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Needs Assessment in the use of Digital Technology for Learning Loss Recovery of Students at the Basic Education Level

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Abstract. Globally, COVID-19 has disrupted educational practices, causing basic education institutions in Thailand to close temporarily. Schools in Thailand as well as the world over have switched to online learning environments to guarantee students' educational continuation. The purposes of this study were firstly to determine whether digital technology is required for learning loss recovery; secondly, to conduct a systematic literature review using bibliometric keywords; thirdly, to assess the need for using digital technology to recover students' learning losses at the

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basic education level, both during and after the COVID-19 pandemic, and finally, to summarize data in an infographic landscape format pertaining to this topic. A questionnaire survey was conducted with 600 online respondents from throughout Thailand. The respondents included 56 educational supervisors, 40 school administrators, and 504 teachers. The results show that the following can be used: (a) student communication websites and applications, (b) student work acceptance websites and applications, (c) learning management systems, (d) digital media libraries, (e) online assessment tools, and (f) teaching methods and tools for future use. The respondents indicated that students have learning loss relating to (a) morality, ethics and manners, (b) good citizenship, (c) imagination and creativity, (d) health promotion, and (e) mathematical processes.

Keywords: needs assessment; learning loss recovery; bibliometric; landscape

1. Background of the Study

Globally, COVID-19 caused significant disruptions to the educational system. Most nations closed their educational facilities temporarily (Donnelly & Patrinos, 2022), while the abrupt shift in the regular teaching and learning activities in schools has had a long-term impact on education systems (UNESCO, 2022). During that era, all students studying were impacted by the COVID-19 epidemic. Additionally, it was amply demonstrated that students lost more learning the longer educational facilities were closed (Donnelly & Patrinos, 2021). It is also a contributing factor to the high rate of student dropouts.

Similar to other nations, Thailand has unavoidably been impacted, which increases the possibility that students will leave the educational system. For example, 85.40% of students attend class but occasionally do not, 7.40% of students drop out, 7.20% of students are unreachable, and 51% of students have been followed up by teachers and educational institutions but have not yet resumed their regular schedules (Equitable Education Fund, 2021). When compared to other basic education levels, elementary school children experienced the most recession difficulties during the first term, accounting for 72.2% of the total (Office of the Education Council, 2022b). The main factor contributing to students' declining learning is a shortage of online learning tools. Despite this, all educational establishments remain proactive and adjust to the swift changes to ensure that students continue to study. However, because of how long-lasting and ongoing the COVID-19 epidemic has been, students will unavoidably experience a learning recession. Nevertheless, because instruction is still coordinated through methods such as online learning, educational institutions do not actually close or cease to exist.

The topic of learning loss and learning loss recovery was thoroughly and publicly discussed after the COVID-19 epidemic progressively abated. For individuals engaged in teaching and for the education community, it is a crucial issue. Numerous nations worldwide are presently investigating the problem of declining learning and figuring out how to reverse this. In order to maintain the

educational system in the face of the pandemic, key guidelines were identified, including extending the academic year; increasing school hours and days for studying; offering tutoring after school, summer learning, individual learning plans, and working with the community and parents; creating a digital media library for open learning and connecting educational resources; and providing teachers with the supplies and equipment they need to prepare for all forms of teaching and learning (Aldosemani & Khateeb, 2022; Donnelly & Patrinos, 2022; Equitable Education Fund, 2022). A dynamic approach to learning in the educational loss that makes use of the HyFlex learning model consists of three main components: (a) online instruction for students unable to attend regular classes, (b) in-person instruction for those who can, and (c) recording instruction and organizing previous learning activities via the education management system (LMS). This allows students to access learning at their convenience (Alda et al., 2020; Pholpuntin et al., 2022).

Thailand worked hard to adapt its educational system to the changing circumstances; from the traditional educational system to home-based learning, and from the classroom to individual study (personalized learning) in conjunction with the element of digital technology change (digital disruption). The latter has emerged as a significant issue in educational management, encompassing the management of education during the epidemic crisis and the evolution of education following the COVID-19 era, leading to adaptations by both the teachers and the students.

Technology may also be a helpful tool in creating opportunities for lifelong learning to advance long-term education in the nation and to maximize Thailand's human resource potential for future competitiveness (Office of the Education Council, 2022b). The findings of a study on educational management in the context of the COVID-19 pandemic regarding the impact of the pandemic on the evolution of education in Thailand revealed that the pandemic influenced the educational system negatively with respect to student learning achievement, revealing a decline in academic achievement (Office of the Education Council, 2022b).

Under the COVID-19 scenario, educational management was required to leverage educational technology and media as key instruments to set up online or distant learning environments for students. To adapt to changes in teaching and learning based on the preparedness of each location, educational institutions have improved their information and communication technology systems. For example, they have developed Internet networks, produced electronic media, and provided equipment for online broadcasting, allowing teachers to use platforms or applications to plan online instruction.

Schools were able to reopen when the COVID-19 pandemic's effects were minimized and controlled. Nonetheless, student care is essential to implement pandemic prevention measures. A few students have started their regular studies in the classroom. Furthermore, some students are still feeling the negative after-effects, and some have moved during the COVID-19 pandemic and cannot be

reached. For this reason, teachers need to plan their online and classroom teaching. Every school controls how digital technology is used to accommodate various learning situations. A range of methods were employed according to the availability of educators and students; nevertheless, there was no evaluation of the need for utilizing digital technology to deal with students' learning loss. Because of this, the researchers need to determine whether using digital technology is necessary to address this issue at the basic education level. The purpose of this research was to determine whether digital technology is required for learning loss recovery, to conduct a systematic literature review using bibliographic keywords, to assess the need for using digital technology to make up for students' learning losses at the basic education level both during and after the COVID-19 pandemic, and to summarize data in an infographic landscape format pertaining to this topic. The research investigates the following questions:
Q.1. Which digital technology may be applied to the rehabilitation of learning loss?
Q.2. What are the keywords that link digital technology to the learning process and that may be utilized to make up for lost learning?
Q.3. Which digital tools do teachers utilize to make up for the learning losses that students experienced during and after the COVID-19 epidemic at the basic education level?
Q.4. How can needs assessments be used in an infographic landscape format to help students at the basic education level recover from learning loss?

2. Literature Review

Learning Loss

The term "learning loss" describes the discrepancy in learning levels. A distinction is now made between learning that takes place in a school year that is COVID-19 free and learning that takes place during periods of interruption (Aldosemani & Khateeb, 2022). Regression describes reversals in academic advancement, primarily brought on by wider gaps or student discontinuities, or particular or general knowledge and abilities. Any kind of education, online or in person, equips students with critical knowledge and abilities necessary for personal and professional development. When education is interrupted, real knowledge loss also happens. A study on school closures brought on by teacher strikes has shown similar findings, as well as a decrease in students' knowledge. This element is also affected by distant learning and school closures (Pasani et al., 2021). Students are impacted by school closures, while educational disparities are linked to the family's socioeconomic standing.

A loss of learning can make a student less prepared to move on to the next grade level as well as making it more difficult for them to access the material annually (Aldosemani & Khateeb, 2022). The global COVID-19 epidemic has seriously disrupted the educational system everywhere. It has created widespread fear and impacted around 1.6 billion students in more than 190 nations. The closing of schools and other educational institutions affected 94% of students worldwide. The possibility exists that those students will eventually forget what they have learned as they have lost out on opportunities to study that should have been theirs since the extended school break may extend to the length of the typical

school year. Thus, a reflective condition is the study of learning loss (United Nations, 2020; Office of the Education Council, 2022). Regression in terms of information that students have lost over time and the opportunities for learning that should be offered during regular school hours might be influenced by extended school breaks or the COVID-19 epidemic.

Over the next ten years, the learning loss will negatively affect society and the economy in addition to having a significant influence on each student's academic achievement. It is time for the state to intervene as it has the authority to stop or reverse the learning loss. One major concern associated with school closures to stop the spread of COVID-19 was that students would not learn much during the online learning sessions. Numerous social and economic issues have also been brought about by school closures (Pasani et al., 2021).

The overall image of the learners' level determined the amount of learning loss on the part of the learners throughout COVID-19. There is a modest impression of learning loss in basic education, with students in grades 1-6 believing that their academic performance in foreign language classes has declined. When it comes to such regression, the most typically affected fields are science and mathematics. In the meantime, third graders felt that their academic performance in science, arithmetic, and foreign languages had declined. Academic success regression was most prevalent for students in grades 4-6 in the subjects of science, mathematics, and foreign languages. The following learning losses are associated with secondary school students, according to the Office of the Education Council (2022b): (a) learning loss and cognitive linkage; (b) learning loss in attitude toward learning and subjects; (c) learning loss regarding scientific and practical skills; (d) changes in secondary school learners' characteristics; and (e) emotional, relational, and mental health conditions of secondary school learners.

A number of factors contributed to secondary school students' learning loss during the COVID-19 pandemic. These include (a) a shift in motivation and readiness for learning; (b) teachers' need to adjust to new methods of instruction and learning; (c) parents' comprehension of and support for their children's education; (d) modifications to school policies and management during the pandemic; and (e) media and technology inadequacy as a cause of learning media and devices (Council on Education Secretariat, 2022).

The recovery technique involves comparing the unit of learning about what comprises the knowledge and skills necessary for each unit throughout the year with the pre- and post-assessments of student development and accomplishment following instruction using the specified curriculum. A multitude of potentials enable the accomplishment of diverse academic objectives. The following factors play a role in facilitating learning and enhancing student learning outcomes: (a) Self-regulating learning skills give students a focused, short-term learning curriculum; (b) Utilizing microlearning strategies is a crucial step in any necessary potential intervention; (c) Student incentives should be encouraged; and (d) Levels of engagement should be raised (Aldosemani & Khateeb, 2022).

The Office of the Education Council (2022) advised that measures to counter learning regression were firstly, redesigning learning management processes that respond to the changing contexts and needs of learners. This might involve adjusting the school curriculum, adjusting the format and methods of measurement and evaluation, managing integrated learning, and connecting learning to the everyday experiences of the learners. There may be a need for self-directed learning which is appropriate to the age of the learner. This will promote the learning of individual learners, as will organizing activities that develop the social and emotional skills of the learners. It might be possible to develop a mobile classroom model that promotes hybrid learning management, the design, development, and allocation of appropriate learning materials, as well as the development of learning resources that promote the learning of a wide range of learners.

The second measure entailed empowering teachers and school administrators by developing their teaching techniques. This could involve developing the digital technology competencies of teachers and adapting teacher roles to make them effective coaches or facilitators of learning. It might be possible to adapt the role of school administrators to become super coaches in learning management. Schools could also use practice-oriented development patterns and methods to develop teaching and learning. Furthermore, a teacher development centre could be established to restore the quality of learning at the school and district level, leading to learning enhancement. A third way to counter learning regression is by engaging in effective learning management among schools. Teachers and parents could collaborate in effective learning by providing courses or guides for parents. This could lead to good interaction, building relationships and promoting community engagement activities in learning management between teachers and parents. Attempts could also be made to build a network of partnerships from different sectors to revive education.

In addition, developing a digital media library for open learning and for linking educational information is a fourth strategy to counter learner regression. (Open Educational Resources). This could be opened up as a repository of learning media, and shared among teachers, learners, and parents, thereby integrating essential information links. A fifth measure to counter learning regression is by creating positive attitudes towards learning and the well-being of learners in terms of both physical and mental health. Valuing positive attitudes and well-being, such as providing an appropriate environment for learning, promoting activities leading to the development of physical and mental health, fostering a positive attitude towards learning and improving life, and promoting awareness in terms of technology materials for learners to set up mental health support systems would improve the social and emotional makeup of learners in the academy and create quality interactions between teachers and learners, both in the classroom and beyond.

Learning regression can further be countered by elevating learning with the support of Edtech, such as providing free Internet for educational purposes, as well as covering the cost of equipment for learners. State-of-the-art tools and

programs should be provided to schools and their teachers by establishing educational media and technology centers at the provincial or district level to accelerate the development of a variety of learning platforms.

Finally, learning regression can be countered by the provision of welfare and safety support, leading to an increase in morale. This support can take the form of the provision of travel and safety assurances for teachers working outside the school premises. There should be a system to build the morale of teachers who are dedicated, selfless and dedicated to teaching and learning, including strengthening the system and mechanisms of care and safety of educational institutions for learners in a quality and standardized manner (Office of the Education Council, 2022b).

It is necessary to mitigate guidelines for learning loss to improve the quality of learning of secondary school students. This entails six approaches, namely (a) recommending budget allocation for Internet access, equipment, media, and technology for learning; (b) providing the right environment for learning, promoting both physical and mental health; (c) developing teacher learning management techniques; (d) making content adjustments involving the reduction of student workload and assignments; (e) using resources and media to encourage collaborative learning; and (f) communicating with parents and providing clarification about these learning management approaches to ensure their support (Office of the Education Council, 2022a).

A further aspect of promoting learning and learner quality consists of four approaches, namely promoting activities and exercises for the well-being of students; promoting engagement and interaction among students, parents, and teachers; promoting and preparing media and technology equipment; and promoting motivation and enhancing self-directed learning on the part of students (Office of the Education Council, 2022a).

Distance Learning during the COVID-19 Pandemic

Distance learning involves the use of a variety of websites and applications to provide academic continuity, most of which are familiar to teachers. In the transition process, teachers were faced with various challenges (Francom et al., 2021).

During the COVID-19 pandemic, the closure of schools and institutions and the transition from in-person learning to online learning forced learners to adapt to the changes. The challenges faced by young learners and adults took three forms: changes in learning styles, psychological outcomes, and a drop in academic performance (Ingemarsson, 2021). Teachers had both positive and negative experiences regarding online teaching. The fact that education could continue from home, and that teachers improved their teaching practices are often positively commented upon. It is also worth noting that for future online teaching, teachers should be educated on how to use the necessary technological tools for effective online teaching (Manoharan et al., 2022). This means that support is essential for the development of technical skills, coupled with sharing with

colleagues and establishing effective current practices. This leads to a greater sense of agency among instructors, and a willingness to embrace change (McQuirter, 2020). Lockdown, social distancing, and safe hygiene practices related to COVID-19 made the usual face-to-face course delivery options impossible for many higher education institutions globally and they have been forced to accept the transition to online learning as the only alternative (Turnbull et al., 2021).

A synthesis of the literature review regarding learning loss and distance learning during the COVID-19 pandemic is presented in Table 1.

Table 1: Synthesis of literature review

Literature review	Meaning	References
Learning loss	Conditions that reflect a recession in learner knowledge that has been forgotten over time, or a recession in learning opportunities that should have been provided during the normal hours of the school year, may be determined by the school's long breaks during the school year's recess or during the COVID-19 pandemic.	Aldosemani & Khateeb (2022); Donnelly & Patrinos (2022); Frey & Verhagen (2021); United Nations (2020); Ndaruhutse et al. (2021); Makarov & Guschenko-Cheverda (2021); Yoo & Kweon, 2019; Zhdanov et al. (2022); Office of the Education Council (2022a)
Distance learning during the COVID-19 pandemic	Using a variety of websites and applications to provide academic continuity. The COVID-19 pandemic caused the closure of schools and institutions, and the transition from in-person learning to online learning, which forced learners to adapt to the changes. The challenges faced by young learners and adults are divided into three topics: learning styles; psychological outcomes and low academic performance	Francom et al. (2021); Ingemarsson (2021); Manoharan et al. (2022); McQuirter (2020); Turnbull et al. (2021); Sarnok et al. (2019); Gulatee & Nilsook (2016); Wannapiroon et al. (2021); Voratitipong (2019)

Needs Assessment

A needs assessment is the process of collecting data to analyze differences between expected competence and actual competence. Then it is necessary to prioritize the differences (Tangdhanakanond & Wongwanich, 2012; Livergant et al., 2021; Nadjarzadeh et al., 2023). The need assessment process is divided into three parts, namely (a) identification of all the necessary needs that arise in the organization. This involves identifying problems with different objectives. Each group has both risks and beneficial factors. The response to the regeneration of learning also needs to consider the resources available or required, and the potential of the support factors such as the community and the government. It is also necessary to identify how the data collection is designed. The strategies to be

implemented should include a consideration of budget, time, and a review of the existing responsibilities together with the creation of assessment questions. It will be necessary to consider the variables that may have an impact on the response and determine who will be the best informants. (b) The techniques used to collect data are varied and the method used depends on the nature of the desired data. The full name of $PNI_{modified}$ is an improvement of the original PNI formula, i.e. (I-D), that is, the mean of the predicted conditions minus the mean of the actual conditions multiplied by the value. Mean of actual conditions, $PNI_{modified}$ formula, or $PNI_{modified}$ is a guideline to find the difference (I-D) and divide by the D value to control the size of the need to stay within the boundary that is not too broad and which gives a comparative meaning The status quo level is used as a basis for calculating the rate of development to the expected state of the group (Thabmali et al,2020).

$$\mathbf{PNI_{modified} = (I\text{-}D)/D}$$

(c) In defining a needs solution, the formulation of solutions is necessary to ensure that the needs are eliminated. Group discussions such as brainstorming can be used. Interviews are also utilized in formulating solutions to the problem (Thabmali et al., 2020). The benefit of a needs assessment is derived from the need to assess an effective management tool that can be used to define a roadmap that is consistent with the needs of the agency and is clear on its implementation. It can provide individuals with answers on how to use resources to improve work and ensure that implementation meets the real needs of the organization (Thabmali et al., 2020). There are several studies that incorporate the need assessment concept to develop research/measurement and evaluation capabilities. These studies formulate strategies and solutions using $PNI_{modified}$ techniques to prioritize problems.

3. Methodology

The study's background and related literature analysis led to the formulation of the following research questions: (a) What digital technology can be used to help students at the basic education level to recover from learning loss? (b) What keywords connect digital technology to the learning process and can be used to make up for lost learning? (c) Which digital tools do teachers use to make up for the learning losses that students experienced during and after the COVID-19 epidemic? and (d) How can needs assessments be used in an infographic landscape format to support students at the basic educational level in recovering from learning loss? A sample of 600 people was given access to an online questionnaire designed to provide answers to these study questions. In order to assess what is needed for the use of digital technology for learning loss recovery of students at the basic education level, this research employed a quantitative approach.

Participants

A simple random sampling was employed from 489,851 employees of the Ministry of Education's Office of the Basic Education Commission (OBEC) (2022), after notification to the OBEC Director. The 600 participants from five different

regions of Thailand filled out the online questionnaire: (a) the north, (b) the south, (c) the central and eastern regions, (d) the northeast, and (e) Bangkok and the vicinity. There were 504 teachers, 56 educational supervisors, and 40 school administrators. Of these, 49% were from Bangkok and the vicinity, 31% were from the central and eastern regions, 12% were from the northeast, 5% were from the south, and 4% were from the north.

The participants' experience in teaching ranged from one year to twenty-five years or more. Teachers in elementary schools made up 13% of the respondents; kindergarten teachers comprised 3%; teachers in primary and kindergarten schools accounted for 2%; teachers in kindergarten and elementary schools made up 24%; teachers in secondary schools amounted to 54%; and education supervisors from school district offices comprised 9%. Numerous subjects, including music, mathematics, science and technology, computing, careers, social studies, religion and culture, the arts, English, and the Thai language, were taught by the respondents.

Research Tool

The research tool used to collect the data was an online questionnaire. Respondents could choose to rate their experience on five different levels: very poor, poor, fair, good, and excellent, with a double response type (dual-response format). It was divided into three parts: part 1 included 12 questions about the basic information of the respondents; part 2 had 57 items about the use of digital technologies to manage learning both during and after the COVID-19 pandemic; and part 3 comprised 10 items related to t the learning loss of students. In total, 79 questions passed the index of item-objective congruence (IOC) examination and the verification of content conducted by five experts. It was found that all IOC candidates achieved results of 0.8 or above.

The questionnaire was tested by obtaining actual information from educators, school administrators, and supervisors of education that matched a sample provided by the Office of the Basic Education Commission. It used the alpha coefficient calculation to examine the questionnaire's reliability, giving a whole scale of 0.91. The online questionnaire survey was conducted using both close-ended and open-ended survey questions. Examples of such questions included, "To what extent does the use of digital technology address learning loss?", "What learning loss did learners experience?", and "Which teaching approaches and which tools should be used next?"

Data Analysis

The quantitative data was a synthesis of the digital technologies used to manage learning during the COVID-19 pandemic in 2018-2022. Bibliometric analysis of keywords that connect the learning process and digital technology was used to recover the learning loss using Mendeley and VOSviewer. Analysis of survey information from teachers, school administrators, and educational supervisors about the use of digital technology for helping students at the basic education level to recover from learning losses utilized reference data such as average and percent criteria to determine the difference between the average during and after the COVID-19 pandemic by means of computer programs. The five stages of the

Wongvanich (2007) approach determined the significance of scores. A score of one indicates the lowest level, while a score of five indicates the highest level. The modified priority needs index technique ($PNI_{modified}$) was used to compare during and after the COVID-19 pandemic to assess how digital technology might help students at the basic education level to recover from their learning loss by analysis and creating a landscape of digital technology for learning loss recovery of students at the basic education level.

4. Results

Participants' answers collected during the study amounted to 49% from Bangkok and its vicinity, 4% from the north, 5% from the south, 31% from the central and eastern regions, and 12% from the northeast. Teaching experience ranged from one year to 25 years or more. Elementary teachers accounted for 13% of the respondents, 3% were kindergarten teachers, 2% were kindergarten and primary school teachers, 24% were kindergarten and elementary school teachers, 8% were elementary and secondary school teachers, 54% were secondary school teachers, and supervisors from school district offices made up the remaining 9%. Respondents taught many different disciplines, including Music, Mathematics, Science, Social Studies, Arts, English, Thai Language, Science and Technology, Computing, Careers, Social Studies, Religion, and Culture.

Digital technology that the teachers, school administrators, and educational supervisors require for learning loss recovery of students at the basic education level is categorized into four sections as follows:

4.1 Digital Technology for Learning Loss Recovery

According to Table 2, which synthesizes the technology used to manage learning during the COVID-19 pandemic in 2018-2022, there is a variety of websites, applications, and teaching approaches and tools that can be used. These include (a) websites and applications used to communicate with students, (b) websites and applications used to receive and return students' work, (c) learning management systems, (d) digital media libraries, (e) online evaluation tools, and (f) teaching practices and tools that will continue to be used.

Table 2: Technologies used to manage learning during the COVID-19 pandemic in 2018-2022

Technology used	Reference												
	(Malik et al., 2021)	(Francom et al., 2021)	(Barman, 2022)	(Turnbull et al., 2021)	(Stecuła & Wolniak, 2022)	(Hart, 2022)	(Office of the Education Council, 2022a)	(Sompakdee et al., 2021)	(Songkram & Osuwan, 2022)	(Chiablaem, 2021)	(Mathuros Suwimon, 2021)	(Wattanakasiwich et al., 2021)	(Kongmanus Kobsook, 2018)
1. Websites and Applications used to communicate with students													
1.1 Zoom	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1.2 Google Meet	✓	✓				✓	✓		✓	✓		✓	✓
1.3 Microsoft Teams	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓
1.4 Cisco Webex	✓					✓	✓	✓	✓			✓	✓
1.5 Google Classroom		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.6 ClassDojo		✓				✓	✓						✓
1.7 Email		✓			✓	✓	✓	✓		✓		✓	✓
1.8 YouTube		✓		✓	✓	✓	✓	✓		✓		✓	✓
1.9 Schoology		✓				✓	✓	✓	✓	✓			✓
1.10 Line							✓	✓	✓	✓	✓	✓	✓
1.11 FB Messenger							✓	✓	✓	✓	✓	✓	✓
1.12 Twitter				✓			✓	✓	✓	✓	✓	✓	✓
1.13 Instagram							✓	✓	✓	✓	✓	✓	✓
1.14 TikTok							✓	✓	✓	✓	✓	✓	✓
2. Websites and Applications used to receive students' work													
2.1 Google Classroom	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓
2.2 Microsoft Teams	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓
2.3 Email		✓			✓	✓	✓	✓		✓	✓	✓	✓
2.4 Google Apps Edu	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓
2.5 Schoology		✓				✓	✓	✓	✓	✓			✓
2.6 Seesaw						✓	✓	✓		✓	✓	✓	✓
2.7 Zoom						✓	✓	✓	✓		✓	✓	✓
2.8 Line						✓	✓	✓	✓	✓	✓	✓	✓
2.9 Facebook				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Learning Management Systems													
3.1 Google Classroom	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓
3.2 Microsoft Teams	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓
3.3 Schoology		✓				✓	✓	✓	✓	✓			✓
3.4 Moodle						✓	✓	✓	✓		✓	✓	✓

Reference													
Technology used	(Malik et al., 2021)	(Francom et al., 2021)	(Barman, 2022)	(Turnbull et al., 2021)	(Stecula & Wolniak, 2022)	(Hart, 2022)	(Office of the Education Council, 2022a)	(Sompakdee et al., 2021)	(Songkram & Osuwan, 2022)	(Chiablaem, 2021)	(Mathuros Suwimon, 2021)	(Wattanakasiwich et al., 2021)	(Kongmanus Kobsook, 2018)
3.5 Thai Moocs							✓	✓	✓	✓	✓	✓	✓
4. Digital Media Library													
4.1 OBEC							✓	✓	✓	✓	✓	✓	✓
4.2 Trueplookpanya							✓	✓	✓	✓	✓	✓	✓
4.3 DLTV							✓	✓	✓	✓	✓	✓	✓
4.4 SciMath							✓	✓	✓	✓	✓	✓	✓
4.5 YouTube							✓	✓	✓	✓	✓	✓	✓
4.6 Web E-learning							✓	✓	✓	✓	✓	✓	✓
4.7 E-book						✓	✓	✓	✓	✓	✓	✓	✓
5. Online Evaluation Tools													
5.1 Google Forms						✓	✓	✓	✓	✓	✓	✓	✓
5.2 Microsoft Forms						✓	✓	✓	✓	✓	✓	✓	✓
5.3 Live Worksheet						✓	✓	✓	✓	✓	✓	✓	✓
5.4 Kahoot						✓	✓	✓	✓	✓	✓		✓
5.5 Socrative						✓	✓	✓	✓	✓	✓	✓	✓
5.6 Zip grade						✓	✓	✓	✓	✓	✓		✓
5.7 Quizizz						✓	✓	✓	✓	✓	✓	✓	✓
5.8 Mentimeter						✓	✓	✓	✓	✓	✓		✓
6. Teaching Practices and Tools that will continue to be used													
6.1 assignment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.2 Sharing Materials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.3 Video	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.4 Announcements and Updates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.5 Two-Way Comm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.7 Testing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.8 General Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.9 Parent Comm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.10 Grade Book	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6.11 Attendance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

4.2 Keywords to connect the Learning Process and Digital Technology to recover Learning Loss

The keywords that link the process of learning with digital technology that may be utilized to recover from learning loss are displayed in Figure 1, which is a visual representation of a bibliometric network created using Mendeley and VOS viewer as a tool for bibliometric analysis. It was found that learning loss has been exacerbated by the COVID-19 pandemic. Troubleshooting learning loss identified the following relevant keywords: (a) Learning management: student engagement, collaborative learning, deep learning, adaptive learning, and microlearning, 2(b) Technologies for learning: digital workplace, Moocs, mixed reality, virtual reality, mobile learning, virtual world, second life, and online learning, and (c) Education: higher education and adult education.

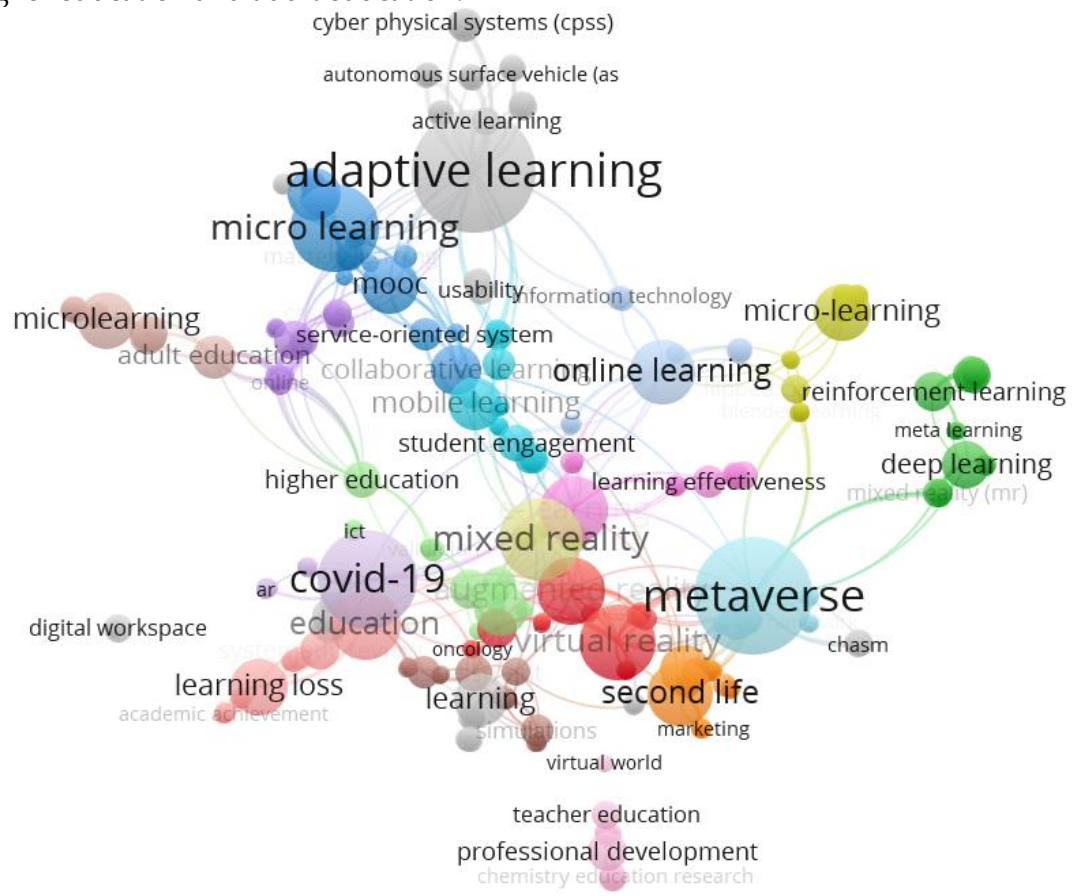

Figure 1: Visualizing bibliometric networks of keywords

4.3 Digital technologies that teachers need to recover the learning loss of students at the basic education level during and after the COVID-19 pandemic

Table 3: Digital technologies to recover the learning loss of students at basic education level

The use of digital technology	During COVID-19		After COVID-19		I - D	$PNI_{modified}$ (I – D)/D
	Average	Percent	Average	Percent		
1. Websites and Applications used to communicate with students						
Zoom	3.31	66.23	3.60	71.90	-0.2833	-0.0788
Google Meet	3.76	75.13	3.91	78.20	-0.1533	-0.0392
Microsoft Teams	2.63	52.57	2.35	46.93	0.2817	0.1200
Cisco Webex	1.61	32.23	2.61	52.10	-0.9933	-0.3813
Google Classroom	3.34	66.77	3.37	67.33	0.0283	-0.0084
ClassDojo	1.63	32.50	2.57	51.40	-0.9450	-0.3677
Email	3.29	65.77	2.79	55.87	0.4950	0.1772
YouTube	3.97	79.30	4.05	81.02	-0.0858	-0.0212
Schoology	1.68	33.63	1.65	32.90	0.0367	0.0223
Line	4.55	91.03	4.54	90.77	0.0133	0.0029
FB Messenger	3.38	67.50	3.69	73.87	-0.3183	-0.0862
Twitter	1.79	35.77	2.65	53.03	-0.8633	-0.3256
Instagram	1.97	39.47	2.72	54.47	-0.7500	-0.2754
TikTok	2.24	44.73	2.90	57.93	-0.6600	-0.2278
2. Websites and Applications used to receive students' work						
Google Classroom	3.47	69.33	3.30	65.90	0.1717	0.0521
Microsoft Teams	2.33	46.67	2.26	45.27	0.0700	0.0309
Email	2.93	58.53	3.52	70.40	-0.5933	-0.1686
Google Apps Edu	2.47	49.40	2.36	47.20	0.1100	0.0466
Schoology	1.57	31.40	2.58	51.67	-1.0133	-0.3923
Seesaw	1.47	29.40	1.52	30.33	-0.0467	-0.0308
Zoom	2.58	51.53	2.47	49.43	0.1050	0.0425
Line	4.33	86.50	4.09	81.83	0.2333	0.0570
Facebook	3.19	63.73	3.19	63.73	0.0000	0.0000
3. Learning Management Systems						
Google Classroom	3.61	72.10	3.63	72.57	-0.0233	-0.0064
Microsoft Teams	2.55	50.93	3.23	64.61	-0.6837	-0.2117
Schoology	1.60	32.00	1.59	31.70	0.0150	0.0095
Moodle	1.58	31.50	1.64	32.80	-0.0650	-0.0396
Thai Moocs	1.87	37.40	1.78	35.53	0.0933	0.0525
4. Digital Media Library						
OBEC Content Center	3.00	59.93	2.94	58.89	0.0518	0.0176
Trueplookpanya	2.89	57.83	2.78	55.67	0.1081	0.0389
DLTV	2.87	57.36	2.77	55.35	0.1004	0.0363
SciMath	2.76	55.14	2.69	53.78	0.0680	0.0253

The use of digital technology	During COVID-19		After COVID-19		I - D	$PNI_{modified}$ (I – D)/D
	Average	Percent	Average	Percent		
YouTube2	4.17	83.34	4.04	80.83	0.1256	0.0311
Web E-learning	2.63	52.51	2.49	49.86	0.1325	0.0532
E-book	2.61	52.13	2.48	49.60	0.1268	0.0511
5. Online Evaluation Tools						
Google Forms	4.19	83.77	3.91	78.21	0.2779	0.0711
Microsoft Forms	2.41	48.17	2.34	46.84	0.0661	0.0282
Live Worksheet	2.56	51.14	2.48	49.52	0.0809	0.0327
Kahoot	2.70	53.98	2.58	51.50	0.1238	0.0481
Socrative	1.63	32.56	1.65	32.99	-0.0215	-0.0130
Quizizz	2.55	51.02	2.45	49.07	0.0975	0.0397
Mentimeter	1.90	37.93	1.84	36.87	0.0527	0.0286
6. Teaching Practices and Tools that will continue to be used						
Assignment	3.52	70.49	3.57	71.47	-0.0490	-0.0137
Sharing Materials	3.01	60.26	2.96	59.20	0.0529	0.0179
Video	3.88	77.64	3.67	73.36	0.2139	0.0583
Announcements and Updates	3.31	66.15	3.24	64.83	0.0663	0.0204
Two-Way Comm	3.36	67.14	3.39	67.80	-0.0332	-0.0098
Testing	3.45	68.95	3.41	68.13	0.0405	0.0119
General Activities	3.16	63.28	3.18	63.64	-0.0183	-0.0058
Parent Comm	3.06	61.16	3.08	61.59	-0.0216	-0.0070
Student Support	3.31	66.18	3.32	66.50	-0.0161	-0.0048
Grade Book	3.02	60.41	3.08	61.50	-0.0545	-0.0177
Attendance	3.26	65.30	3.26	65.30	0.0000	0.0000

Table 3 indicates that assessing the need to use digital technology to solve the learning regression on the part of basic education learners can be divided into the following six areas, namely (a) websites and applications which are used to communicate with students, (b) websites and applications used to receive and return students' work, (c) learning management systems which need to use digital technology to remedy the learning loss, (d) online evaluation tools are essential when using digital technology to solve the learning regression, (e) online evaluation tools are invaluable to address learners' learning loss and (f) teaching practices and tools that will continue to be used which indicates that it is necessary to use digital technology to solve the problem of learning loss.

Websites and Applications used to Communicate with Students

The ten most widely used websites and applications used to communicate with students include Line, YouTube, Google Meet, Facebook Messenger, Google Classroom, Zoom, Email, Microsoft Teams, TikTok, and Instagram (Figure 2). There are also many other websites and applications ranging from learning management systems (LMSs) to basic communication tools (e.g., text messaging,

Google Voice, phone calls) and video and screen casting applications (including Twitter, Schoology, ClassDojo, and Cisco Webex Meetings).

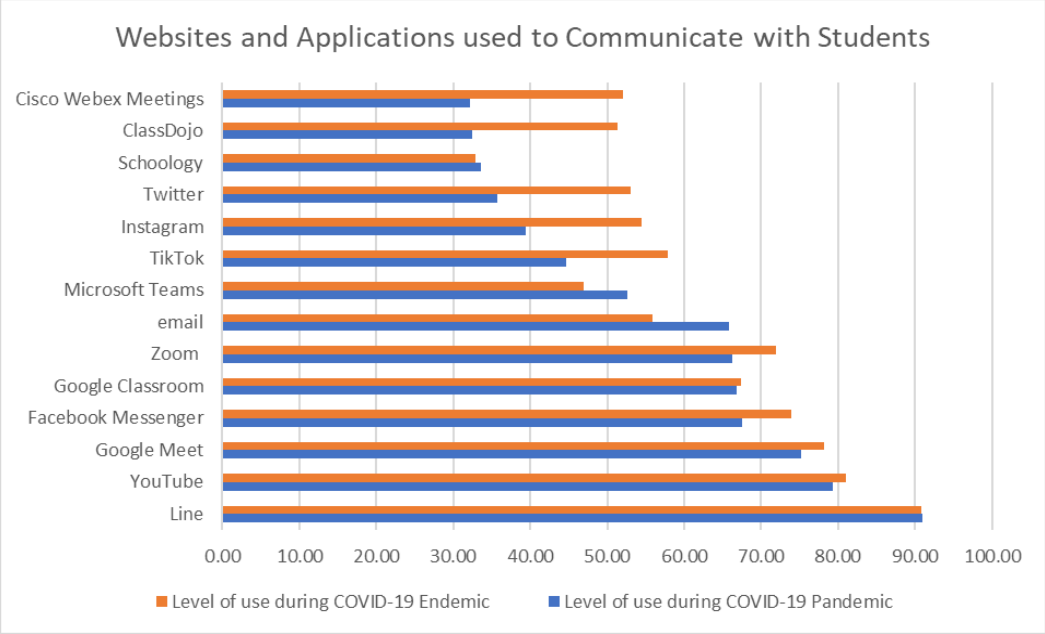

Figure 2: Websites and applications used to communicate with students

Websites and Applications used to Receive Students' Work

Many of the same previously mentioned websites and applications were used to receive and return students' work. Among the variety of these resources, the nine most widely used websites and applications are Line, Google Classroom, Facebook, E-mail, Zoom, Google Apps for Education, Microsoft Teams, Schoology, and Seesaw (Figure 3). School administrators and in-service educators also mentioned many other websites and applications, including further learning management systems such as Padlet, Google Forms, Wordwall, Liveworksheets and Messenger.

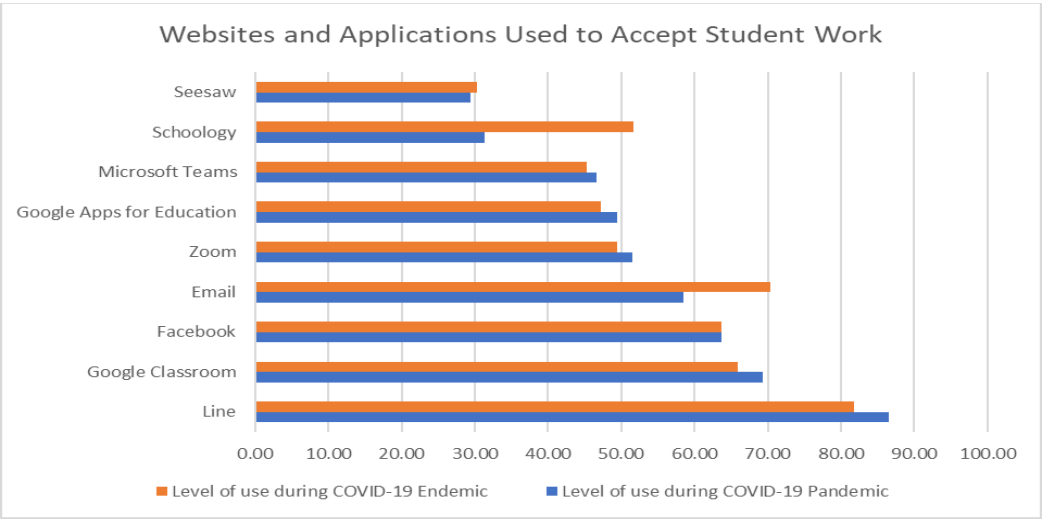

Figure 3: Websites and applications used to receive students' work

Learning Management Systems

There are many learning management systems available for this purpose, indicating a wide range of such resources. In addition to the five most frequently used learning management systems mentioned, teachers, school administrators, and in-service educators also indicated many other learning management systems, including Padlet, School Platform, CUD Smart School, and Google Drive (see Figure 4).

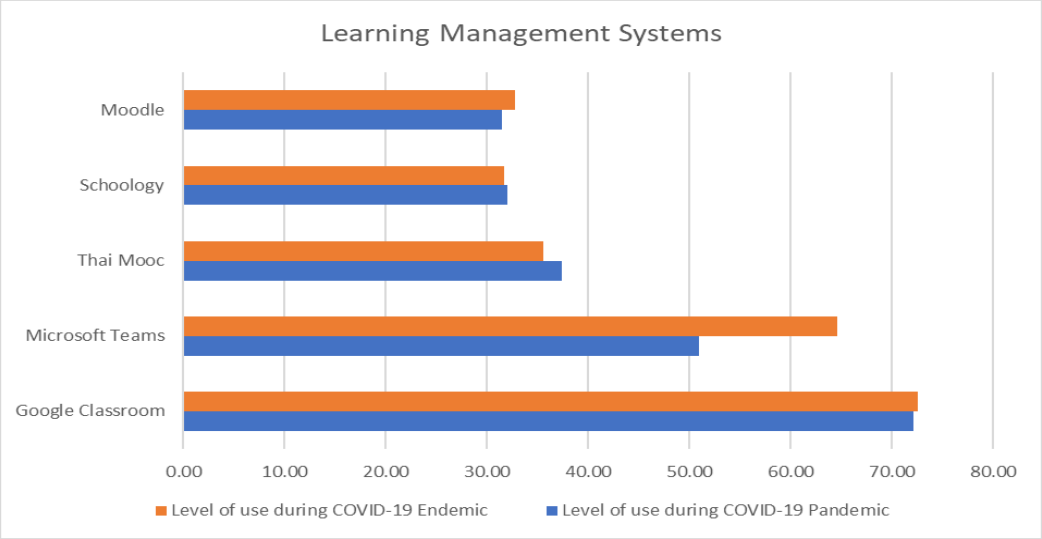

Figure 4: Learning management systems used during the COVID-19 pandemic

Digital Media Library

Once again, many digital media archive systems are mentioned, indicating a wide range of such resources. The top seven learning management systems were YouTube, OBEC Content Center, DLTV, SciMath, Web E-learning, and E-book (Figure 5).

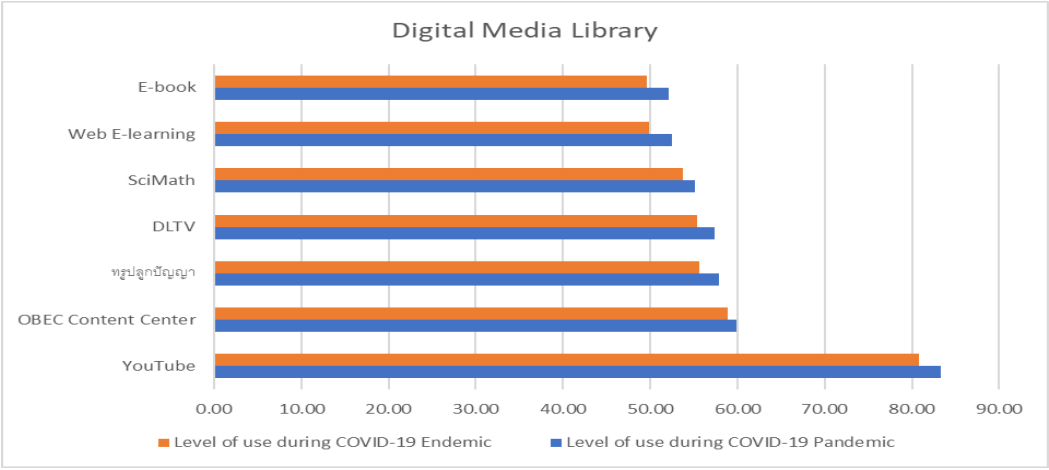

Figure 5: Digital media library

Online Evaluation Tools

A wealth of online measurement and evaluation tools were mentioned, indicating a wide range of such resources. Figure 6 lists the following seven most widely used learning management systems, namely Google Forms, Kahoot, Live

Worksheet, Quizizz, Microsoft Forms, Mentimeter, and Socrative. Teachers, school administrators, and in-service educators also utilized many other online measurement and evaluation tools, including Project 14, Virtual School Online, and Pinterest.

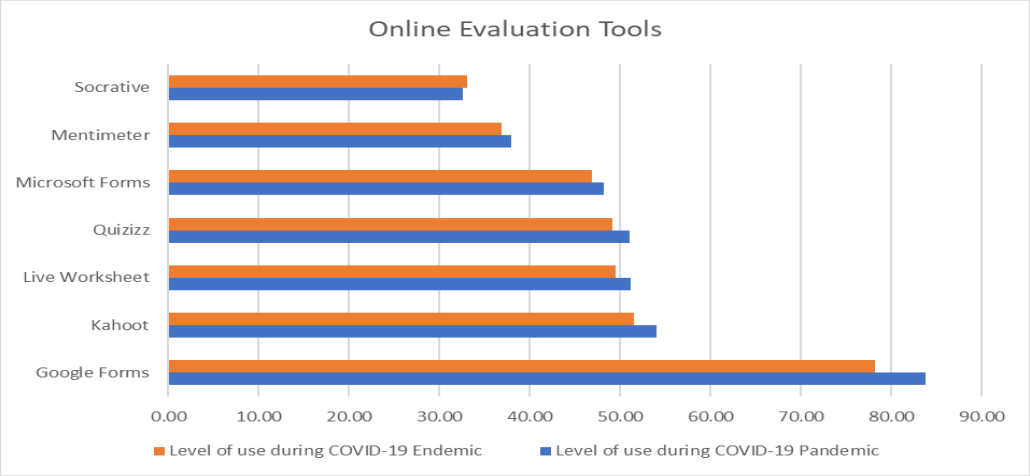

Figure 6: Online evaluation tools

Teaching Practices and Tools that will Continue to be Used

In terms of the pedagogical approach and tools that will be used in future, many were mentioned, indicating a wide range of suitable resources. The most important of these are video, assignments, testing, two-way communication, offering student support, announcements and updates, monitoring attendance, general activities, parent communication, compiling grade books, and sharing materials, as depicted in Figure 7.

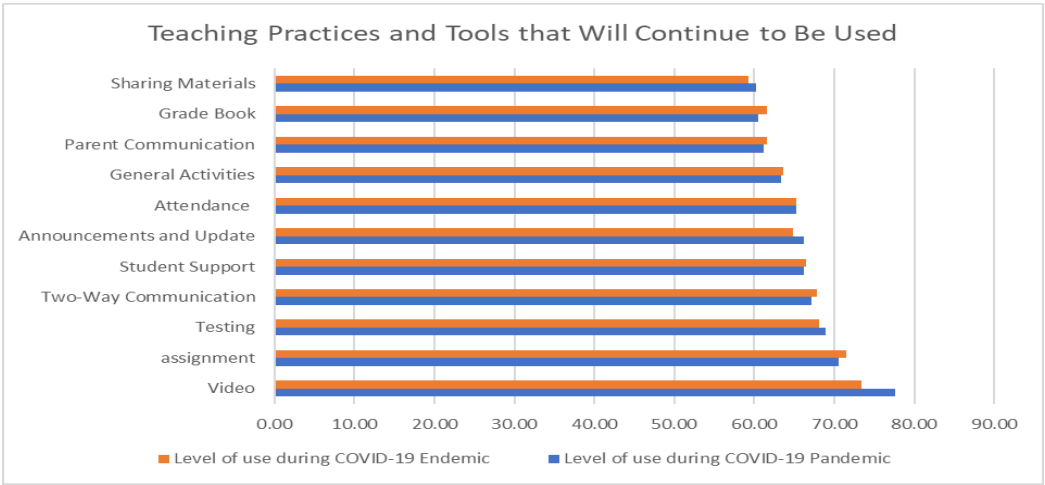

Figure 7: Teaching practices and tools that will continue to be used

Table 4: Average and percentage of learners with learning loss

No.	Learners incurring losses	Average	Percent
1	Morality, ethics, and etiquette	3.13	62.64
2	Knowledge and skills of good citizenship	2.92	58.32
3	Knowledge and skills to think, imagine, and create art	2.82	56.50
4	Knowledge and skills to enhance health	2.82	56.36
5	Knowledge, skills, and mathematical processes	2.80	55.91
6	Occupational knowledge and skills	2.79	55.75
7	Knowledge, skills, and scientific processes	2.77	55.30
8	Knowledge and skills in listening, speaking, reading, and writing in Thai	2.75	54.93
9	Knowledge and skills in listening, speaking, reading, and writing in English	2.73	54.63
10	Knowledge and skills in the use of technology	2.72	54.46

4.4 Digital Technology in an Infographic Landscape Format for Learning Loss Recovery

The analysis of the survey data on digital technologies for recovering learning loss at the basic education level can be applied to enhance learners' experience and select the appropriate teaching approaches and tools necessary to create a landscape as shown in Figure 8.

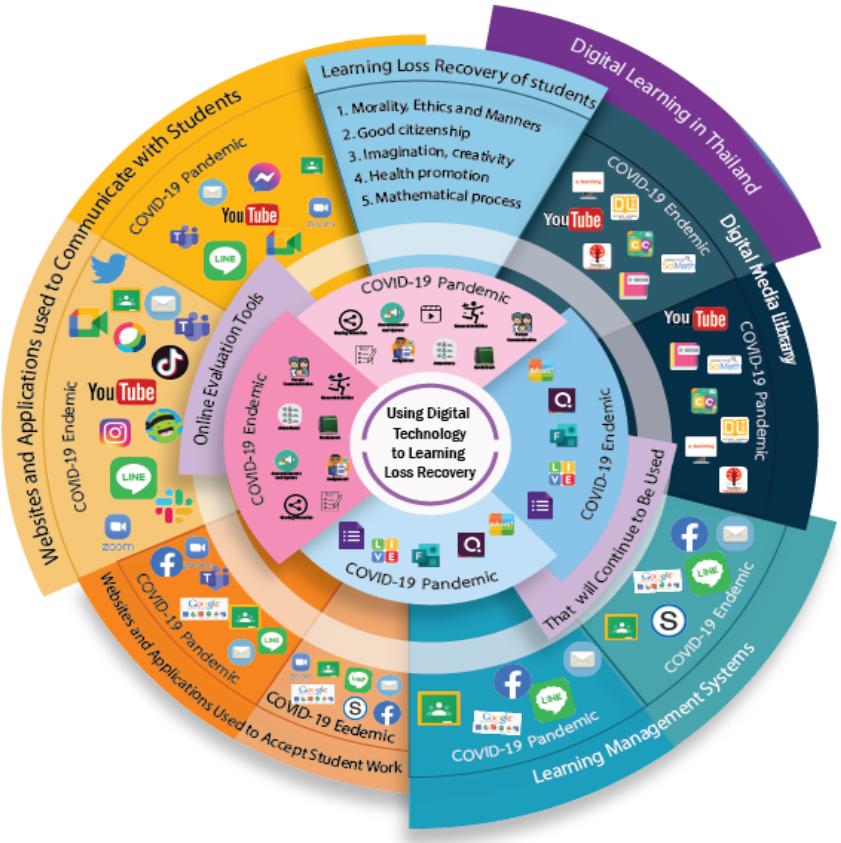

Figure 8: Digital technology for learning loss recovery of students at the basic education level

5. Discussion

The results of this study show that digital technology is indispensable for teachers to address the learning recession of basic education students. During the COVID-19 epidemic teachers facilitated learning with groups of learners by means of various digital technologies with the applications downloaded from websites. These findings are consistent with those described by Francom et al. (2021). In the transition process, teachers faced various challenges (Francom et al., 2021; Manoharan et al., 2022). In addition, the key challenges facing young and adult learners differ. Therefore, it is necessary to be aware of the challenges faced by learners at both levels so that these challenges can be addressed in the future.

Some students and teachers do not have communication equipment, digital learning devices, or access to the Internet. Teachers and students need supportive budgets to bridge the gap between Internet access at home and school performance (Bauer et al., 2020). The study indicates that assessing the appropriate digital technology to deal with the learning regression of basic education learners can be divided into six approaches, the first of which are websites and applications used to communicate with students. The most frequently used are email, Microsoft Teams, Schoology, and Line. Secondly websites and applications are used to receive and return student work. It is necessary to use digital technology to solve the problem of learning regression. The popular technologies for this purpose are Line, Google Classroom, Google Apps for Education, Zoom, and Microsoft Teams. Thirdly learning management systems require the use of digital technology such as Web E-learning, E-book, Trueplookpanya, DLTV and YouTube to cope with learning regression. Fourthly, the digital media library uses learning management systems such as YouTube, OBEC Content Center, DLTV, SciMath, and Web E-learning. Furthermore, online evaluation tools are essential in terms of using digital technology to cope with learning regression. The most useful are Google Forms, Kahoot, Live Worksheet, Quizizz, and Microsoft Forms. Finally, in terms of teaching practices and tools to cope with learning regression, it is necessary to use digital technology for videos, announcements and updates, sharing materials, testing, monitoring attendance, and offering student support. From the study, it was found that the most significant learning losses among students include morality, ethics and manners (62.64%), good citizenship (58.32%), imagination and artistic creativity (56.50%), health promotion (56.36%), 5) and mathematical processes (55.91%) (see Figure 9).

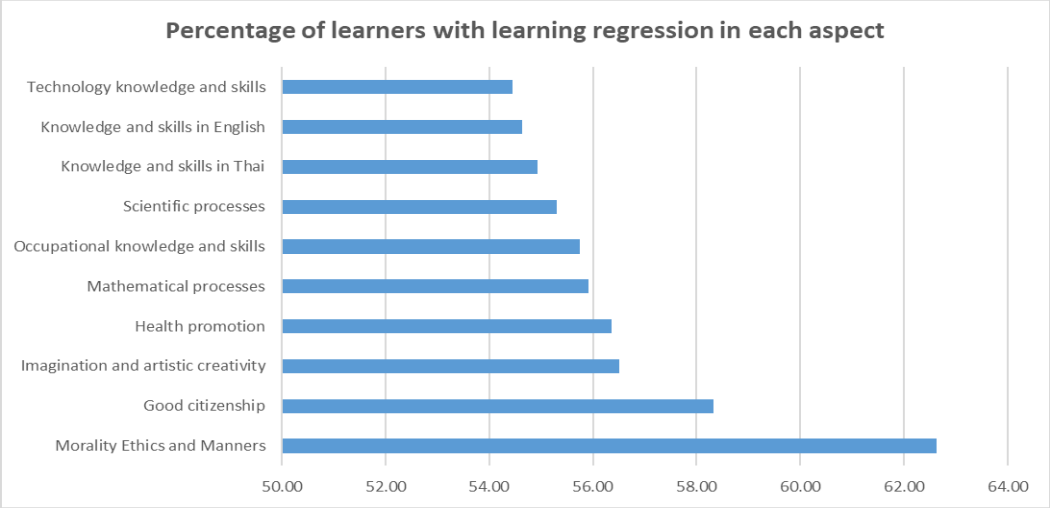

Figure 9: Percentage of learners with learning regression in each aspect

In terms of pedagogical approaches and tools to deal with learning loss, there is a variety, consisting of video, assignments, testing, two-way communication, student support, announcements and updates, attendance, general activities, parent communication, grade books and sharing materials. It was found that restoring potential learning loss will increase academic achievement (Aldosemani & Khateeb, 2022). It is necessary to provide a comprehensive learning process by means of which schools can assess and resolve learning regression that may arise from distance learning periods caused by the COVID-19 pandemic. In terms of skills and abilities, a successful learning process is largely based on theory which provides important elements that instructional designers and policymakers should consider. These are critical to shaping the learning process and its success and include the role of the teacher, the practical role of the learner and the role of digital content.

6. Conclusion

As a result of the COVID-19 pandemic, the education system in Thailand had to shift from the normal system in schools to home learning. The move to home-based learning, that is from the classroom system to personalized learning, has had an impact on the education system in terms of learning achievement. Digital technology has been an important aspect of education management, both during the pandemic crisis and in the post-COVID-19 education development. After the COVID-19 pandemic, schools are now open as usual. Teachers need to manage a combination of school learning and online or distance learning. There is also the need to assess the interest in the use of digital technology to deal with the learning regression of students at the basic education level. This study identified keywords for summarizing information in an infographic landscape format related to the use of digital technology to deal with this learning loss. It is important to support teachers, school administrators, supervisor educators and educational personnel in applying the information in such a way so as to improve education and recover learning loss in a way that meets the needs of the school.

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