rooms can facilitate interactive and student-centered learning.

5.2. Facilitation for Group Discussion

Learning space design has shifted from “information commons” to “learning commons”, or from design based on resources to human-centered basis (Brown & Long, 2006). Facilities that encourage learner participation are increasingly important in learning space design (Jamieson, et al., 2001). Brown and Long (2006) suggested that space layout and furniture design should enable easy reconfiguration to facilitate constructivism learning. Lam et al. (2016) identified that learning activities such as...
debate, discussion and teamwork are conducive to active learning principles, which can best be carried out in small discussion groups. Flexible furniture, such as movable chairs and modular table, can allow speedy re-grouping of students into different group sizes to facilitate group discussion.

5.3. Multifunction

The size and form of a lecture theatre govern much of the teaching that happens within it. New learning environments need to allow for multi-functionality (Jamieson, et al., 2001). The learning space should be able to reconfigure on an as-needed basis to support computer, activities, teamwork, presentations and interaction in the geographically distributed setting (Fruchter, 1999; Lippincott, 2006). The design of multifunctional classrooms should allow for the speedy reconfiguration of the learning space. Movable partitions such as glazing panels in N001/002/003 enable flexibility in the learning space.

5.4. User-friendliness

Maximizing user-control of facilities by teachers and students is important in interactive learning (Jamieson, et al., 2001). Usability implies clarity, ease of use, access and control of the provisions. Users need to understand the operation of the facilities and feel empowered to use them (Cornell, 2002). The upgraded IT/AV tools such as multiple monitors, touch-sensitive monitors, projector screen and writing glass panels should be user-friendly and simple in operation.

5.5. Comfortability

The intent of addressing comfort is to promote well-being and minimize distraction (Cornell, 2002). Interior design, furniture design and microclimatic condition of the classroom/lecture theatre are contributing factors to comfortability. Teachers should be able to move close to students and walk freely around the classroom to engage individual students without physical obstacles (Chiu, 2016). Furniture should be flexible and facilitate grouping (Chiu, 2016; Ceppi & Zini, 1998). Mobile chairs with flexible backs, adjustable seat height and adequate foam support for personal comfort are preferred to facilitate grouping (Cornell, 2002). Ambient lighting, good sound insulation and adjustable interior temperature can provide a comfortable environment for learning. Lively colour, interesting textures and patterns can further motivate learning (Lippincott, 2006; Chism & Bickford, 2002).

5.6. Manageable and Pleasant Environment

The right environment can create a more relaxing and sociable setting (Cornell, 2002). It is doubtless that a pleasant, comfortable and appealing environment can motivate learning. The feeling of comfort may vary under different climatic conditions. For instance, a higher lighting level and warmer interior temperature are preferred in the cold winter season. The ability of users to adjust the interior condition of learning
spaces according to their needs at different times can ensure a comfortable and pleasant environment that promotes learning.

Table 2.  **Pattern Matrix**

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td>.142</td>
<td></td>
<td>-.717</td>
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<tr>
<td>1.3</td>
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<td>-.193</td>
<td></td>
<td>.168</td>
<td></td>
<td>-.585</td>
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<tr>
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<td></td>
<td></td>
<td>-.818</td>
<td>.108</td>
<td></td>
<td>-.104</td>
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<td></td>
<td>-.865</td>
<td></td>
<td></td>
<td>-.155</td>
</tr>
<tr>
<td>2.3</td>
<td></td>
<td></td>
<td>-.885</td>
<td></td>
<td>.117</td>
<td>.116</td>
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<td></td>
<td>.915</td>
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</tr>
<tr>
<td>3.2</td>
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<td></td>
<td></td>
<td>.722</td>
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<td>4.3</td>
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<td></td>
<td></td>
<td>.904</td>
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<td></td>
</tr>
</tbody>
</table>

*Note: Extraction Method: Principal Component Analysis.*

Rotation Method: Oblimin with Kaiser Normalization.
Rotation converged in 10 iterations.

**Legend**

1.1 The equipped technologies (e.g. computers, projectors, smartboards, video auditing equipment, video conferencing tools, 3D visualization, etc.) enhance learning

1.2 The provision of plug-n-play (access to technology, ubiquitous power and data connection) is useful

1.3 Say-n-see: You can easily present, modify, record and retrieve information by using the provided facilities

2.1 Versatility: The learning space is designed for multiple uses

2.2 Relate-n-reflect: The space design facilitates group discussion

2.3 Fold-n-go: the furniture can be easily reconfigured to facilitate grouping in different sizes

3.1 Chairs with flexible backs and adjustable seat heights are comfortable and enhance concentration in learning

3.2 The acoustics of the room are satisfactory and improve concentration

3.3 Lighting is ambient

3.4 Adjustable lighting level can enhance learning

3.5 The interior temperature is comfortable

3.6 The ability to adjust interior temperature is important to learning comfort
4.1 Inspire-n-invite: the environment is comfortable and enjoyable
4.1 The use of color can motivate learning
4.3 The textures, patterns and finishing are interesting which can motivate learning

Table 3. Summary of Factor Analysis

<table>
<thead>
<tr>
<th>Components</th>
<th>Factors</th>
<th>Underlying Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 Technologies enhance learning 1.2 Technology-associated provision is useful</td>
<td>Modern Technologies</td>
</tr>
<tr>
<td>2</td>
<td>2.2 Space design facilitates group discussion 2.3 Furniture design facilitates different groupings</td>
<td>Facilitation for Group Discussion</td>
</tr>
<tr>
<td>3</td>
<td>2.1 Learning space designed for multiple uses</td>
<td>Multifunction</td>
</tr>
<tr>
<td>4</td>
<td>1.3 Ease of use of facilities i.e. user-friendly</td>
<td>User-Friendliness</td>
</tr>
<tr>
<td>5</td>
<td>3.2 Good acoustic provision can improve concentration in learning 3.3 Ambient lighting is important 3.4 Adjustable lighting enhances learning</td>
<td>Comfortability</td>
</tr>
<tr>
<td>6</td>
<td>3.6 Adjustable room temperature provides learning comfort 4.1 Comfortable and enjoyable environment is important</td>
<td>Manageable and Pleasant Environment</td>
</tr>
</tbody>
</table>

6. Discussion and Conclusion

The data collected from the 402 completed questionnaires were analyzed by Factor Analysis processed by SPSS. After factor reduction, six components were identified. The six components can be categorized into six underlying factors relating to Modern Technologies, Facilitation for Group Discussion, Multifunctionality, User-friendliness, Comfortability, and a Manageable and Pleasant Environment. The development of applying IT/AV technologies is rapid, which induces pedagogical changes. Modern technologies such as computers, projectors, smartboards, video auditing equipment, video conferencing tools and 3D visualization have become common teaching media. Ubiquitous power and data connections should be provided in classrooms and lecture rooms for access to IT/AV technologies. In interactive and collaborative learning, students are encouraged to participate in group discussion. The design of the learning spaces and furniture should facilitate grouping. The design of the teaching room is preferred to be multifunctional for effective use of space and adaptability to different methods of teaching/learning. Movable partitions can easily divide a large teaching space into smaller rooms for different class sizes and for carrying out different activities.
Modular furniture can be easily reconfigured into different group sizes. The provided technologies should be user-friendly and simple in operation, allowing students and teachers to operate them with little to no technical support enhancing efficient collaborative learning. A comfortable environment can promote student concentration in learning. Good acoustic provision, ambient lighting and thermal comfort contribute to learning comfort. User-manageable interior conditions are important in providing a comfortable learning environment. Users should be able to adjust the interior temperature of classrooms and lecture theatres according to different weather and climatic conditions. Lively interior design can motivate learning. Careful selection of colour, texture and pattern of finishing can create a vibrant atmosphere.

Conclusively, pedagogical space design is important to facilitate interactive learning and collaboration among teachers and students. The design of the learning space should be student-oriented, which facilitates the application of modern technologies in teaching and learning. Flexibility in the use of learning and teaching spaces should be allowed to maximize the functionality of the room. Furniture design should facilitate group discussion which should create a comfortable and pleasant interior learning environment as vital design considerations.

7. Acknowledgements

The authors gratefully acknowledge the Working Group of Innovative Learning Spaces of The Hong Kong Polytechnic University for providing funding to support this research effort.

8. References

Diversification of Study Materials with Regard to Student’s Abilities

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Abstract. One potential way to adapt educational methods to different types of students is through the diversification of study materials with regard to the student's abilities. This paper will present our experience with preparing two types of learning materials (worksheets and research days) for secondary school children in science subjects, based on their abilities (gifted, average, and special education-students). The conclusions of eye-tracker technology verification of learning materials will be discussed.

Keywords: Science, Special educational needs student, Gifted student, Twice-exceptional student, Worksheet, Research day, Eye-tracker.

1 Inclusion in Education in Czech Republic

250 years of systematic education in the Czech Republic has witnessed many different models that have reflected the needs of society, reacted to technical development, and adapted to current didactic trends. Changes in the political and social conditions created a demand for numerous changes to be made to the school system. These changes were enshrined in new laws and decrees. In 1990, the main changes were the abolition of the "unified" school and the introduction of the possibility of differentiating teaching according to the abilities and interests of children, the abolition of provisions on the obligation of a unified ideological orientation of education, and the introduction of legal personality of schools and the creation of non-state education. At the same time, the integration of students with special needs into mainstream schools began. In 2005, the prerequisites for equal access to education were declared in the Education Act (No. 561/2004 Coll.) which provides special provisions for the education of children of members of national minorities, students with special educational needs, and gifted pupils (“Východiska a právní rámec”, 2019). Nevertheless, inclusion was mainly focused on students with special educational needs because these changes were strongly financially supported.
1.1 Quality of Primary and Secondary Schools

In general, the management and administration system of education was greatly decentralized in the described period. With the significant decentralization of Czech education, emerging differences in school quality were also related. According to The Organisation for Economic Co-operation and Development (“OECD”, 2019), a difference of up to one and a half years of schooling may arise in the skills and knowledge of children of the same age in different schools. Yet, the Czech Republic is one of the countries with the lowest skill level differences between different groups of people. Between 2006 and 2015, the Czech Republic ranked among the countries where the most important influence on a child's results is their family background. The Educhange Foundation also points to the slight long-term deterioration of results in math and science at the end of primary and secondary schools for this difference (based on PISA 2012 and 2015, TIMMS 2007 and 2011). The differences in schools are also related to the fact that there is a large number of municipalities in the Czech Republic that set up the schools, and currently, according to the analysis, about 60% of these schools are not founded by experts qualified in education. At present, there are 14.5 pupils per teacher on average, which is only one child more than five years ago. However, the average is not a good indicator in this case as it compares small classes in villages where there are few students and, often, unskilled teachers with large classes in cities usually with 30 students.

The lack of teachers was just one of the main complaints that the European Commission addressed to Czech education last year. The teaching staff is also aging – only 19% of all primary school teachers are under 35, and almost 18% of domestic teachers are over 56 years old. Considering the date when the inclusion of diverse pupils begun in Czech education, it is clear that older teachers do not have sufficient information or experience to deal with inclusion.

In addition, there have been significant changes in the pupil's generation with the rapid development of technology. We are now facing the question of how to improve teachers' competences both in terms of the differentiation of pupils and in terms of the need to reflect current trends, mainly related to the development of digital technologies. One way to improve the situation is through lifelong learning for active teachers; providing them with training or guidance and materials to work with.

1.2 Identification of Students

There is currently no functional tool in the Czech Republic to identify gifted or special needs students. Identification is based on optional requests by parents for pedagogical-psychological testing, which is often a very long process. The assessment of each pupil's abilities and possibilities to develop their potential is currently dependent on the initiative of the teachers. Special education needs, due to their long history of implementation, are already more recognizable to teachers. It is more difficult to identify gifted pupils; teachers perceive them rather as being undisciplined. Gifted children can often get bored at school; they are disruptive and do not pay attention to the teacher. Therefore, teachers perceive them as hyperactive. However, professional literature shows that, especially in gifted children, misdiagnosis and conclusions can
occur in this context and therefore targeted, psychological diagnosis is needed to determine or refute ADHD. The most complicated situation is in the case of twice-exceptional students, meaning gifted children who give evidence of having one or more disabilities (e.g. SpLD, ADHD, speech and language disorders, emotional/behavioral disorders, etc.). Handicaps and talents are often compensated for and/or masked by one another, and therefore these children are usually referred to by teachers as being average.

2 Our Project

The strengthening of teaching competences of secondary school teachers of science subjects (biology, chemistry, physics, geography, and cross-curricular overlap of mathematics) regarding the diversity of students’ abilities is solved by our project Příroda (supported by the European Social Fund in 2017-2019). We primarily adapted the learning materials to different types of students through the diversification of study materials with regard to student's abilities as well as prepared methodologies aimed at describing the target groups of pupils. Both of these project’s outputs will provide the teachers with information about the characteristic features of such students and about the specifics of their educational requirements. The target groups of students were children aged 12/13 and 14/15 at secondary school (ISCED 2A). The aim of the project was to prepare two types of learning materials for each selected topic – worksheets and research days. Furthermore, the didactic methodology for each science subject and the age group of pupils, plus the methodology for each of the three levels of pupils, were prepared.

2.1 Objectives of the Research

The project was designed in two rounds of action research. The base point at the beginning of the research was the selection of the topic from the subject and the mapping of its current educational approach in secondary schools. In collaboration with psychologists, educators, experts in didactic method and experts, the theoretical background was created, which defined the ways of processing individual learning materials. It also defined various groups of pupils and teaching methods to be used in the preparation of the materials. Primarily, inquiry-based learning method and project-based learning were selected. The project was particularly beneficial because it sought to present science subjects as malleable and to point out their interesting side with potential for further development, research, and cognition. It could also show that science is not only a set of concepts, definitions, and algorithms, but it is closely linked to real life. Secondly, fieldwork, especially in the case of research days, was proposed.

Based on the theoretical background, teaching materials were created, taking into account both the different levels of pupils and reflecting the teaching methods. Even though each student is unique, we used rough fuzzification to create three groups of students – gifted, average, and special education-students. One worksheet per topic in each subject was prepared for each age group with regards to the curriculum and set to last for 45 minutes, including the reading time. The worksheet was intended for individual study and its length corresponded to one lesson. The document comprised
a set of activities that a pupil was supposed to do and subsequent questions that would help him/her to make conclusions from the observations. Research days were prepared for eight teaching hours. It was an all-day program for pupils, composed of practical activities on the given topic, mostly done in the field or laboratory. During the research days, students worked in groups, but there were also activities, experiments, and/or measurements realized by each pupil individually. The group plays the role of a discussion forum, but with efficient grouping, it is also possible to create the best work situation for each pupil. Pupils who are not proficient in science can be handy and skilled or have potential in other areas, so they also contribute to the team's success.

2.2 Diversification of Materials

The model of the easiest adaptation for pupils was often used initially in the implementation of inclusion in education. The model of easiest adaptation would mean reducing tasks for pupils with special needs, prolongation of time for the solving of tasks for these students, or adding more tasks for gifted pupils. Since we had a limited time, we could not prolong the time students had to complete the tasks. Instead, we modified the number of questions/activities based on the students’ needs. It is clear, however, that such a procedure is not sufficient because a different level of pupils is not based on the length of time required for solving the tasks, but on a different level of logical thinking operations. If we want to tailor materials to different groups of pupils, the questions and tasks themselves must be formulated differently (Haar, Hall, Schoepp, & Smith, 2002; Hooda & Devi, 2017).

In the case of pupils with special educational needs, we used other methods – for example, a sample task appeared, which they could then use to solve other tasks or, a supplementary picture was given to help them imagine the situation. In the case of research days, in addition to the assignment, there was a list of job aids and workflow that helped them prepare and realize the measurement. While average students had a list of job aids to use for the measurement, gifted students had only the assignment – they chose the tools and workflow of measurement at their discretion. Weaker students evaluated their results through questions that prompted them what they should observe and how to explain the results. Gifted students had the opportunity to make hypotheses before the measurement and confront the results with their estimates. We were also faced with twice-exceptional students. Because twice-exceptional students usually have a combination of talent with learning disabilities (dyslexia, dysgraphia, etc.) or behavioral disorders, we have to work carefully with the length of the text, distracting effects of other irrelevant parts of the material, etc. In the case of these students, it is also necessary to give them space for their own creativity. The activities that are realized in groups might not be comfortable for them, so we needed to prepare the groups thoughtfully so that every pupil found his/her place in the team.

2.3 Verification of Quality

Subsequently, there were two rounds of action research within the project, which verified the functionality of the created materials. Each round of the action research
was closed by a roundtable where conclusions and modifications of teaching materials were set. During each round of the action research, pilot testing of the prepared materials was carried out at 30 partner schools by 65 teachers. Overall, more than 80 pilot tests of worksheets and 80 pilot tests of research days were conducted. Each topic was tested on an average of 10 classes, approximately 250 pupils. The division of pupils into groups was very diverse, as there was no other way to organize it other than to leave it to the teachers' discretion. Some teachers classified almost the whole class as average, while some identified more than 80% of pupils as gifted. In some cases, division into groups did not clearly correspond to generally known statistics. Because the materials differed not only by the number of questions but also by the assignment itself, it was not possible to sufficiently evaluate the results of the pilot testing for unsuccessful pupils especially in classes where the division of students was statistically disproportionate.

More detailed information was taken by the eye-tracker measurement, with which we have previous experience (Škrabánková, Laš, & Bujok, 2018; Škrabánková & Trnová, 2015). With this technology, we did not measure the entire materials but only selected tasks. Measurements were made on a small number of students (on average 10 students per one learning material). First of all, the eye-tracker measurement gave us feedback on the concept of learning materials. It also provided us with valuable information on how pupils were able to concentrate, how they solved the tasks, and whether they monitored the whole assignment. For example, by tracking the eye contact with a monitor, it has been clearly shown that in cases where a sample task was given, weaker students return to it and actually solve all other tasks by comparing them with the sample task. If there was not a sample example in the task, or if another solution procedure was needed, they did not solve it. It was also possible to verify the time duration of the solution of individual tasks. For longer texts, the interruption of eye fixation and repeated returning to the assignment was seen, which means that the pupil was unable to carefully read the entire task before solving it. It is therefore better to break down more complex tasks into several smaller steps. It was also interesting to observe that, in general, students were not used to working with images and graphs and did not verify their results on them, even though the task offered them. At the same time, gifted pupils were able to select very quickly whether the image was usable for the solution itself or just accompanying the text. We also gathered information on how twice-exceptional students worked.

3 Conclusions

We are currently finalizing the conclusions of the two rounds of the action research and formulating them into subject methodologies. After their finalization, we will make conclusions in three general methodologies, for each group of pupils individually. In the meantime, we have received feedback from the teachers who participated in the project. They especially appreciated the research days since they were more complex, reinforced cross-curricular links between different subjects, and were fun and interesting for pupils. In addition, the selection of topics for which the materials were developed was positively evaluated because these topics are difficult to teach and the support was therefore welcome. The worksheets have been recommended as suitable
primarily for novice teachers. The questions of individual work versus group work as well as the setting of working groups were also discussed. The most significant benefit of the research days is the differentiation of materials with regard to the level of pupils, as they make it easier for the teacher to individualize teaching.

A number of other questions have also been opened during the research. The most striking was the fact that pupils at school are not encouraged to work with new technologies – which was necessary for the materials we created. The internet, as well as mobile devices, are forbidden to use in many schools, most often to prevent pupils from playing games during their classes.

However, the overall results of the research and quality of our work will be clear after finishing the project, when the final materials, as well as the methodologies, will be made available to all teachers to offer them more information about working with individual groups of pupils.

Acknowledgments

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References

My Speaking Apps: Non-Face-to-Face (NFtF) Medium of Learning in 4.0 Education

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Abstract. Educators need to be creative and innovative in the use of technologies in their pedagogical approaches in Education 4.0. Thus, a language learning module has been innovatively designed and developed using the mobile application My Speaking App (MSA) to overcome students’ difficulty in finding time and partners for face-to-face (FtF) speaking practice. It was created as a tool for personalized learning for non-face-to-face (NFtF) communication. A mixed method was employed in this study to gain a deeper understanding on the research feedback from 163 pre-university students before they sit for the Malaysian English University Test (MUET). The app has been used for their preparation of the MUET speaking test on their own time without attending oral classes. The findings of the research indicate that the app received positive feedback and has potential as a NFtF language learning technique. The learning potential as a NFtF language learning tool is heightened by the fact that students have access to it anywhere. Hence, m-Learning is the most preferred learning style practiced by the Netizens, and the use of the mobile app as a language learning tool could be the best medium for 4.0 Education.

Keywords: My Speaking App (MSA), non-face-to-face (NFtF), face-to-face (FtF) Education 4.0, mobile learning (M-learning)

1. Introduction

Mobile learning (or m-learning) has become a strong potential learning method among the young generation in this recent year and suits the demands of Industrial Revolution 4.0 which focuses on innovative technology. Industrial Revolution 3.0 focuses on the
need for ‘technology society’ while Education 4.0 fulfills this need of the society in this ‘innovative era’. The Z generation (born between 1997 and 2012) and future Alpha generation (born from 2010 to 2025) need to acculturate the new technology that exists around them, and to grow with this knowledge and skill set for the rest of their lives. These needs are to be matched with the skills required in 4.0 Education; the skills are leadership, collaboration, creativity, digital literacy, effective communication, emotional intelligence, entrepreneurship, global citizenship, problem-solving skills, and teamwork (Puncreobutr, 2016).

The Z generation and future alpha generation are the targets of this 4.0 Education because they were born and live with these new technologies, as mobile phones become part of their life. They prefer to learn through virtual methods rather than using books and lecture notes (Jeschke & Heinze, 2014). Therefore, challenges that educator need to face in 4.0 education is to design and develop customized teaching and learning materials that are offered via social media. Traditional FtF communication requires both speaker and listener to be at the same time and place (Saniah, 2017). Communication is possible to be conducted in different contexts and times, without facing each other? How? Yes, it is possible through the integration of technology. The use of variety of devices such as mobile phones, tablets, and iPads could be the next alternative for virtual communication to be implemented. It started in 3.0 Education when computer-mediated communication (CMC) served different particular needs and also as a functional alternative to FtF communication (Flaherty, Pearce & Rubin, 1998). The idea of using new technology could also be adapted to the use of mobile learning when the app, as a NFtF communication channel, is being used as a complement to FtF communication.

The present study incorporates the assumption that language learners are motivated to choose MSA as a functional alternative to FtF communication. MSA is designed for language learning and especially in enhancing communication skills. It is one of the fastest-growing new communication technologies. The current study is conducted to explore if the technology could be an alternative partner for a student to practice speaking skills. There is limited research conducted in analyzing speaking practices through mobile apps, and it is still considered a new way of practicing language skills. Practicing speaking skills frequently will reduce communication apprehension (CA), or a person's level of anxiety, among language learners. Therefore, by using a MSA mobile app to practice the target language, students are expected be more prepared to communicate FtF. This is because learners experienced using the language by completing the exercises given in the app repeatedly before engaging in real conversation.

In this study, we have an alternative way to practice the language NFtF, i.e., using a mobile app. It is hoped that the findings of this study will contribute to 4.0 Education, whereby the use of mobile devices can be utilized for educational purposes. Additionally, it will encourage more educators to engage in the design and development of their own teaching and learning materials in a simple, fun, and creative way using mobile apps. Therefore, the research intends to address these questions: (1) What are the users’ requirements for the development of MSA as NFtF medium for language
learning in Education 4.0? (2) What are the important elements of mobile speaking app contents for non-face-to-face (NFtF) language learning?

There have been a number of studies in previous years, such as a survey of 100 Elon students (Drago, 2015), and 300 community members and students (Dwyer, 2017), that showed that the expansion of technology is negatively affecting FtF communication. In contrast, Baym, a principal researcher at Microsoft Research, believes that digital communications increase connection when people communicate by using devices” (Jeschke & Heinze, 2014), and this proved that people prefer a NFtF communication with the other people. She also indicated that 46% of respondents communicate more frequently with friends and family via technology, and also showed that FtF interactions have decreased both in quality and in quantity.

2. Required Skills in 4.0 Education

Education 4.0 is more than just education because it is outfitting the needs of the society in this “innovative era”. The purpose of learning in this era should be to help learners develop their ability in applying new technology in the changing society (Puncreobutr, 2016). 4.0 Education should allow learners to grow with knowledge and skills for life (Sinlarat, 2016). Netizens who live in this digital era should possess 21st-century skills such as leadership, collaboration, creativity, digital literacy, effective communication, emotional intelligence, entrepreneurship, global citizenship, problem-solving skills, and teamwork (Puncreobutr, 2016). Besides that, it is important to integrate life skills and innovative skills to build an intelligent nation with critical thinking, creativity, innovative ability, cross-cultural understanding, information and media literacy, and career and learning skills. Designing and developing a language learning package through the mobile application will benefit the user. Educators, app developers, and Netizens are encouraged to design and develop more inventions as it involves different skills such as critical thinking, design and selective thinking, productive and problem-solving thinking, entrepreneurial thinking, responsible thinking, social-consciousness thinking, and scenario thinking.

3. Materials and Methods

The study is conducted to find solutions to the problems that arise in enhancing the language learners' speaking performance, specifically for MUET candidates who are preparing themselves for their oral examination. Students were exposed to the MSA app for a duration of six months before they sat for the MUET oral test. They had their own practices through the exercises provided in the app as it offers a complete language learning package. MSA consists of examination tips, tutorials, speaking simulations, and assessments. Besides that, the users are guided by the tutor in enhancing their speaking performance through the Telegram App or WhatsApp attached in the app. A survey on needs analysis and the usability of the applications were conducted for quantitative analysis among 7 lecturers, 163 students, and 15 experts. The Fuzzy Delphi
method was used for collecting 15 experts' consensus on the MSA from ICT, mobile and language expertise. Additionally, qualitative approaches that involved interviews, observations, and document analysis were used to gain in-depth understanding of the phenomena being studied.

3.1 My Speaking App (MSA), a Mobile Application

Mobile gadgets have become a survival tool for learning. In fact, “Learning through mobile applications can increase motivation and student achievement” (Vogel, Kennedy, Kuan, Kwok, & Lai, 2007). Hence, it is necessary to design and develop mobile learning applications for NFiF learning for English language skills to enhance students' communication skills. MSA is a complete language-learning package designed and developed for language learners based on MUET, Common European Framework References (CEFR), and Asian local context. MSA focuses on social expression usage and speaking practices. It is suitable for personal learning as language users can use it in a flexible way and at their own pace. The main goal of the app is to offer a new medium of NFiF environments in learning and acquiring speaking skills. In the app, language learners are able to record their answer or opinion and detect their mistakes when they listen to the recording again. This virtual speaking practice offers more personalized learning to the language learners and solves the problem of finding a partner for F&F communication.

It is hoped that by using MSA, MUET candidates, who will be sitting for varsity requirement testing before graduation, will be familiar with various speaking contexts and topics. MSA will expose them to real-life situations whereby polite or correct expressions are used for apologizing, asking for clarifications, interrupting, giving descriptions, etc. Another purpose is to provide the language learners adequate and interactive practice in using the language in delivering their opinion on a topic. The app consists of MUET speaking tips, grading criteria, lessons, practices, enrichment exercises, vocabulary banks, YouTube simulations of MUET speaking tests, and links to social media such as WhatsApp and Telegram. Bloom’s Taxonomy prescribed the level of practice difficulty in the app. Users can listen to an interactive audio simulation of group discussions. They are free to explore the app’s contents and to choose the situation and type of a candidate they are interested in. Moreover, they are able to record their own opinion of the task given in the app just by using the microphone icon provided in the app. However, as evaluating an opinion is subjective, the designer has limitation in setting the score marks. Users can check their marks which are dependent on the correct language expression usage in the given duration of time of two minutes. Even though language learners work on their own, they will be scaffolded by the language tutor through the WhatsApp/Telegram platforms in the app. In this platform, language learners can get help and guidance from the tutor to further improve their skills.
Figure. 1. The ‘Use Case Diagram’ which portrays the interaction of the system and the user, and how to use it. The MSA application allows students access language instruction adapted to their needs for free. They can begin at any time and adapt the program to their own needs. The users of the app are free to explore any part of the app without follow-up (Nawi, A. 2017).

4. Results & Discussion

Researchers conducted a needs analysis, aimed for achieving consensus on English language learning modules in MSA applications. There were 15 experts involved in this study, included language and mobile learning expertise. Figure 2 below shows the findings obtained from an expert to assess the MSA applications. There were five criteria that achieved the same mean scores of five i.e., five being the highest. All experts achieved a 100% consensus that the app allows users to use it any time at their will and pace independently. This would reinforce the collaborative learning process outside the language classroom using social media platforms (Telegram App or WhatsApp); practice learning the app quickly by themselves and with the presence of the peers and tutors; that it allows users to explore NFtF language learning activities innovatively and creatively; it saves the record of their self-learning time (SLT), and finally, that the users may find the app cost effective because it can be used offline. A mean score of 4.86 was given to the app for having an adequate difficulty of Blooms’
Figure 2: The Needs Analysis from Experts on the Design of MSA as a Teaching & Learning Strategy in 4.0 Education.

The following results answered the research questions in this study to indicate the transformation of FfF to NFfF communication in practicing the speaking skills in 4.0 Education. Data was collected among 163 engineering students in one of the Engineering Matriculation Colleges. Figure 3 below highlights the potentiality of a mobile application, such as NFfF, in language learning in Education 4.0. As MSA is designed for personalized learning and for NFfF communication, the requirement of offline usage is necessary. Users can use the app anytime and anywhere once they have installed it on their smartphone. This will solve their problem of finding a partner for speaking practices and their time constraint. The above mean score for every 4.0
Education elements indicates that MSA contributes a positive influence on language learning, especially in enhancing speaking performance.

Figure 3: The Influence of MSA as NFTF medium in Language Learning in Education 4.0.

Figure 3 shows that MSA fulfilled the elements needed in education 4.0 and has a great potential as a NFTF medium in language learning, especially for speaking skills. The above findings show that there are high mean scores (5.0) in four elements of education 4.0 such as heutagogy, diverse learning, creatives, and communication. Below, is a list of Education 4.0 elements which have been accomplished by the MSA as a learning tool for NFTF:

i. Heutagogy - users were able to use the app at their own pace explore all the MSA contents at anytime and anywhere they liked. Educators, or app designers and developers, should utilize mobile social media as a catalyst for a pedagogical shift from traditional teacher-directed pedagogy towards student-determined heutagogy (Thomas & Laurent, 2014).

ii. Cybergogy – the app provides an experience of virtual-based learning ubiquitously.

iii. Paragogy - the usage of MSA is scaffolded by a social platform (WhatsApp or Telegram App) where users were able to collaborate with peers and their instructor for further practice.

iv. Diverse learning - users were able to have their own practice and train themselves to master the MSA content.

v. Creative – integration of artificial technology; Google speech-to-text enabled the user to transfer their speech to text or vice versa.
vi. Communication - the most important element in the speaking app was to provide users with an authentic experience; users could also listen to the recorded audio and record their voice in the app.

vii. Analytical - the users’ achievement depended on the correct usage of the language expression in the MSA.

viii. Evaluation - users were able to evaluate their performance based on the score marks.

ix. Informative - the app provided fluid and organic information in its content and with the example of media clips through the YouTube link.

x. Problem-solving - the task provided in MSA required the user to give their opinion to solve the problem.

Therefore, MSA is a ubiquitous and suitable tool to be used outside the classroom at any time or place, which meets the requirements for the 21st Century style of language learning. Practicing speaking skills through MSA could be a new way of learning the skill (Kulkuska & Demooy, 2010) as it moves from FtF to NFtF communication. In fact, there are a number of similar language apps available in the Google Play-Store. While these apps might be useful or become the best apps for language learners to learn in learning the speaking skills, they might not be suitable to those who will sit the MUET speaking test. Thus, this MSA is created to fulfill their needs, not only for examination purposes but also to enhance their speaking skills, as MSA highlights the use of language expression in daily conversation and discussion.

Although it is quite subjective to evaluate students’ oral presentation using technology, it can be carried out with the social media platform linked with this MSA application. Educators and learners are responsible to shape the language learning process and the presence of a teacher to guide learners in the activities is still very important (Kukulska, Norris, & Donohue, 2015). Thus, educators act as a facilitator to support the MALL (Mobile-Assisted Language Learning) users for those who feel that they still need some mediation to complement and support their language learning. Nevertheless, MSA also fulfills the requirement of 4.0 Education as aforementioned in the above section, as it applies the artificial control in its system to evaluate the language expression usage recorded by the user. The developer will update the content of MSA, according to the need and changes in MUET syllabus, which is also aligned with the CEFR requirement. Hence, MSA offers ubiquitous learning, and allows the language learners to be independent, and enhance their own lifelong learning (Drago, 2015). The target of Education 4.0 is to prepare graduates who are capable of exploiting digital resources and who are competent in their communication.

5. Conclusions

In conclusion, the research findings revealed that MSA has a potential language learning tool in Education 4.0 for NFtF mode. Practicing speaking skills using a smartphone that complements the inputs from the interaction between among the users. With the integration of artificial intelligence, a cybergogy environment could be the driver for Education 4.0. Education 4.0 offers a virtual class without the presence of a lecturer, the MSA offers offline usage, whereby users can use it without an internet connection, and it replaces language books. The smartphone, with the unique features
of being small in size, portable, having the capacity to record audio and video, etc. has become the most popular tool for learning in the era of the 4.0 Revolution. Hence, MSA is innovated and developed in a simplified way; informative with guidance and practices which support an interactive self-learning environment for the ease of the user. It can be concluded that MSA could be the driver for 4.0 Education in language learning as it caters for the requirements of 4.0 Education elements.

References


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Conference Proceedings 2019- Singapore Learning Design and Technology Conference

This book features the best papers presented at the Singapore Learning Design and Technology Conference in 2019. Chapters include research conducted by experts in the field of Learning Design and Technology. Put together by East Asia Research and Siam University, this book serves as a useful resource for educators, researchers, thought leaders and policy makers.