CICE Hiroshima University, *Journal of International Cooperation in Education*, Vol.24-2 (2021) pp.131 ～ 151

Digital Learning Landscape in Malaysia during the COVID-19 Pandemic: The Perspective of Ecological Techno-Subsystem Theory

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Abstract

This study aims to analyse the digital learning landscape based on an 'ecological' approach. Using an ecological approach, the ecological technology-subsystem theory frames Malaysia's digital learning environment as a complex interplay between technology, society, industry and policy. Such a practice is vital in addressing issues relating to challenges, policy-making, and digital learning governance during the COVID-19 pandemic in Malaysia. This paper proposes ecological technology subsystem theory to understand the transformation of a child as a digital learner during COVID-19 in the Malaysian school context. Data were gathered through document analysis, mass media, policy papers, and questionnaire from 670 Malaysian teachers. The analysis provides insight to three levels of the digital learning landscape in Malaysia during the COVID-19 pandemic: first, at the individual student level within the microsystem, primarily at the home as a place for digital learning during the COVID-19 pandemic lockdown; second, at the level of social mediation, principally related to parents and teachers who both serve as bridges for the children to cross digital learning boundaries across any Subsystem; and third, at the national level, where government policies and industries shape a digital learning culture while reducing the digital divide among children from different socioeconomic backgrounds.

Keywords: Digital learning, ecological techno-subsystem, COVID-19 pandemic, Malaysian school and student

Introduction

Many pandemics have occurred in human history, such as the Black Death (1347-1353) and Spanish flu (1918-1919), which produced catastrophic conditions throughout the world (Schmid et al, 2015; Taubenberger & Morens, 2006). It seems that the COVID-19 pandemic has followed a similar pattern, which indicates that the pandemic will not end soon. Many countries have taken significant steps to combat COVID-19, such as promoting social distancing, encouraging self-isolation policies, and postponing main events. Malaysian lifestyles have changed due to the spread of COVID-19. Most of the Malaysian routine involving school, work and others have had to embrace a new norm to prevent the virus from spreading viciously. Therefore, Malaysian school terms have changed to cope with the challenges of the COVID-19 pandemic. Attention should be paid to the reconfiguration of the Malaysian schooling period that addresses the mode of delivery and the goal of formal education itself in the age of the crisis. Malaysian students have had to stay at home, which has forced them to embrace the new norm of learning called remote learning. When students experience remote learning, they are not meeting with teachers face-to-face. This situation is quite challenging for students, rather than other parties such as parents, teachers and policymakers. Regular practice during the typical face-to-face school period has been diminished, as all activities and interactions now occur online. This signifies that Malaysia's school system will rapidly undergo digital transformation, and there is no turning back to depend solely on the conventional way of conducting teaching and learning activities.

Theoretical Framework of the Study

The latest theories in child development state that there is a connection between environmental and the biological factors that affect the child's growth and ultimately the child's academic performance. These two factors will lead the child to become functional in life (Luria, 1976). Based on ecological systems theory (Bronfenbrenner, 1979), it is postulated that multiple levels of the surrounding environment affect a child's life. Ecological system theory has served as a complete framework to address how central social contexts in a child's life interact and influence critical outcomes, including social and emotional adaptation. However, each child is unique in the sense of the variation of interactions that affect their development. The interpretation of interaction may be based on attributes of the developing child, the surroundings, and the areas of development that are evolving at the time.

Bronfenbrenner (1979) categorized the contexts of development into five nested environmental systems. The first category, which is the innermost layer, is the microsystem, which refers to the immediate environment, such as home and school interactions. This layer is considered the small, immediate environment to which the child belongs. In this layer, the child interacts directly with parents, caregivers at home or teachers in their classroom. Thus, the positive interactions of a child with the entities inside the microsystem will influence the child's potential to grow in a positive direction. The second outer layer, the mesosystem, comprises connections between immediate environments; in this case, it is the interaction between the home and school environment. The third layer is the exosystem, which refers to environmental settings that indirectly affect child growth. The fourth layer is the overarching social ideologies and cultural values. This fourth layer is called the macrosystem. The macrosystem is the largest and most remote environment but still has a significant influence on the child. Finally, the chronosystem highlights the effect of time on all systems and all developmental processes. It drives the pattern of environmental events and transitions over the life course, including sociohistorical circumstances. Therefore, it is also considered a time variable, as it can be understood as the influence of time and developmental change.

Ecological systems theory (Bronfenbrenner, 1979) emerged before the Internet revolution, and the developmental impact of then-available technology was conceptually situated in the child's microsystem. Johnson and Puplampu (2008) proposed their ecological technology-subsystem theory, the extension of Bronfenbrenner's ecological systems theory. Johnson and Puplampu (2008) added the ecological techno-subsystem, a dimension of the microsystem. The original ecological system refers to parents and schools as the immediate environment that affects the child. However, technology produces an immediate environment for the children. Therefore, the ecological technology-subsystem has its own added value, as it highlights technology as an additional entity that interacts with the child in the immediate environment. Technology is considered a non-living entity inside the immediate environment and includes cell phones, computer software, portable audio devices, and the Internet. According to ecological technology-subsystem theory, technology enhances humans' capability, which eventually increases human cognitive processes (Johnson, 2010). The techno subsystem includes child interaction with both living (e.g., peers) and nonliving (e.g., hardware) elements of communication, information, and recreation technologies in immediate or direct environments. From an ecological perspective, the techno-subsystem is the immediate bidirectional interaction between the child and the microsystem. Technology such as the Internet extends children’s access to information and communication seamlessly and mechanisms to support information searching. These features enable children to utilize higher-order thinking to solve more complex problems.

The Internet has been identified as a transformative technology for children, bringing about a new form of literacy and communication essential to their future roles as productive and engaged community members. Previous studies have shown that Internet use facilitates certain developmental aspects during childhood (Greenfield & Yan, 2006). Jackson et al. (2006) mentioned that children who used the Internet more had higher scores on standardized tests of reading achievement and higher grade point averages six months, one year, and 16 months later than did children who used the Internet less. According to the bioecological model, students' digital learning behaviour is strongly influenced by forces in social environments. Understanding the links between students' formative social experiences and their behaviour appears essential in creating a digital learning ecosphere. Bronfenbrenner's bioecological framework is well established within research on developmental aspects of childhood. However, the reinterpretation of Bronfenbrenner's bioecological framework to ecological technology subsystem theory has been utilized to frame Malaysia's digital learning environment as a complex interplay between technology and society. The framework is based on five layers of environments that students experience digital learning: microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Bronfenbrenner & Morris, 2006).

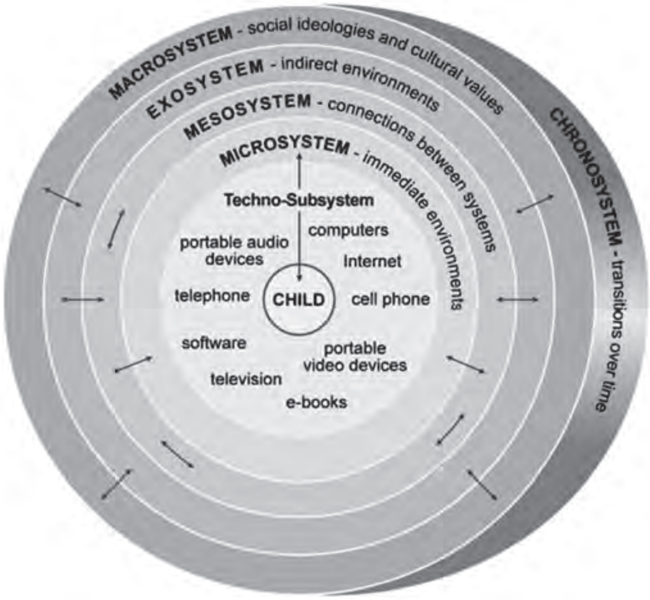

Figure 1. The Ecological Techno-Subsystem (Johnson & Puplumpu, 2008)

The Context

Malaysia is one of the 165 countries that have closed schools in response to the COVID-19 pandemic. The March school holidays in Malaysia were extended by three weeks. Starting in mid-March 2020, schools in Malaysia were ordered to close. Since then, lessons have been conducted online when the enforcement of the movement control order (MCO) was made to curb the spread of COVID-19. However, when the COVID-19 situation improved, most of the MCO measures were eased, including the reopening of schools in stages. For the schools to be fully reopened, there are three operation models: a single session, dual session, and rotational model. A single session model means schools open in one session with the requirement that students and staff obey social distancing regulations. The dual session model means that the school is operating in double sessions, as the school does not have the capacity to cater to all students in one session. Finally, the third model is applicable when the school cannot conduct single or dual sessions. The rotational model refers to implementing a blended learning approach whereby there is a mixture of face-to-face and home-based learning depending on the school's schedule. Although all the schools have been reopened, immediate measures will be taken if the number of COVID-19 cases surges. Areas are classified as "red zones" when 41 or more COVID-19 cases are registered for 14 days. If the surrounding community where the school belongs is categorized as a red zone, the Ministry of Health will advise the Ministry of Education to close that particular school to protect students and staff. In addition to schools in red zones, schools with positive COVID-19 cases and areas under the controlled MCO will also be closed. The schools encompass all primary and secondary schools under the Malaysian Ministry of Education and private schools registered with the Ministry. Students and teachers will resume home-based learning during this time.

Methodology of the Study

This study aims to analyse the digital learning landscape based on an 'ecological' approach. The ecological approach is used to analyse the range of factors that affect Malaysia's digital learning landscape. The ecological approach identifies multiple levels of influence on the digital learning landscape in Malaysia:

1. Learner factors such as knowledge, attitudes, beliefs and personality
2. The interaction of the learner with other people can provide social support or hinder the digital learning process
3. School and home factors, including the rules and informal structures that constrain or nurture the digital learning process
4. Society factors such as formal and informal social norms that exist among individuals, groups, or communities can limit or enhance the digital learning process
5. Public policy factors, including local, state and national policies that regulate or support the digital learning landscape in Malaysia

Using an ecological approach, ecological technology-subsystem theory is used to frame Malaysia's digital learning environment as a complex interplay between technology, society, industry and policy. Such a practice is vital in addressing challenges, policy-making, and digital learning governance during the COVID-19 pandemic in Malaysia. This paper proposes ecological technology subsystem theory to understand a child's transformation as a digital learner during COVID-19 in the Malaysian school context. Data were gathered from a document analysis of mass media, policy papers and research papers. The document analysis findings are arranged based on five layers of ecological technology subsystem theory: microsystem, mesosystem, exosystem, macrosystem, and chronosystem. Although the data were mainly gathered through the document analysis, an online survey was sent to 670 Malaysian teachers. The questionnaire's findings are needed, as Malaysian teachers' acceptance of using digital learning technologies can indicate how successful policymakers and private sectors play their roles in synergizing the digital learning culture at the macrosystem level. The teachers' acceptance of digital learning technologies is considered at the mesosystem level. Teachers' acceptance needs to be surveyed, as they will affect what happens at the microsystem level. As the key players in implementing digital learning policies, teachers need to be studied in terms of their acceptance levels. They deal directly with the students to undergo the digital learning process. The questionnaire was adapted from Al-Maroof & Al-Emran (2018) to measure Malaysian teachers' acceptance of using digital learning technologies. The measurement of teachers' acceptance is based on the Technology Acceptance Model, which consists of four variables: Perceived Ease of Use, Perceived Usefulness, Behaviour Intention and Actual Use (Davis, 1989). In the context of this study, the technology acceptance model (TAM) is an information systems theory that models how teachers come to accept and use digital technology. The model suggests that when teachers are presented with new digital technology, several factors influence their decision about how and when they will use it, notably:

i. *Perceived usefulness* – This was defined by Davis (1989) as "the degree to which a person believes that using a particular system would enhance his or her job performance", that is, whether teachers perceive digital technology as useful for what they want to do.
ii. *Perceived ease of use* – It is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989). If digital technology is easy to use by teachers, then the barriers are overcome. If it is not easy to use and the interface is complicated, teachers will not have a positive attitude.

The questionnaire used in this study consisted of 16 questions. Six questions belong to perceived usefulness, five questions to perceived ease of use, three questions to behaviour intention, and two questions to actual use. The reliability analysis found that the Cronbach alpha values for each of the variables were greater than 0.7, which implies that the questionnaire is reliable for use in this study (Table 1).

Table 1: Alpha Cronbach Value for Each Variable of TAM

Variables	Alpha Cronbach Value
Perceived Usefulness (PU)	0.782
Perceived Ease of Use (PE)	0.714
Behaviour Intention (BI)	0.880
Actual Use (AU)	0.859

Findings

Microsystems

Microsystems comprise the most immediate contexts in which a child may reside, such as the family, peers, school, or neighbourhood. According to ecological theory, demographic factors and psychological attributes such as learning styles and attitudes may influence students to have different digital learning receptivity. In managing digital learning, teachers may be able to capitalise on students' experiences in other contexts by incorporating appropriate behaviours, interactions, or experiences in some manner in the virtual learning environment. Past research indicates that children who use the Internet regularly and intensively gain more skills and online opportunities.

Malaysian students' backgrounds may influence their experience of digital learning. The COVID-19 pandemic likely affected the digital gap among Malaysian students, as Malaysia consists of places categorized as urban, semiurban, and rural. Ideally, students need to have a high-speed internet connection and proper devices such as smartphones or laptops for an ideal digital learning experience. However, not all parts of Malaysia are urban, for example, in remote areas such as Sabah and Sarawak and places where Orang Asli live, Internet availability is limited.

The government had already addressed the digital gap between rural and urban areas before the COVID-19 pandemic started (Marhaini Mohd Noor & Abdul RaufuAmbali, 2014). Developing countries, such as Malaysia, have begun to build ICT infrastructure in rural areas by establishing ICT access points known as community e-centres. Community e-centres are one of the means of increasing access to ICTs in rural areas. Telecentres' nature and functions vary slightly from one country to another (World Bank, 2012). Nevertheless, the common aim is to provide tools and skills to enhance communication and information sharing among people and promote connectivity.

To solve this issue, the Malaysian Minister of Communications and the government have introduced an initiative to boost students' internet access while taking their national exams (Malay Mail, 2020). Under those initiatives, telecommunications corporations, namely, Celcom, Digi, Maxis, U Mobile, and Telekom Malaysia, provide prepaid data passed for a limited time for students taking the national exams. YTL. Meanwhile, YTL Communications provides free SIM and data for students nationwide and free 4G smartphones for students from low-income families.

Mesosystem

School Internet portals are mesosystemic, allowing parents to access their children's homework assignments, attendance records, and grades. The mesosystem comprises processes and linkages between or among two or more of the settings in which children interact. The mesosystem is essentially a microsystem system and illuminates how these contexts are typically integrated and act together to influence children's behaviour.

The Malaysian Ministry of Education has introduced a digital learning platform called DELIMa, or 'Digital Educational Learning Initiative Malaysia' (Microsoft News, 2020). The DELIMa platform offers all the applications and services required by teachers and students within the Malaysian school system, including digital learning enabling technologies and resources such as Google Classroom, Microsoft Office 365 and Apple Teacher Learning Center. Considering the many applications of DELIMa that can be used for digital learning, it is suggested that Malaysian parents need to be educated to help and provide guidance to children, especially those at the lower primary school level. Technology can connect school and home contexts and help parents follow and become involved in their children's academic development (Lewin &Luckin, 2010). However, parents often need to be instructed on how to do so (Yu, Yuen, & Park, 2012), and despite common beliefs, students need to be taught digital skills (Ng, 2012). When schools closed due to the COVID-19 pandemic, children with less-educated parents were disadvantaged. They were left to learn how to utilise the platforms. Many families in the B40 group are relieved that schools are finally reopening. Their children have not been reaping the benefits of online schooling due to poor Internet connections and a lack of electronic devices.

Parents' tendencies to become involved with their children's assignments in the digital learning environment may positively affect their children's academic performance. Parental involvement can include facilitating schoolwork, attending parent-teacher conferences, offering support for success, and setting high expectations for achievement (Hill & Tyson, 2009). Englund, Luckner, Whaley, and Egeland (2004) found that the quality of instruction that parents provide for their children in problem-solving situations before school entry contributes to higher child IQ and indirectly affects their achievement. Similarly, parenting behaviours that stimulate reading and constructive play and provide emotional support have been shown to promote academic achievement in young children (Davis-Kean, 2005).

Past studies have indicated that there is some connection between the home and school. In a study of parents' involvement in inner-city elementary and middle schools, Dauberand Epstein (1993) found that parents who were more engaged in their children's education tended to have children who obtained better marks in school. Sheldon, Epstein, and Galindo (2010) found that better implementation of math-related activities to enhance family involvement predicted students' performance on math achievement tests. Epstein and Sheldon (2002) found that by having a close partnership with families, schools can also lower student absenteeism.

Exosystem

The third layer is the exosystem, which refers to environmental settings that indirectly affect child growth. The exosystem level involves the other people and places that the child may not interact with. Nevertheless, the exosystem has a significant effect on children, such as through their parents' career performance and the surrounding community at their home. These contexts may not directly affect the children, but they enable other factors to positively affect children. For example, when the child's parents can obtain higher salaries, the parents are more likely to be able to fulfil the child's physical needs. Another example is if all the community members always have the same vision in keeping the neighbourhood area safe, the child will feel secure living in that neighbourhood area.

Parents in unstable or stressful work conditions may be less actively involved in their children's educational activities because of strain and demanding work schedules. Stressful work experiences appear to negatively impact family life, and children's experiences at home may transfer to the classroom. Teachers need to be aware of the diverse family backgrounds of their students. Parents may become disengaged from their children's education because of external stressors or merely a lack of time. If teachers are aware of these challenges, they may be able to make accommodations in scheduling events and the use of time and resources. For instance, events might be scheduled at times when these parents are more readily available. Additionally, strategies and resources for time management (tutoring and after-school programs on weekends) to increase parental involvement in schooling might be discussed at parent-teacher conferences. For teachers, understanding the social contexts in which their students live and the social resources and challenges they face may help shape teachers' personalized learning strategies. It may also help teachers in at-risk communities incorporate curriculum topics, including stress management, conflict resolution, and communication and interpersonal skills.

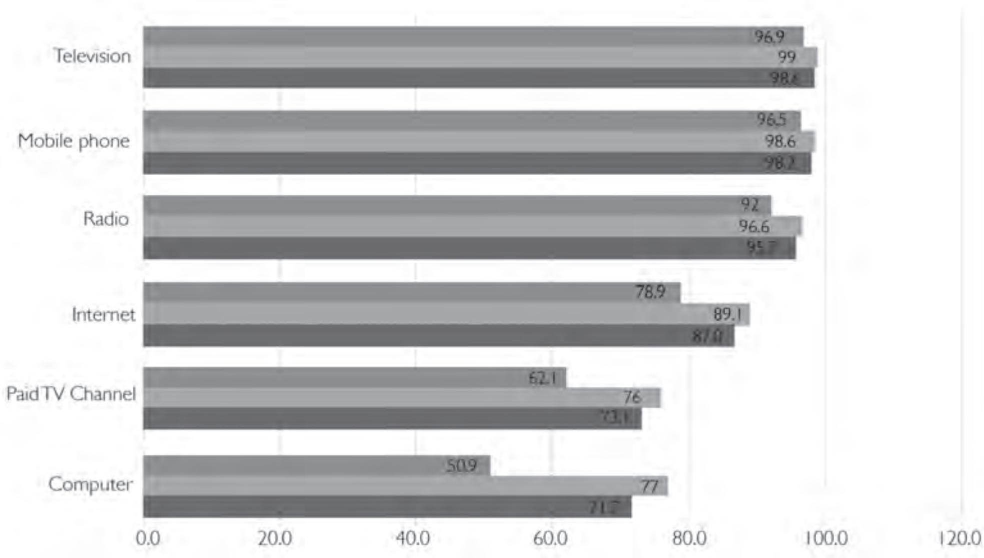

Figure 1: ICT Access by Malaysian Household 2018

Source: Department of Statistics, Malaysia (2019)

According to the ICT Use and Access by Individuals and Household Survey in 2018 (Department of Statistics Malaysia, 2019), 87% of households have access to the Internet, while only 71.7% of households have computers. In comparison, 98.6% of households had access to television. Therefore, the coverage of students via television is wider than online platforms. Malaysia has already started this initiative like providing Kelas@ Rumah, which airs for two one-hour slots on Okey TV daily (Wan, 2020). This could be expanded further to provide more classes to children of all ages and throughout the day. Instruction and guidance for parents could also be channelled through mobile phones to have a wider reach than online communications. It can be seen Figure 1 that 98.2% of the parents have access to a mobile phone.

Macrosystems

The fourth layer includes the overarching social ideologies and cultural values. This fourth layer is called the macrosystem. The macrosystem is the largest and most remote environment, but it still exerts a significant influence on the child. Macrosystems establish the cultural value of the uses of the Internet as a tool for digital learning. The current policy made by the Malaysian Ministry of Education has widened the scope by promoting the concept of Democratization of Education for digital learning. Through the Democratization of Educations, Malaysian school communities have more choices in selecting different types of learning technologies and applications. For example, Google and Microsoft introduced their learning applications, which are parked in KPM digital learning. Malaysian school communities can choose and customize platforms to fit their unique purpose. KPM digital learning existed before the COVID-19 pandemic, but now, it has become more prevalent as Malaysia's schooling system has moved to remote learning approaches. Therefore, it is not just about combining these tools but changing them over time for a range of needs and requirements. As COVID-19 cases surged dramatically in 2020, the Malaysian Ministry Of Education announced a refresh of its digital learning called DELIMa, or 'Digital Educational Learning Initiative Malaysia'. The platform was the culmination of several years of efforts from the Ministry and Google, Microsoft, and Apple. DELIMa, was envisioned with the following guiding tenets:

- Platform democratization — digital learning accessible to all, supporting a multitechnology ecosystem.
- Lifelong learning — student-centric experience so learning can take place at any time.
- Digital transformation — Malaysian Ministry Of Education’s commitment to the country’s future needs.

As the Malaysian Ministry of Education has moved into the Democratization of Education policy for digital learning, school communities will have more autonomy to ship learning technologies in and out. This evolution will only become more challenging and more exciting over time. However, teachers and students, as the end users of these learning technologies, have been empowered to choose the learning technologies they would prefer. Although the Malaysian Ministry of Education has a collaborative effort with three teach industry major players, Google, Microsoft, and Apple, this paper will focus on Microsoft as a case study to demonstrate how it plays a role in synergizing the culture of digital learning among Malaysian teachers and students.

Microsoft has provided a holistic approach to the Malaysian school community based on four pillars: (i) leadership and policy, (ii) teaching and learning, (iii) intelligent environment and (iv) student and school success. Under these four pillars, Microsoft has collaborated with the Educational Technology and Resource Division, Malaysian Ministry Of Education, to organize many digital learning programs for Malaysian teachers, school leaders and students. For example, Certified Microsoft Innovative Educator Experts has been awarded to Malaysian teachers who actively use Microsoft 365 applications. Microsoft awards the Microsoft Showcase School program to the selected schools in Malaysia based on their high commitment to enculturating digital learning culture among teachers, school leaders and students. Microsoft implemented the Minecraft Education Challenge to provide a long-term project for Malaysian students to work on for several weeks, which has been an alternative to daily classes if the school is closed. Minecraft: Education Edition is a version of Minecraft designed for education in a classroom setting. Malaysian teachers had the opportunity to create their lesson plans using the resources available to them in the Minecraft game.

Microsoft aggressively promotes and trains Malaysian teachers to use Microsoft technology for digital learning, especially during the COVID-19 pandemic breakdown. Therefore, there is a need to investigate the factors that can influence Malaysian teachers' acceptance of Microsoft technology for digital learning through an empirical study. A covariance-based structural equation modelling (SEM) approach was used to assess the path analysis of the factors that influence teachers to use Microsoft technologies. The path analysis model was developed based on the technology acceptance model (TAM) by Davis (1989). In the context of this study, the TAM suggests that two main beliefs determine teachers’ behavioural intention to use Microsoft technologies: perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the degree to which a person believes that using a particular system would enhance job performance, whereas PEOU refers to the degree to which a person believes that using a particular system would be free from effort. In the present study, the TAM is adopted to measure teachers' acceptance of Microsoft technologies as a digital learning tool in their daily teaching activities during the COVID-19 pandemic. In this respect, TAM provides a solid background for the effectiveness of new technology. In addition, the TAM also suggests that when teachers are exposed to new technology, many factors can influence their acceptance decisions. The study was conducted in the northern area of Malaysia. This study's sample consists of teachers who have received training and used Microsoft technologies for digital learning activities during the COVID-19 pandemic. An online questionnaire survey was sent to targeted samples to collect data regarding technology acceptance model (TAM) factors. These factors include the perceived usefulness of Microsoft technologies (PU), the perceived ease of use of Microsoft technologies (PEOU), the behavioural intention to use Microsoft technologies (BI), and the actual use of Microsoft technologies (AU). The questions asked in the questionnaire for this study were adopted from Davis (1989) with further adjustment to fit this study's scope. A total of 690 responses were received from a total of 750 questionnaires administered, which shows a response rate of 92%.

The result of covariance-based SEM indicates that the model did not fit the data well by the chi-square test, $\chi^2(N = 690, df = 100) = 562.88$, $p < .05$ (Figure 2). Although the hypothesized model did not fit the observed variance-covariance matrix well by the chi-square test, the baseline comparison fit indices of NFI, RFI, IFI, TLI, and CFI were all above 0.9 (range: 0.910–0.929) (Table 2).

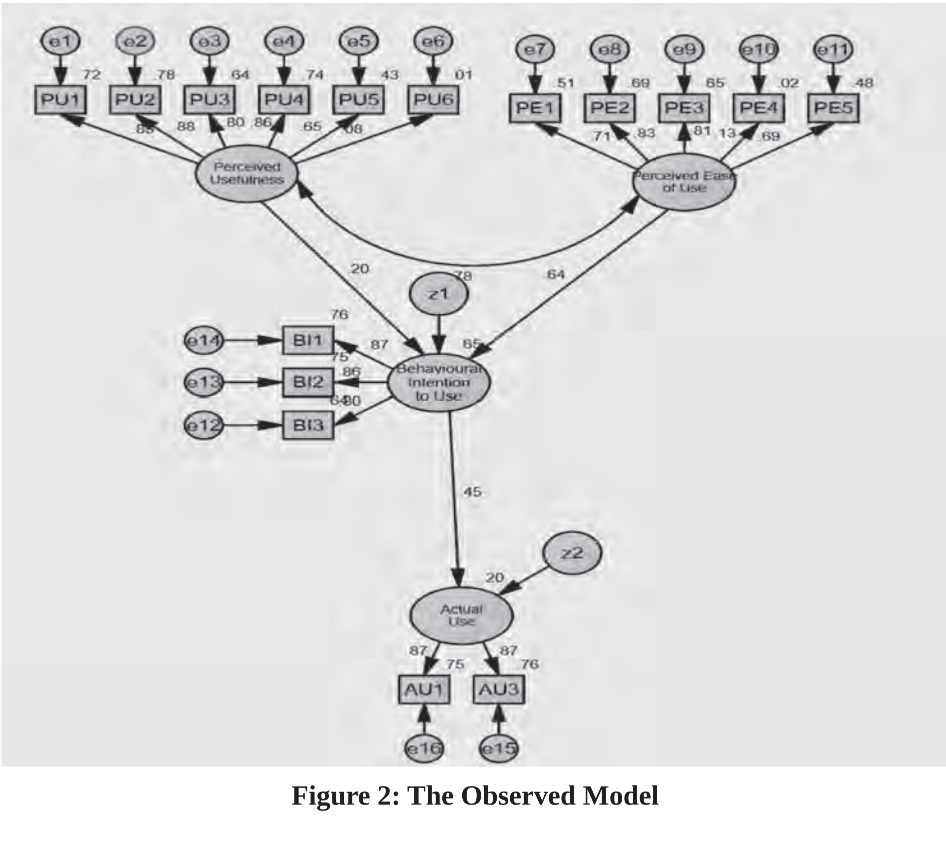

Figure 2: The Observed Model

Table 2: Baseline Comparisons

Model	NFI Delta1	RFI rho1	RFI Delta2	TLIrho2	CFI
Default model	.916	.910	.930	.915	.929
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

These indices compare the fit of the hypothesized model to the null or independence model. Although there are no clearly established rules regarding what constitutes a good fit, a widely applied guideline for these incremental fit indices is 0.90 (Bentler, 1980; Bentler and Bonett, 1980). With the incremen¬tal fit indices ranging from 0.910 to 0.929, the possible improvement in the fit of the hypothesized model (range: 0.071–0.090) appears so small as to be of little practical significance.

In the regression weights table, the results indicate that the unstandardized regression weights are all signed by the critical ratio test (>±1.96, p <.05) (except for those parameters fixed to 1) (Tables 3 and 4). In terms of measurement properties, the results indicate the following:

i. Six questions asked in the questionnaire (PU1, PU2, PU3, PU4, PU5 and PU6) were significantly represented by the perceived usefulness variable (p <.05).
ii. Five questions asked in the questionnaire (PE1, PE2, PE3, PE4, and PE5) were significantly represented by the Perceived Ease of Use variable (p <.05).
iii. Three questions asked in the questionnaire (BI1, BI2 and BI3) are significantly represented by the variable Behavioural Intention to Use (p <.05).
iv. Two questions asked in the questionnaire (AU1 and AU3) were significantly represented by the Actual Use variable (p <.05).

Table 3:Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Intent	<---	Ease	.687	.069	9.973	***	
Intent	<---	Useful	.187	.052	3.586	***	
Actual	<---	Intent	.669	.066	10.103	***	
PU1	<---	Useful	1.000				
PU2	<---	Useful	.998	.034	29.569	***	
PU3	<---	Useful	1.037	.041	25.422	***	
PU4	<---	Useful	1.018	.036	28.346	***	
PU5	<---	Useful	.869	.046	18.982	***	
PU6	<---	Useful	.160	.078	2.061	.039	
PE1	<---	Ease	1.000				
PE2	<---	Ease	1.009	.050	20.155	***	
PE3	<---	Ease	1.067	.054	19.610	***	

PE4	<---	Ease	.274	.088	3.128	.002
PE5	<---	Ease	1.067	.063	17.000	***
BI3	<---	Intent	1.000			
BI2	<---	Intent	1.007	.040	25.075	***
BI1	<---	Intent	1.038	.041	25.416	***
AU3	<---	Actual	1.000			
AU1	<---	Actual	.995	.072	13.914	***

Table 4: Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
Intent	<---	Ease	.642
Intent	<---	Useful	.200
Actual	<---	Intent	.452
PU1	<---	Useful	.846
PU2	<---	Useful	.881
PU3	<---	Useful	.802
PU4	<---	Useful	.858
PU5	<---	Useful	.653
PU6	<---	Useful	.081
PE1	<---	Ease	.711
PE2	<---	Ease	.831
PE3	<---	Ease	.806
PE4	<---	Ease	.126
PE5	<---	Ease	.693
BI3	<---	Intent	.797
BI2	<---	Intent	.864
BI1	<---	Intent	.875
AU3	<---	Actual	.869
AU1	<---	Actual	.866

In terms of path analysis (Tables 3 and 4), the results indicate the following:

i. Perceived Usefulness is significantly and positively related to Behavioural Intention to Use (standardized regression weight: $\beta = 0.200$, $p < .05$). The results also indicate that the Perceived Ease of Use is significantly and positively related to Behavioural Intention to Use (standardized regression weight: $\beta = 0.642$, $p < .05$). Thus, the higher Perceived Usefulness and Ease of Use, the more Intention to Use. However, based on the beta value, the factor of perceived ease of use has more influence on the behavioural intention to use Microsoft Technologies compared to the perceived usefulness.

ii. The results indicate that Behavioural Intention to Use is significantly and positively related to Actual Use (standardized regression weight: $\beta = 0.452$, $p < .05$). Thus, the higher intention to use, the more actual use of Microsoft Technologies.

The squared multiple correlations show that 0.652 or 65.2% of the vari¬ance of Behavioural Intention to Use is accounted for by the variances in PU and PEOU. The squared multiple correlations show that 0.204 or 20.4% of the vari¬ance of the Actual Use is accounted for by the variances in Behavioural Intention to Use.

The outcomes reveal that all the factors are significantly influential in terms of behavioural intention and the actual usage of Microsoft technologies for digital learning. Although both perceived usefulness and ease of use emphasize that familiarity in usefulness and ease played an important role in teachers' acceptance of Microsoft technologies, ease of use is a prime factor compared to the usefulness of Microsoft Technologies. Thus, more training opportunities for teachers should be provided so that teachers' can discover the comprehensive and effective features of Microsoft technologies and implement them widely.

Chronosystem

Internet applications and social expectations of Internet competence change with life transitions, such as when children have undergone remote learning during the COVID-19 pandemic. Any attempt to explain development requires that we attend to the passage of time. Change can be defined only with reference to time. Many of Bronfenbrenner's definitions, propositions, and hypotheses refer to change. However, his initial framework did not incorporate time as a specific element. Later, he added a specific reference to time in the notion of a "chronosystem." A chronosystem encompasses change or consistency over time not only in the characteristics of the person but also in the environment in which that person lives (e.g., changes over the life course in family structure, socioeconomic status, employment, place of residence, or the degree of hecticness and ability in everyday life). In general, the chronosystem represents the passage of time, as time affects the person, relationships, settings, mesosystems, the macrosystem, and other aspects of both the person and the ecosystem. All are moving through time. Ecosystems and their elements change for many reasons: time passes, history happens, and the world changes. Change may occur quickly or slowly. Over time, the person adapts to changes that occur in herself, her settings, and all other ecosystem components. How rapidly changes happen may determine how easily the person adapts. The chronosystem is added to complete the graphic model. The chronosystem reflects technological and other changes in society that demand that we develop new and different ways of understanding the environment and acting in it.

The Malaysian Ministry of Education provided a digital transformation programme before COVID-19 was declared a pandemic in the context of policy-making related to digital learning. This means that Malaysia is already on the right track for digital transformation, but the COVID-19 pandemic has accelerated the process. With or without COVID-19, the Malaysian education system has already undergone a digital transformation since 2019. This can be observed based on the Malaysian Education Blueprint (Malaysian Ministry of Education, 2013), which has been developed with three specific objectives:

i. Understanding the current performance and challenges of the Malaysian education system, with a focus on improving access to education, raising standards (quality), closing achievement gaps (equity), fostering unity amongst students, and maximizing system efficiency;
ii. Establishing a clear vision and aspirations for individual students and the education system as a whole over the next 13 years; and
iii. Outlining a comprehensive transformation programme, the system, including key changes to the Ministry, will allow it to meet new demands and rising expectations and ignite and support overall civil service transformation.

The process of developing the Blueprint included multiple experts and international agencies to evaluate and assess Malaysia's education system's performance (Malaysian Ministry of Education, 2013). These included the World Bank, the United Nations Educational, Scientific, Cultural Organization (UNESCO), the Organization for Economic Co-operation and Development (OECD), and six local universities. The Ministry also worked with other government agencies to ensure alignment with other public policies related to education. For example, the Ministries worked closely with the Performance Management and Delivery Unit (PEMANDU) to develop the Government Transformation Programme (GTP) 2.0 initiatives on education to reflect the priority reforms in the Blueprint from 2013 to 2015. Furthermore, the Ministry engaged with the rakyat on a scale never seen before. In a year, over 55,000 Ministry officials, teachers, school leaders, parents, students, and members of the public across Malaysia were engaged via interviews, focus groups, surveys, National Dialogue townhalls, Open Days and roundtable discussions. More than 200 memorandums were submitted to the Ministry, and over 3,000 articles and blog posts were written on the issues raised in the Blueprint. The Ministry also appointed a 12-member Malaysian panel of experts and a 4-member international panel of experts to provide independent input into the review findings (Malaysian Ministry of Education, 2013).

Many areas have been analysed to develop the Blueprint; one of them is ICT for Education (Malaysian Ministry of Education, 2013). The ultimate goal of ICT for Education policy is to harness the potential of ICT to deepen and improve the overall quality of education, including to develop higher-order thinking skills for students through the use of ICT in teaching and learning. In the Blueprint, the policy is divided into three waves: (i) Wave 1 in the range between 2013 and 2015, with the goal of enhancing the foundation; (ii) Wave 2 in the range between 2016 and 2020, with the goal of introducing ICT innovations; and (iii) Wave 3, which is the range between 2021 and 2025, with the goal of maintaining innovative, system-wide usage of ICT (Malaysian Ministry of Education, 2013). In Wave 1, the Malaysian Ministry of Education built upon the existing base to ensure that basic ICT infrastructure and competencies were in place throughout the system while avoiding commitments to any specific technological platform. The main priorities included (i) ensuring that students and teachers have sufficient access to ICT devices; (ii) providing the education system with a learning platform and adequate network bandwidth to use ICT services; and (iii) ensuring that all teachers have basic competency in ICT. Other priorities during this period included refining existing monitoring systems to provide more accurate assessments of progress in ICT initiatives, infusing ICT into the curriculum and providing quality, cost-effective content. In Wave 3, as the foundations for ICT are strengthened in the Malaysian education system, the Ministry will study additional opportunities to transform ICT usage in the classroom by scaling up best practices from areas of excellence and innovation identified in Wave 1. Currently, the digital transformation of the Malaysian Education System is in Wave 3. The COVID-19 pandemic started in 2020, which was at the end of Wave 2. It can be argued that the COVID-19 pandemic has accelerated the digital transformation of the Malaysian education system. As the only choices to conduct lessons through remote learning, Malaysian teachers choose to use online learning to teach their students at home. The scenario of learning during the COVID-19 pandemic is aligned with Wave 3 of the Malaysian Education Bluprint in terms of the use of ICT teaching and learning. Based on Wave 3, it is stated that ICT should be fully embedded throughout the education system's pedagogy and curriculum. The COVID-19 pandemic has shown the importance of digital learning as a solution for learning to occur remotely during the lockdown. Aligned with Wave 3, the Malaysian Ministry of Education is now focusing on scaling up and intensifying ICT usage among students and teachers nationwide.

Conclusions

Ecological systems theory provides a comprehensive conceptual framework to organize and understand the potential impact of digital learning during the COVID-19 pandemic on child development. Such a framework is a prerequisite to exploring the techno-subsystem, generally, and digital learning landscape during the COVID-19 pandemic. This paper proposes ecological technology subsystem theory to understand the digital transformation of a child as a learner during COVID-19. The analysis sheds light on three levels of the digital learning landscape in Malaysia during the COVID-19 pandemic:

1) at the level of the individual student within the microsystem, primarily of the home as a place for digital learning during the COVID-19 pandemic lockdown;

2) at the level of social mediation, principally related to parents and teachers, who both

serve as bridges for the children to cross the boundaries of digital learning across any subsystem
3) At the national level, government policies and industries act as shaping factors to create the culture of digital learning nationwide while reducing the digital divide among students coming from different socioeconomic backgrounds.

The analysis at the mesosystem level indicated that teachers could enable of narrow the digital divide between schools, as teachers are key players in optimizing the digital infrastructures provided by the government and industries for students' benefit. Upskilling teachers to be digitally competent is not the sole factor in achieving the mission, but the digital tools themselves should be easy to use and useful for teaching and learning.

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Appendix A

Item	Content	Variable
PU1	Microsoft's educational technology increases efficiency in teaching and learning activities.	Perceived Usefulness
PU2	Microsoft's educational technology enhances the effectiveness of teaching and learning activities.	Perceived Usefulness
PU3	Microsoft's educational technology allows me to prepare for lessons quickly	Perceived Usefulness
PU4	Microsoft's educational technology improves teaching performance	Perceived Usefulness
PU5	Microsoft's educational technology has unique features that are not present in other educational technologies	Perceived Usefulness
PU6	Microsoft's educational technology may not necessarily apply to all subjects in schools	Perceived Usefulness
PE1	Microsoft's educational technology is easy to use	Perceived Ease of Use
PE2	Microsoft's educational technology makes it easy to upload teaching materials for online learning	Perceived Ease of Use
PE3	Microsoft's educational technology makes it easy for me to produce a wide variety of teaching and learning activities	Perceived Ease of Use
PE4	Those who want to use Microsoft's educational technology do not need to receive any training	Perceived Ease of Use
PE5	Microsoft's educational technology makes it easy for teachers to overcome common barriers to teaching and learning	Perceived Ease of Use
BI1	I plan to increase my frequency of using Microsoft educational technology in my career	Behaviour Intention
BI2	I would recommend my fellow teachers use Microsoft educational technology	Behaviour Intention
AU1	I do use Microsoft technology for a day -to -day affairs in my career	Actual Use
AU3	I have always used Microsoft educational technology	Actual Use
BI3	I plan to use Microsoft educational technology regularly in the future to enhance my image of professionalism	Actual Use