TPACK'S CONTRIBUTION TO IMPROVING ICT LITERACY IN HIGHER EDUCATION INSTITUTION: A SYSTEMATIC LITERATURE REVIEW

Stephanus Turibius Rahmat[1], Anthony A. Salim[2], Ferdina[3], Ivan Hanafi[4], Teguh Trianung DS[5], Ignasius Febryanto R. Bora[6]

[1,6]Universitas Katolik Indonesia Santu Paulus Ruteng
[2,4,5]Universitas Negeri Jakarta
[3]Universitas Ibn Khaldun Bogor

stephan_rahmat@yahoo.com

ABSTRACT

The research aims to describe the contribution of TPACK (Technological Pedagogical Content Knowledge) in shaping 21st century skills, in particular: improving ICT literacy (Information, Communication, and Technology) in higher education that has been in the era of technological disruption. An era of innovation and massive change is fundamentally due to the presence of digital technology. The literature review in this article focuses on the contribution of TPACK in improving ICT literacy in higher education. The TPACK model represents the knowledge necessary to integrate technology in learning. TPACK has components that can support the knowledge that educators must possess, namely technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technology content knowledge (TCK). Based on this TPACK framework, lecturers and students in utilizing technological facilities not only have access, but must be skilled in using it. In designing learning and solving pedagogical matters, lecturers should cautiously think about the potentiality of technology. The TPACK model can create a transformation in learning, especially improving ICT literacy. Researchers use the Systematic Literature Review (SLR) method to identify, evaluate, and interpret research relevant to the topic of TPACK's contribution to improving ICT literacy. With that, the use of the SLR Method can systematically review and identify journals relevant to TPACK contributions while following the steps or protocols that have been established in each process. This method is complemented by research questions relevant to TPACK's contribution to cultivate the ICT literacy for higher education. The results showed that TPACK contributed positively in improving ICT literacy in higher education institutions.

Keywords: *tpack; 21st century skills; ict literacy; higher education*

INTRODUCTION

The ICT practices led to the shifting of the learning process from training to practice, from paper to "on line" or channel, from cycle time to real time, from classrooms to anytime and anywhere, from physical facilities to networking facilities. In the teaching-learning process, ICT plays a major role. Speaking the role of technology could be divided into three, namely (1) The role of additional technology (Sudarsana, Putra, & Temon, 2019), technology can be a teaching tool in addition to conventional methods. Technology such as the internet is not

absolutely used as a source of learning, only as an additional reference; (2) Complementary roles, to seek additional materials other than those delivered by the teacher, as well as books and media provided in schools; (3) The role of substitute, as a substitution for distance learning activities by replacing the existence of teachers in the classroom (Ghavifekr & Rosdy, 2015). Technological, Pedagogical, and Content Knowledge (TPACK) is an idea that has been widely accepted as a framework for the use of learning technology. This conceptual framework is very powerful in guiding teachers to understand in what way the technology could be included into instructional strategies and teaching materials to improve student achievement and learning outcomes (Mishra & Koehler, 2006). Many studies have been conducted on TPACK, for example researching the impact of TPACK on improving learning outcomes and ICT literacy skills in students of primary and secondary education english programs (Drajati et al., 2018), the impact of TPACK on teacher education programs (Akcil et al., 2021; Tondeur, 2018), and the development of AR/VR technology using the TPACK model (Jang et al., 2021).

One of the TPACK's impacts is the improvement of digital literacy skills for both lecturers and students. This is similar with the direction shifting, in which the works and productivity direct what is primary goal in an education. There is a real tension between the goal of developing self-critical thinking skills and the goal of developing a highly skilled workforce. In the past, especially in Europe, there were two pathways to higher education. First, the pathway that leads to vocational and technical training. Second, the path that leads to academic education in science and the arts. However, there is an increased emphasis on developing countries in preparing learners for 21st century jobs.

Technology is an integral part of everyday life, because in public schools we are considered to be digital native users who are accustomed to always being connected to internet devices that exist in schools. Therefore, all parties have a responsibility to integrate technology into learning and teaching and prepare learners for skill in the 21st century (Cakir, 2012). What kind of skills are associated with 21st century life? One of that is information skills, media, and internet technology (digital literacy). These skills are oriented towards ICT, such as the capability to search, verify, and synthesize information from the internet and then present it on a specific communication medium so that it could accessible widely. These are the so-called general knowledge skills that are cross-employment and required in almost all types of works as 21st century skills (Huang et al., 2019).

TPACK is currently very important for teachers to implement ICT in the learning process, because it could be used to assist teachers in utilizing (Voogt & McKenney, 2016) hardware and software, make selection on the advantages and disadvantages of its features and using the device correctly, effectively, and pedagogically. Looking at TPACK on an elementary basis is a development of learning practices that match its

components. One of the most commonly used measuring tools for analyzing TPACK is the control of teacher reports, the provision of data on the effectiveness of self-performance, beliefs, and attitudes (Razak, Habibi, Yusop, & Abdul, 2019), (Baran, Bilici, Sari, & Tondeur, 2017). When talking about college-level TPACK research, is still dominated by the development of integration programs for teacher education. The aim is preparing prospective teachers to possess a way of thinking and practical ability in applying digital technology into learning strategies and teaching materials in the classroom (Strydom et al., 2021; Tondeur, 2018). Beyond education, this conceptual framework is also used in the department of pharmacy at the University of Sydney to improve student learning in the classroom (Bartlett et al., 2021). However, when compared to research that uses the TPACK framework, it stands still in the area of primary and secondary education than higher education. Specifically, to perceive the implications of students' digital literacy skills enhancement, more research needs to be done on TPACK's content (subject matter content), learning, and teaching (Brinkley-Etzkorn, 2018).

Linking TPACK to subjects can lead to decreased interest in ICT in the teacher's education curriculum despite the interest by everyone (Voogt & McKenney, 2016). Uniqueness in this article lies in the study to fill the TPACK research for colleges in particular, to see the impact on improving students' digital literacy skills. This article has one research question: how does the TPACK contribute to improving ICT literacy at the college level? Based on this question, the study intends to provide a systematic summary to readers about research so far related to the contribution of TPACK to the improvement of digital literacy in universities.

LITERATURE REVIEW

ICT literacy is one of the components of 21st century skills. University as a higher level of education after secondary education need to have and develop ICT literacy. In order to develop ICT literacy in universities, educators need to possess Technological Pedagogical Content Knowledge (TPACK). Therefore, the author conducted a literature review of these three concepts, namely Technological Pedagogical Content Knowledge (TPACK), 21st century skills, and ICT/Digital literacy.

Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK) is a framework of knowledge derived from Shulman's construct (1986) on Pedagogical Content Knowledge (PCK) (Shulman, 1986). This PCK concept includes knowledge (Knowledge/K), how to align (Pedagogy/P) and master learning materials according to the field (Content/C). It is not just a part or a combination of pedagogy knowledge and mastery of the material, but reinforced mostly by the teachers' practices (Tacit Knowledge).

The term PCK evolved into TPCK, and it was changed into TPACK in 2008 by involving many knowledge

domains in it (Hunter, 2015). As a model, TPACK is a foundation for the effective integration of technology in learning by linking three important domains of knowledge namely content, pedagogy, and technology. In this case, TPACK is directly related to the creativity of teachers. Therefore, the TPACK framework accommodates learning in new context with the help of highly complex technologies to discover and solve learning problems. The flexibility and range of knowledge is a must to integrate technology and make learning an inherently creative act.

The concept of TPACK is the knowledge that teachers should possess to facilitate students' learning on specific substance through pedagogical and technological approaches (Angeli & Valanides, 2015). In other words, TPACK as the knowledge is necessary to integrate technology in learning. TPACK is often used on the educational research subjects as an outline to design learning models by integrating three main aspects namely technology, pedagogy, and content (Keengwe & Onchwari, 2019). The integration of these three aspects of knowledge can improve the quality of learning. Quality learning requires a multifaceted and interconnected understanding between knowledge three main sources (technology, pedagogy, and content) and how it will be applied according to their context (Koehler et al., 2013). Thus, TPACK becomes a center of learning consisting of three main components namely Technological Knowledge, Pedagogical Knowledge and Knowledge Content or Material Knowledge (Content Knowledge) (Koehler et al., 2013).

Researchs show the result that TPACK is strongly influenced by a person's experience when attending lectures related to technology and pedagogy (Koehler et al., 2013). The information and communication technology development has had a major influence on learning process. Therefore, 21st century skills encourage the intellectual community (college) to explore learners' knowledge of information and communication technology.

The seven (7) framework components of the knowledge domain in TPACK can be described as follows (Koehler & Mishra, 2006; Matthew J. Koehler, Got Mishra, Christian Kereluik, Tae Seob Shin, 2014; Hunter, 2015; Herring, 2016) namely: 1) Content Knowledge (CK) or the mastery of the field study or learning materials. A teacher must possess knowledge of the subject matter for all learners; 2) Technological Knowledge (TK) is knowledge about digital technology utilization to support a learning process; 3) Pedagogical Knowledge (PK) is knowledge to align learning processes and strategies. In-depth knowledge of the processes and practices in delivering the material learned by the students should be possessed; 4) Pedagogical Content Knowledge (PCK) is a combination of knowledge about the study field or learning materials with learning processes and strategies. In this sense, effective learning requires more than just the separation of understanding and pedagogy content; 5) Technological Content Knowledge (TCK) is knowledge of digital

technology and the study or learning materials. In other words, it is about how technology can create a new picture in certain materials; 6) Technological Pedagogical Knowledge (TPK) is knowledge of digital technology and the processes/strategies learning. It is all about the understanding of learning changes when certain technologies are used in a certain way; 7) Technological Pedagogical Content Knowledge (TPACK) i.e. knowledge of digital technology, knowledge of learning processes & strategies, knowledge of the study field or learning materials. At this point, knowledge deals with the complex interactions between the domain principles of knowledge (content, pedagogy, technology). The seven components of the knowledge domain in TPACK appear in the following image:

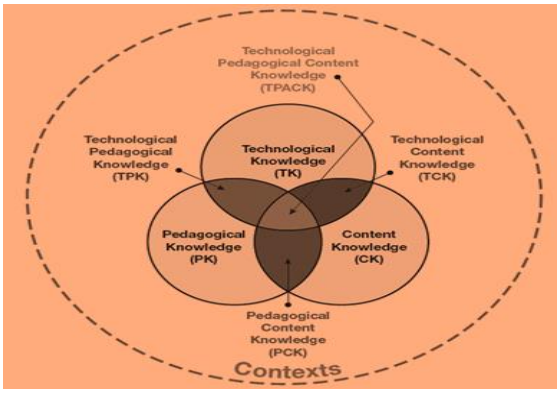

Figure 1. Technological Pedagogical Content Knowledge Framework (TPACK) (Koehler et al., 2013)
(https://www.researchgate.net/figure/The-TPACK-framework-and-its-knowledge-components_fig1_241616400)

Figure 1. Technological Pedagogygal Content Knowledge Framework shows that it is a form of technological integration that provides a guideline, useful for educators in developing technological literacy and understand the role of the technology in the educational process (Koehler et al., 2013; Ng, 2015) . In addition, TPACK is a model for incorporating technological knowledge as an integral component of teaching with technology. TPACK reveals the relationship between technology, pedagogy, and content knowledge is complex. Therefore, educators should possess a combined knowledge of those three components. In other words, in the context of TPACK, educators need to master those three types of knowledge in a learning or facilitate learning process i.e. technological knowledge, pedagogical knowledge and content knowledge (Koehler & Mishra, 2006; Ng, 2015) . Furthermore, ICT literacy supports the use of digital technology and integrates these three domains of knowledge into the learning process. Here, digital technology acts as a tool for the educators to expand the quality of learning for learners (Ng, 2015).

21st Century Skills

21st Century Skills are needed in educational works and in the era of contemporary society. Therefore, the

current educational process should be oriented towards stimulating for learners to gain 21st century skills which is related to the knowledge, skills, attitudes, values, and ethics possessed by the learners (Chu et al., 2017), (Valtonen et al., 2021). Therefore, the educational process preparing learners to master a variety of skills that support the formation of successful persons in the future. 21st century skills still relevant to the four pillars of education: learning to know, learning to do, learning to be and learning to live together. Each educational pillar has special skills should be developed in the learning process, namely critical thinking skills, problem solving, metacognition, communication skills, collaboration, innovation and creation, literacy information, and various other skills. By updating the quality of learning, help and developing learners' participation, implementing personalized or student-centered learning processes, those skills can be achieved. Learning is a collaborative and contextual as well as integrated with the community (Spector, 2015). Thus, learners must have information and communication literacy skills, critical thinking, creativity, and skills to solve the problems (van Laar et al., 2020). By this, categorized learners have high-level thinking skills (HOTS) (Kwangmuang et al., 2021).

Trilling & Fadel in 21st Century Skills (Triling & Fadel, 2009; Sakuliampaiboon et al., 2015; Ongardwanich et al., 2015; Spector, 2015; Chu et al., 2017) classifying 21st century skills into three categories of competencies, namely (1) Learning and innovation skills i.e. critical thinking and solving problems, communication and collaboration, creativity and innovation. This skill consists of: (a) Way of thinking, i.e. some thinking skills must be mastered by learners to face the world such as creative thinking, critical thinking, problem solving, and decision making; (b) The way to work is the ability to participate in a global and digital world such as collaborating and communicating. The 21st century generation must be able to communicate, applying a variety of methods and communication strategies. In addition, learners must able to collaborate and cooperate with individuals as well as communities and networks. This communication and cooperation network utilizes a variety of ICT-based methods and strategies in order to work together with different abilities. (2) Skills using technology and information media, namely information literacy, media literacy and information and communication technology literacy (ICT). Learners must master information, media, and technology as tools for work and master in working by using tools to work as well. Mastery of ICT and information literacy is a must since a person will difficult to develop his ICT and information sources based on all bases; (3) Life and career skills namely flexibility and adaptation, initiative and self-direction, social and cross-cultural interaction, productivity and accountability, leadership and responsibility. In this case, a person should have an established life and career, be personally and socially responsible.

ICT Literacy

ICT literacy is required for human life as the integration of technology, including in learning. Technology is an innovation, change, or modification of the natural environment to meet human desires. It requires knowledge or literacy (Garmire & Pearson, 2006). People should have technological knowledge or literacy to meet their needs.

ICT literacy is about the users' proficiency in utilizing digital media, such as communication tools, internet networks and so on (Noh, 2017). It also describes as the ability to understand, to apply the information from a variety of sources when presented through digital tools, to generate and communicate the information in various forms through the critical frameworks creation for retrieval, institutions, evaluation, and presentation, and to use the information with digital technology tools. In addition, the ICT literacy represents the capacity to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technology for decent and entrepreneurial work (UNESCO, 2018). Here, competencies related to computer literacy, information literacy and media literacy.

ICT literacy works as an individual skill to live, learn and work in a digital society; skill related to collaboration and communication; learning to use digital and media tools and make informed decisions to achieve goals (Spante et al., 2018). User proficiency in utilizing digital technology includes the ability to find, work, evaluate, use, create and utilize the communication wisely, intelligently, carefully and precisely according to its usefulness (Techataweewan & Prasertsin, 2018). Thus, ICT literacy has two (2) level of categories: basic level as the utilization of ICT or digital technology for everyday life such as information on searching and communication; and a higher level as establishment of cognition and utilization aspects of ICT technology for careers (Techataweewan & Prasertsin, 2018).

It is a fundamental for the people to utilize the ICT for the lives. As a form of mental readiness, knowledge is needed here to provide benefit direction for each individual through the information and communication technology usage. So, literacy can be achieved after going through four stages, namely: (1) information literacy, (2) computer literacy, (3) digital literacy, and (4) internet literacy (Saleh, 2015; Techataweewan & Prasertsin, 2018; UNESCO, 2018). In addition, ICT should being supported also by digital skills, digital culture, digital ethics and digital safety (Ministry of Information & Communication, 2021).

The ICT needs to be developed in a learning and academic environment since the ICT application literacy can wiser the academic community in using and accessing technology. It will happenned if ICT literacy is connected with the capabilities of its users. Therefore, ICT users have the responsibility to practice technology as wisely as possible to create positive interaction and communication. It is also related to the notion of literacy as a person's ability to understand, in applying useful technology and

discuss informations (Syahputra Bania et al., 2021). Thus, literacy is concerned with the ability to receive and use all knowledge, to produce and share it, more than that, it is about the capability to express consent with the data made by other people (Syahputra Bania et al., 2021).

On that basis, a person possesses ICT literacy if there is knowledge, critical thingking, decision making and capabilities (Garmire & Pearson, 2006). Based on these concepts, ICT literacy is the ability to use digital, communication tools or networks in finding, evaluating, using, making and utilizing the information in a healthy, critical, wise, intelligent, careful, precise, and law-abiding way in order to foster communication and interaction for life span. Thus, literacy is closely related with person's ability to apply ICT to discover, evaluate, utilize, create, and communicate content or information with cognitive and technical process (Mulat &Natarajan, 2020).

ICT literacy has a positive effect on learners' skills for the creation of successful learning (Techataweewan & Prasertsin, 2018). Nowadays, education is controlled by digital technology that is more accessible than traditional practices with paper-based resources for learning. Educational institutions had been transformed from face-to-face learning models into ICT-based learning for communication, knowledge sharing and simulation of learning processes. Educators and learners need to use digital literacy so as not to avoid difficulties in the learning process, get more learning opportunities and excel academically. Therefore, educational institutions must cultivate digital literacy in the education system to acquire knowledge and skills in technology to do their work effectively (Techataweewan &Prasertsin, 2018).

Thus, ICT literacy benefits the learners in the learning process: (a) facilitating learners in the process of finding and understanding information that can add insight on knowledge; (b) enhance the ability of learners to be more critical in thinking and understanding information; (c) mastery the learners' vocabulary of various information read; (d) improve the verbal skills of learners; (e) increase the learners' focus and concentration; (f) increase the ability of learners in reading, stringing sentences and writing information.

ICT lireracy is also the basis for lifelong learning by battering intellectual ability of reasoning and thinking for learners. It helps learners to build a constructive framework on how to learn that actually underlies sustainable growth throughout the student's career. Thus, ICT literacy becomes a major component of the concept for lifelong learning by expanding learning beyond formal classroom settings and giving space for self-practice and increasing responsibility to answer learners in all areas of life (Mulat & Natarajan, 2020).

RESEARCH METHODS

Researchers use the Systematic Literature Review (SLR) method to identify, review, evaluate, and interpret all research appropriate to the field of research topic with specific relevant

research questions (Wahono, 2007; Kitchenham et al., 2009; Triandini et al., 2019). The usage of SLR method is to systematically review and identify relevant research results on TPACK and 21st century skills in each process follow established steps. The steps in the SLR method are implemented by three (3) main stages (Wahono, 2007; Kitchenham et al., 2009) as described by the following image:

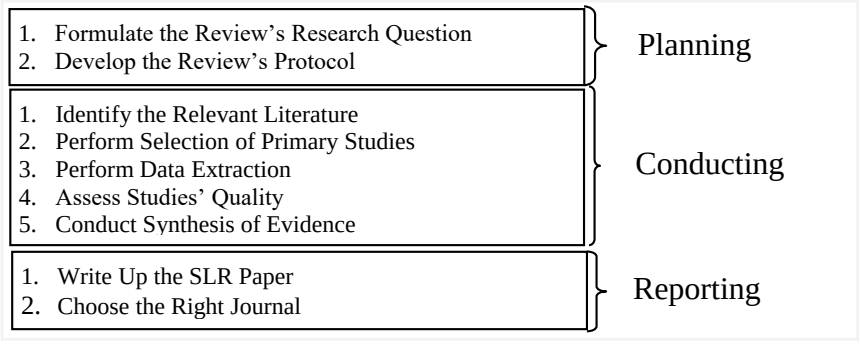

Figure 2. SLR Stages

Based on these steps, the authors formulate research problems, identify relevant topics, assess the quality of the studies, summarize evidence, and interpret all findings that are in line with the purpose of this study, namely describing the contribution of TPACK to improve digital literacy in universities.

RESULTS AND DISCUSSIONS

This article intends to answer the question about how does TPACK contribute to the improvement of ICT literacy at the higher education level? Based on this question, there are two purposes of this article, namely describing the literature review of the research results related to the contribution of TPACK to increase in digital literacy/ICT in universities; provide recommendations to encourage the use of TPACK framework by lecturers to improve the quality of learning in improving digital literacy/ICT. Therefore, three (3) results and discussion came out to answer the questions and purposes of this study, namely:

TPACK in University

Research conducted by observing TPACK knowledge from 1185 prospective teachers of diploma programs at higher education institutions in Singapore found out that prospective teachers had only five out of the seven typical TPACK frameworks, namely content knowledge, technological knowledge, pedagogical knowledge, teaching knowledge with technology as well as critical reflection knowledge (Koh et al., 2010). The teachers did not know the differences of each TPACK framework such as content knowledge, pedagogy and technology. Other research also found that teachers have below-average categorised content, pedagogy and technology (Tsiotakis, 2016). This study shows that prospective teachers do not have the knowledge, so they have not been able to apply techniques and teaching that are in accordance with the field of study. Therefore, prospective teachers in colleges and teachers need to be guided to understand and practice the

TPACK framework in the learning process.

University as a unit of education that organizes the education needs to facilitate educators to understand and integrate technology in learning. Based on the literature study conducted, the implementation of the TPACK model in universities was initiated by the Education Faculty in order to prepare the professionalism of prospective teachers in various levels of education and subjects. The use of the TPACK model helps in finding the weaknesses of teacher development programs related to digital literacy and technology that have been done, namely partial and additional so that after being given training, it is not done only in the classroom (Drajati et al., 2018). The TPACK model assists lecturers in creating programs to prepare prospective teachers with a more integrative approach to the use of digital learning technology both to improve pedagogical effectiveness and understanding the teaching material content (Strydom et al., 2021).

Furthermore, there are methods of developing teacher education technology literacy developed from the TPACK model, one of which is SQD. The SQD *(Synthesis of Qualitative Evidence)* model emphasizes teachers as role models in schools when using technology. The process is as follows: 1) Teachers act as role models, 2) The reflection of technology roles in education, 3) Learning to use technology by design, 4) collaboration with peers, 5) *scaffolding* authentic technology experiences, and 6) providing ongoing feedback (Tondeur, 2018).

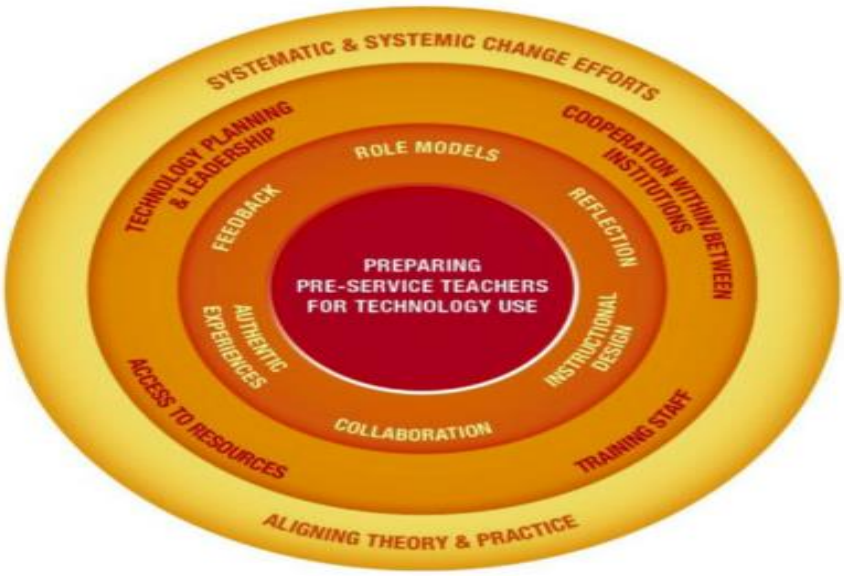

Figure 2. Model SQD (Tondeur, 2018)

TPACK acts as a framework model for integrating effective technologies in learning. As a knowledge, educators should integrate it into a learning process. TPACK is the knowledge about when, where, and how to use technology for guiding learners in order to improve the

knowledge and skills of learners in a particular field by using an adequate pedagogical approach (Brantley-Dias & Ertmer, 2013). In this case, TPACK is directly related to the creativity of teachers. Teacher ought to be creative and innovative in using TPACK's work in order to accommodate learning in new context with the help of technology to discover and solve learning problems. This integration is a must to form learners in order to get 21st century skills. Universities need to encourage learners to explore ICT knowledge or literacy. Therefore, educators or lecturers who teach in universities need to engage with technology and develop learning content with the help of technology (Keengwe & Onchwari, 2019).

Based on the TPACK framework model described earlier, then there are three components of knowledge that educators in college need to possess, namely knowledge of the subject field material/content, pedagogy and technology. These three models have components that support the educators' knowledge, namely technological knowledge (kindergarten), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technology content knowledge (TCK). The integration of content, pedagogy and technology as a whole in the learning process provides a new frame of mind for educators to create varied learning models in order to improve processes and outcomes.

The TPACK model that is integrated into learning in a meaningful way is not only by equipping classrooms with computers or other devices, but also contributes for complex thinking going forward about the integration of technology into curriculum and learning (Koehler &Mishra, 2006). This model requires the educators: first, ponder the content to be taught, then combine it effectively with learning methods for teaching with technology, plan a meaningful learning experiences and then make teaching decisions in an effective way (Koehler & Mishra, 2006). The TPACK model describes what kind of knowledge, an educator needs effectively to teach with technology at the connection of three domains: content knowledge, pedagogy and technology (Di Blas, 2016). The teachers must have technological knowledge of how the device works, how to solve problems, how to navigate applications, and general knowledge about the device. In addition, an educator actively designs the curriculum using content knowledge and pedagogical knowledge. Furthermore, educators can make decisions about the best way to incorporate technology into the curriculum with an emphasis on when and why using technology specifically for teaching concepts or approaches (Koehler & Mishra, 2006).

TPACK with 21st Century Skills

One of the competencies needed for educators in the 21st century learning is the ability to design learning by applying the principle of combining teaching, pedagogical, and Information and Communication Technology (ICT) or TPACK (Hunter, 2015; Keengwe & Onchwari, 2019). The TPACK model also allows educators to improve 21st century

skills (Khine et al., 2017). It is most relevant learning approach in today's online learning. Since, the TPACK approach combines aspects of knowledge (Knowledge/K), how to align (Pedagogy/P), mastery of learning materials in the field (Content/C) with ICT (Technology/T) (Koehler & Mishra, 2006; Koehler et al., 2013).

21st century skills illustrate a diverse range of practices and competencies geared toward preparing individuals for work and a career in a changing future, technology-driven landscape (Chu et al., 2017). These skills are described as creativity (*C*), collaboration (*C*), critical thinking (*C*), and communication (C) or labelled as 4C. Learners require additional skills for a future work place driven by technological innovation. Digital literacy skills here, include information, media, and ICT. Learners should learn literacy to become literate individuals on information and media, as well as become master of technology (Keengwe & Onchwari, 2019). The role of technology is very pronounced in the education aspect. Because, era of technological disruption occurs an innovation and massive changes fundamentally because of the presence of digital technology. The presence of technology has changed human working system or even able to replace human work, specifically in the field of education. On that basis, education is not only based on aspects of knowledge and pedagogical, but also on technology as a tool and strategy for the better creation, more effective and innovative for learning process. This is where it happens, digital transformation has provided services in a fundamental way or meet the needs of learners during learning process. Digital transformation has placed technology at a key role as a form of new technological solutions and implementations and enables the development of technology (Kim Fahey, 2021).

Education in college needs to prepare learners or prospective teachers who possess 21st century skills, students or prospective teachers who are expected to gain knowledge, skills, critical attitudes, and ICT literacy. This expectation is related to the learners' characteristics as digital natives or teachers with digital era. Learners who could create digital content, evaluate web-based content, and able to create a technologies network or resources in the real world to fight the future. Thus, prospective students or teachers when dealing with subject matter, will quickly become proficient in applying technology in the classroom learning process (Kumar & Vigil, 2011). ICT literacy as one of the 21st century skill components provides a new way to process and access knowledge in all field of life, particularly in the world of ICT. Teaching education assign Pedagogical Kontent Knowledge (PCK) for students in Higher Education Institutions which is fundamental to the transition of TPACK. Research conducted at Sindh University, Jamshoro Pakistan, reported that the adaptation of the TPACK framework among university and faculty members would be helpful in understanding the integration of technology with pedagogical and content knowledge intrapersonally (Soomro et al., 2018).

TPACK's Contribution in Improving ICT/Digital Literacy in Universities

The utilization of ICT in the teaching and learning has changed the study model in the classroom. Learning is nowadays aided by the usage of ICT resources. That approaches changing the strategy, method and learning practice, changing the role of educators and learners (Colás et al., 2018). Research conducted at four Saudi Arabia universities on the impact of ICT adoption on students' academic performance showed improvement, particularly female students as more adaptive on ICT (Basri et al., 2018). Nowadays, almost all institutions in the world invested most of their educational budget to improve e-resources, to easily access any resources they could obtain in every corner of the world with internet facilities only. By that, students will be interested to spend time in front of a computer to find learning materials compared to visiting the conventional library that is available in any educational institutions (Mani et al., 2019). In addition, research on ICT literacy at Bangladesh Private University showed controversial results in academic grades as most students spend time for non-academic purposes by utilizing ICT (Ullah et al., 2019). Therefore, the usage of ICT in universities should have adequate support. In that sense, the higher education institutions familiarize students with the latest educational software as well as introducing them the ICT usage for academic purposes. Students prefer the internet for academic purposes over the use of certain programs or e-learning (Zeidmane, 2019). Studies conducted at Chittagong University, Bangladesh showed that students' academic achievement will better improve if relevant institutions take appropriate steps in their works i.e. the use of ICT for academic purposes (Ullah et al., 2019).

Higher education needs to adopt or implement a learning model that integrates technology in learning with the purpose to advance ICT literacy (Pelletier et al., 2021). Previous research show that the TPACK model has had a positive impact on educators' beliefs about the use of modern technology in education (Alizadeh Jamal et al., 2020). The use of the TPACK profile as a framework for evaluate the teaching skills in higher education shows that when it comes to the technology, educators are the only one who has an ability to use a variety of technology tools, then a balanced and integrated TPACK profile becomes impossible. Conversely, educators who are able to explicitly articulate the understanding and application of their pedagogic ability are more likely to demonstrate the integration of TPACK (Benson &Ward, 2013). The study result shows that a model TPACK as an curricular framework, being organized around three intersecting domains of knowledge: content, pedagogy and technology (Brinkley-Etzkorn, 2018). Using this framework, to combine the expertise of all three domains, educators create lessons or curricula that effectively engage learners through innovative and valid strategies based on teaching with technology.

In accumulation, there are several researchers who have

discussed the use of *Google Workspace Learning Media* as an integrated means to conduct teaching and learning in lecture halls (Akcil et al., 2021). The process of integrating technology into learning is a very complex and multidimensional. However, this pandemic condition makes universities have to rush to find solution over the difficulties of distance learning that it is faced with. *Google Workspace* with its various applications can help lecturers and teachers in designing teaching and learning ranging from the preliminary stage, development until the evaluation stage.

Stage	9 Stages of Teaching Gagne's Model	Logo	Activities to be Conducted and Appropriate Web Tools (Sample)
INTRODUCTION	1. Attraction attention 2. Informing about the target 3. Associating with previous learning		Visual presentation—Google Photo
			Showing videos—YouTube
		Google AR & VR	Making use of simulation—Google AR & VR
			Showing information card—Google Keep
DEVELOPMENT	4. Presenting the content 5. Providing guidance 6. Revealing performance 7. Providing feedback		Research: Google Scholar—Chrome
			Preparing a presentation—Google Slides
			Interaction in the virtual classroom—Google Classroom
			Bringing together the course contents—Google Sites
			Making use of infographics—Google Drawing
			Live lecturing—Google Meet
			Messaging—Gmail
			Using mind maps—Google Mindmap (Chrome Add-on)
			Having discussions—Google Groups
			Interactive practice papers—Google Jamboard
EVALUATION	8. Performance evaluation 9. Ensuring the permanence of the learned and strengthening their transfer		Storing education content—Google Drive
		Google	Commons studies—Google Documents
			Questionnaire/—Google Forms
		Edu lastic	Creating online test—Google Edulastic
			Giving homework and feedback —Google HomeWorks

Figure 3. Use of Google Workspace in Learning Design (Akcil et al., 2021)

By utilizing the TPACK model, educators can examine what they know, how they teach, and how technology can be used to influence learners' achievement and learning (Keengwe & Onchwari, 2019). Thus, the TPACK model as an ideal frame of reference enables the educators to improve the learning process through the incorporation of digital tools. The educators then, possible to innovate the learning process through technological, pedagogical and content knowledge of the TPACK model. The TPACK model might facilitate the planning, organization and construction of virtual educational spaces through the use of technological, pedagogical and content knowledge. It aims to enhance the learning process through content knowledge (subject topics), technological knowledge (information and communication tools) and pedagogical knowledge (*educational practices, procedures* and *strategies*) (Salas-Rueda, 2019).

LIMITATIONS

This literature review has limitations, particularly the lack of studies on the implementation of the TPACK model, in addition to the Faculty of Education. The authors found that attention to this application model was still limited to the preparation of prospective teachers who will become teachers in school.

However, anxieties about the importance of the TPACK model to be integrated in the learning process are gradually begin the expansion in the college level. One of the studies, discusses a course on pharmacy study program at the University of Sydney that has implemented *USyd Pharmacy Dashboard* as the development of the TPACK model for integrating technology into teaching (Bartlett et al., 2021). As such, there are still wide open possibilities to study the TPACK model for college context outside the Educational Faculty program.

CONCLUSIONS AND RECOMMENDATIONS

The results of this systematic review study show that TPACK contributes positively in improving 21st century skills, particularly improving ICT literacy in higher education institutions. The TPACK model is still a model of technological integration in education at its best. However, the challenge lies in the implementation of this model by lecturers, especially in improving the ability of ICT literacy of students as an important element of 21st century skills. The application of the TPACK model in colleges level still focuses on the Educational Faculty programs that prepares prospective teachers to teach in schools. Meanwhile, the implementation of TPACK in another study programs in universities is the next research opportunity that has great potential to be done.

REFERENCES

Akcil, U., Uzunboylu, H., & Kinik, E. (2021). Integration of technology to learning-teaching processes and google workspace tools: A literature review. *Sustainability (Switzerland)*, *13*(9). https://doi.org/10.3390/su13095018

Alizadehjamal, M., Shahvarani, A., Iranmanesh, A., & ... (2020). The effect of mathematical education based on TPACK model on changing teachers' beliefs. *Technology of Education Journal (TEJ)*, *14*(3), 591–602.

Angeli, C., & Valanides, N. (2015). Technological Pedagogical Content Knowledge Exploring, Developing, and Assessing TPCK. *New York : Springer*. https://doi.org/10.1007/978-1-4899-8080-9

Bartlett, A., Schneider, C. R., Penm, J., & Mirzaei, A. (2021). Use of Visual Dashboards to Enhance Pharmacy Teaching. *Pharmacy*, *9*(2), 93. https://doi.org/10.3390/pharmacy9020093

Basri, W. S., Alandejani, J. A., & Almadani, F. M. (2018). ICT Adoption Impact on Students' Academic Performance: Evidence from Saudi Universities. *Education Research International*, *2018*. https://doi.org/10.1155/2018/1240197

Benson, S. N., & Ward, C. L. (2013). Teaching with technology: Using TPACK to understand teaching expertise in online higher education. *Journal of Educational Computing Research*, *48*(2), 153–172. https://doi.org/10.2190/EC.48.2.c

Brantley-Dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK: Is the construct "just right?" *Journal*

of Research on Technology in Education, *46*(2), 103–128. https://doi.org/10.1080/15391523.2013.10782615

Brinkley-Etzkorn, K. E. (2018). Learning to teach online: Measuring the influence of faculty development training on teaching effectiveness through a TPACK lens. *Internet and Higher Education*, *38*(February), 28–35. https://doi.org/10.1016/j.iheduc.2018.04.004

Chu, S. K. W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2017). *21st Century learning skill*.

Colás, M. P., de-Pablos, J., & Ballesta, J. (2018). Incidence of ICT in teaching in the Spanish education system: a review of the research. *Journal of Distance Education (RED),* *56,*1–23. https://doi.org/10.6018/red/56/2

Di Blas, N. (2016). Distributed tpack what kind of teachers does it work for? *Journal of E-Learning and Knowledge Society*, *12*(3), 65–74. https://doi.org/10.20368/1971-8829/1156

Drajati, N. A., Tan, L., Haryati, S., Rochsantiningsih, D., & Zainnuri, H. (2018). Investigating English language teachers in developing TPACK and multimodal literacy. *Indonesian Journal of Applied Linguistics*, *7*(3), 575–582. https://doi.org/10.17509/ijal.v7i3.9806

Garmire, E., & Pearson, G. (2006). T E C H TA L LY A P P R OAC H E S TO ASSESSING TECHNOLOGICAL. *Washington DC : The National Academies Press*.

Herring;, M. C. M. J. K. P. M. (2016). Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators. *New York : Routledge, Taylor & Francis Group*. https://doi.org/10.4324/9781315771328

Hunter, J. (2015). Technology Integration and High Possibility Classrooms. *New York : Routledge, Taylor & Francis Group*. https://doi.org/10.4324/9781315769950

Jang, J., Ko, Y., Shin, W. S., & Han, I. (2021). Augmented Reality and Virtual Reality for Learning: An Examination Using an Extended Technology Acceptance Model. *IEEE Access*, *9*, 6798–6809. https://doi.org/10.1109/ACCESS.2020.3048708

Keengwe, J., & Onchwari, G. (2019). Handbook of Research on Literacy and Digital Technology Integration in Teacher Education. In *IGI Global*. https://books.google.com.my/books?id=QKTDDwAAQBAJ

Ministry of Information and Communication. (2021). Road map digital literacy 2021-2024. *Jakarta : Siber Kreasi Deloitte - KOMINFO*.

Khine, M. S., Ali, N., & Afari, E. (2017). Exploring relationships among TPACK constructs and ICT achievement among trainee teachers. *Education and Information Technologies*, *22*(4), 1605–1621. https://doi.org/10.1007/s10639-016-9507-8

Kim Fahey. (2021). How Higher Education Can Overcome Barries to Digital Transformation. *Educause Review*, 52–53.

Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic

literature reviews in software engineering - A systematic literature review. *Information and Software Technology*, *51*(1), 7–15. https://doi.org/10.1016/j.infsof.2008.09.009

Koehler, M. J., & Mishra, P. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, *193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, *26*(6), 563–573. https://doi.org/10.1111/j.1365-2729.2010.00372.x

Kumar, S., & Vigil, K. (2011). The Net Generation as Preservice Teachers. *Journal of Digital Learning in Teacher Education*, *27*(4), 144–153. https://doi.org/10.1080/21532974.2011.10784671

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

Mani, M., Hameed, S. S., & Thirumagal, A. (2019). Impact of ICT knowledge, Library Infrastructure facilities on students' usage of E-Resources - An empirical study. *Library Philosophy and Practice*, *2019*(January 2021).

Matthew J. Koehler , Punya Mishra , Kristen Kereluik , Tae Seob Shin, and C. R. G. (2014). The Technological Pedagogical Content Knowledge Framework. *New York : Springer*, 1–1005. https://doi.org/10.1007/978-1-4614-3185-5

Mulat, T., & Natarajan, M. (2020). Digital Literacy Skills Among Library Professionals in Jimma University Libraries. *Library Philosophy and Practice (e-Journal)*, *4629*, 11–15.

Ng, W. (2015). New Digital Technology in Education : Conceptualizing Professional Learning for Educators. In W. Ng (Ed.), *Switzerland : Springer*. https://doi.org/10.1007/978-3-319-05822-1_4

Noh, Y. (2017). A study on the effect of digital literacy on information use behavior. *Journal of Librarianship and Information Science*, *49*(1), 26–56. https://doi.org/10.1177/0961000615624527

Ongardwanich, N., Kanjanawasee, S., & Tuipae, C. (2015). Development of 21st Century Skill Scales as Perceived by Students. *Procedia - Social and Behavioral Sciences*, *191*, 737–741. https://doi.org/10.1016/j.sbspro.2015.04.716

Pelletier, K., Brown, M., Brooks, D. C., Mccormack, M., Reeves, J., Bozkurt, A., Crawfurd, S., Czerniewicz, L., Gibson, R., Linder, K., Mason, J., & Mondelli, V. (2021). 2021 EDUCAUSE Horizon Report. Teaching and Learning Edition. In *Educause*.

Sakuliampaiboon, C., Songkhla, J. N., & Sujiva, S. (2015). Strategies of Information Communication and Technology Integration by Benchmarking for Primary School in Catholic (Layman) School Administration Club Bangkok Arch Diocese for Students' 21st Century Skill. *Procedia - Social and Behavioral Sciences*, *174*, 1026–1030. https://doi.org/10.1016/j.sbspro.2015.01.789

Salas-Rueda, R. A. (2019). Construction and evaluation of a web application for the educational process on normal distribution considering the science of data and machine learning. *Research in Learning Technology*, *27*(1063519), 1–24. https://doi.org/10.25304/rlt.v27.2085

Saleh, B. (2015). Information and Communication Technology (ICT) Literacy of Community in Mamminasata Region. *Jurnal Pekommas*, *18*(3), 151–160.

Shulman, L. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, *15*(2), 4–14.

Soomro, S., Soomro, A. B., Ali, N. I., Bhatti, T., Basir, N., & Gill, N. P. (2018). TPACK adaptation among faculty members of education and ICT departments in University of Sindh, Pakistan. *International Journal of Advanced Computer Science and Applications*, *9*(5), 203–209. https://doi.org/10.14569/IJACSA.2018.090526

Spante, M., Hashemi, S. S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education*, *5*(1), 1–21. https://doi.org/10.1080/2331186X.2018.1519143

Spector, J. M. (2015). Foundations of educational technology: Integrative approaches and interdisciplinary perspectives. In *New York : Routledge, Taylor & Francis Group*. https://doi.org/10.4324/9781315764269

Strydom, S. C., Wessels, H., & Anley, C. (2021). Moving beyond the tools: Pre-service teachers' views on what they value in a digital literacy short course. *South African Journal of Childhood Education*, *11*(1), 1–11. https://doi.org/10.4102/sajce.v11i1.929

Syahputra Bania, A., . I., Devira, M., . F., & . N. (2021). Analysis of Literation Ability to Translate Aceh Language by Elementary School Students in Langsa City. *KnE Social Sciences*, *2021*, 30–36. https://doi.org/10.18502/kss.v5i3.8519

Techataweewan, W., & Prasertsin, U. (2018). Development of digital literacy indicators for Thai undergraduate students using mixed method research. *Kasetsart Journal of Social Sciences*, *39*(2), 215–221. https://doi.org/10.1016/j.kjss.2017.07.001

Tondeur, J. (2018). Tondeur, J. (2018). Enhancing future teachers' competencies for technology integration in education: Turning theory into practice. Seminar.Net, 14(2), 216–224.Enhancing future teachers' competencies for technology integration in education: Turning theory . *Seminar.Net*, *14*(2), 216–224.

Triandini, E., Jayanatha, S., Indrawan,

A., Werla Putra, G., & Iswara, B. (2019). Systematic Literature Review Methods for Platform Identification and Information System Development Methods in Indonesia. *Indonesian Journal of Information Systems, 1*(2), 63. https://doi.org/10.24002/ijis.v1i2.1916

Triling, B., & Fadel, C. (2009). 21St Century Skill. *United State of Amerika : Jossey-Bass*, *Book*, 48.

Tsiotakis, P. (2016). *Measuring the technological pedagogical content knowledge (TPACK) of in- service teachers of computer science who teach algorithms and programming in upper secondary education MEASURING THE TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) OF IN-SERVICE TEACHERS OF COMPUTER SCIENCE WHO TEACH ALGORITHMS AND Spyros Doukakis Dept . of Primary Education University of the Aegean Alexandra Psaltidou and Athena Stavraki The American College of Greece , Pierce College Nikos Adamopoulos ICT Center of Primary and Secondary Education of Ileia Panagiotis Tsiotakis ICT Center of Primary and Secondary Education of Korinthia Stathis Stergou 1st Lyceum of Rhodes Greece*. *January*.

Ullah, M. A., Alam, M. M., Shan-A-Alahi, A., Rahman, M. M., Masum, A. K. M., & Akter, N. (2019). Impact of ICT on students' Academic performance: Applying association rule mining and Structured Equation modeling. *International Journal of Advanced Computer Science and Applications*, *10*(8), 387–393. https://doi.org/10.14569/ijacsa.2019.0100852

UNESCO. (2018). A Global Gramework of Reference on Digital Literacy Skills Indicators 4.4.2. *UNESCO Institute for Statistics*, *July*.

Valtonen, T., Hoang, N., Sointu, E., Näykki, P., Virtanen, A., Pöysä-Tarhonen, J., Häkkinen, P., Järvelä, S., Mäkitalo, K., & Kukkonen, J. (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective. *Computers in Human Behavior*, *116*(November 2020), 1–9. https://doi.org/10.1016/j.chb.2020.106643

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2020). Measuring the levels of 21st-century digital skills among professionals working within the creative industries: A performance-based approach. *Poetics*, *81*(April 2019), 101434. https://doi.org/10.1016/j.poetic.2020.101434

Wahono, R. S. (2007). A Systematic Literature Review of Software Defect Prediction: Research Trends, Datasets, Methods and Frameworks. *Journal of Software Engineering*, *1*(1), 1–16. https://doi.org/10.3923/jse.2007.1.12

Zeidmane, A. (2019). ICT in life of students at the Latvia university of Life sciences and Technologies. *Engineering for Rural Development*, *18*, 1927–1932. https://doi.org/10.22616/ERDev2019.18.N425