



Research article

How teachers manage their classroom in the digital learning environment – experiences from the University Smart Learning Project



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ABSTRACT

The development of modern technologies facilitated for teachers to integrate and use them in managing their teaching classroom. The aim of this paper is to explore how teachers in the Khon Kaen University (KKU) Smart Learning Project use the smart learning concept and innovation to manage their classroom in the digital learning environment. The qualitative research was conducted to clarify the teaching process of teachers in Grade 7–9 at junior high schools using KKKU Smart Learning with three subjects (namely, Mathematics, Science, and English). Consequently, 18 in-depth interviews and six observations were done. The results of this research showed that teachers applied and used the basis of KKKU Smart Learning technologies, contents, and guidelines to manage their classroom, including design teaching activities in accordance with the learners' characteristics; create a pleasant learning atmosphere to enhance their thinking ability, knowledge and skills; organize learning activities and solve problematic situations; promote learning motivation; develop and evaluate learners' competence. However, the classroom management of teachers faced with some problems concerning the limitation of internet connection, lack of digital devices and digital literacy of teachers and learners. The findings of this paper have implications for educators, administrators, teachers and stakeholders to design holistic solutions to enhance the quality of educational activities and academic performance.

1. Introduction

Technology-enhanced learning environment yielded benefits in changing pedagogical styles and applying new teaching strategies, organizing and managing the learning and accessing the useful information sources (Casanova et al., 2020; Fayez et al., 2021; Mei and May, 2018). With the development of modern technology, it is useful to create a smart learning environment that learners could become smart learners with the equipment of smart room and smart pedagogies (Budhrani et al., 2018). In addition, mobile devices and technologies helped learners expand learning spaces and time, objects and opportunities to improve their cognition, engagement and interaction (Hwang and Fu, 2020). Smart learning could create a creative and comfortable learning environment to freely create new ideas, interact, share, perceive, diagnose and analyze learners' learning process (Fayez et al., 2021). Teachers could design their appropriate teaching activities (Dai et al., 2021;

Cheung et al., 2021; García-Tudela et al., 2021). The personalized and adaptive learning, interaction affective, learning data, assessment, formal and informal learning need also to be centered on to understand and manage the individual characteristics, enhance the cooperation, and understand learners strengths and weakness (Cheung et al., 2021; Hwang and Fu, 2020). However, a smart learning required educational institutions to equip technology infrastructure, digital devices, software, learning management system (Fayez et al., 2021), the design of learning environment, intelligent system, tools, models, applications and social media (Alfoudari et al., 2021) to meet learning needs and outcomes. It is also difficult for teachers to have technology knowledge and skills to integrate appropriate technologies and applications, design conventional lessons and teaching activities which promote learners' higher order thinking skills and increase the collaboration and interaction during learning time (Akhrif et al., 2020). Thus, the understanding of features of smart learning could help teachers design a convenient educational

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environment and manage their teaching to promote students' learning and achieve the learning performance.

Smart Learning Academy Project of Khon Kaen University (KKU) has been deployed since 2016 at junior high schools in Northeastern, Thailand to enhance learners' competence through innovative pedagogical methods. Regarding this, teaching and learning activities have been designed to organize and change the classroom, teaching methods, learning environment, learning contents with the integration of technology and application of digital devices. This project focused on improving students' knowledge, skills and attitudes from Grade 7 to 9 with three core subjects (namely, English, Mathematics and Science). The model of KKU Smart Learning designed (1) learning package for students, including textbooks, practice exercises, learning experiences with curriculum content and media and applications insert/supplement for each content in the lesson, and (2) teaching package for teachers, including teaching manuals, media, technology and applications. In addition, contents used in teaching in line with the learners' competency, situational-experienced-local contexts, knowledge-based, real life and integrated problematic situations and connected to application. Pedagogical approaches emphasized on active and collaborative learning to improve the understanding, critical thinking and communication for students with the resource accessibility for learning support, technology infrastructure and applications. Another prominent feature of this project is the evaluation and monitoring of learning outcomes through a test developed according to the PISA assessment standards and based on the lower secondary learning content of all three subjects when students complete three years with KKU Smart Learning innovation (Tuamsuk, 2019). Therefore, this paper aimed to explore how teachers in KKU Smart Learning Project use the smart learning concept and innovation to manage their teaching classroom in the digital learning environment.

2. Related literature

Effective teaching is a challenge for teachers which helps students have pro-founding understanding, enhance their life, solve problems and get higher learning achievement. Teaching methods effected on learning styles and habits of students and learning performance (Churcher et al., 2016). Teaching style referred to teachers' behavior, media, roles, characteristics, and beliefs used to transfer information to learners (Chang, 2010). The study of Chang (2002) indicated that teaching methods based on the constructivist approach promoted flexibility in teaching process, helped learners get deep knowledge and learning strategy through group discussion, thinking and examining concepts they were taught, and developing cognition.

Classroom management is a complicated process which teachers deal with unexpected situations and a changing teaching and learning environment to maximize students' learning achievement. Management competency required teachers to have knowledge and skills in managing classroom effectively, supporting learners during learning process, as well as identifying and interpreting situations could happen in the classroom. Beside this, they needed to encourage students to participate in learning activities and solve learners' problems and behaviors, improve the collaborative relations, classroom atmosphere and learning motivation of students, prevent undesirable behaviors (Glock and Kleen, 2019; Hochweber et al., 2014; Hofman, 2022; Korpershoek et al., 2016; van Driel et al., 2022). The aspects concerning the classroom discipline, learning, attention and behavior, and type of class/student, teacher's roles and behaviors (i.e., teacher styles, the planning and organization of lesson, the relations, classroom climate), and the provision of positive feedback to students when they have expected behaviors and learning participation were also emphasized in the study of van Driel et al. (2022), Mitchell et al. (2017) and Ahmed and Indurkha (2020). In addition, actions of classroom management must be focused on to manage educational process, for instance, learning planning, instruction, monitoring, activating and supporting learners. Teachers needed to create a learning environment which support and facilitate to learning process, to

establish, maintain and secure the classroom (Seufert et al., 2022). Praetorius et al. (2018) mentioned some strategies to manage classroom effectively regarding solving problems, disruption, time management, task increase, rules establishment, and routines.

According to Vaseghi et al. (2012), the understanding of the learning styles helped teachers choose appropriate teaching approaches to enhance teaching effectiveness, improve learning processes and achievement, design proper curriculum and syllabi. There are some features concerning learning style (e.g., learning concentration time, observation, discussion, tasks, online communication, browsing resources, homework completion, academic performance, etc.). Zhao et al. (2020) said that the best way to provide learning to learners was to determine learning styles through indicators, for example, personality, perception, ability and intelligence.

Active learning was considered as a method focused on learner-centered approach to organize teaching activities to promote their active learning roles through different methods, for instance, group discussion, teamwork, case studies and role-play to solve problems and enhance their knowledge and skills (Campbell et al., 2020; Daouk et al., 2016); improve communication and collaboration skills and learning performance (Cole et al., 2021; Hao et al., 2021). It is important for teachers to design lessons and create a pleasant learning atmosphere in the classroom to pay attention to students and motivate learning needs. In this environment, a teacher is a facilitator to navigate and guide the learning process (Daouk et al., 2016). Freeman et al. (2014, p. 8413) mentioned 'active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work'. Therefore, the design of a learning environment with the integration of technology was very crucial to create active learning. Such that students could communicate to teachers and peers through technology and the support of digital devices, tools and equipment, have a comfortable space to redesign concepts and create ideas, and increase their interaction and collaboration (Casanova et al., 2020).

It can be seen that technology has been used in digital education to create a flexible learning environment and increase learning interests. According to Radović et al. (2019), the integration of technology in a course created better interaction and collaboration, and developed learners' abilities in short time, collaborative problem-solving skill, learning engagement (Unal and Cakir, 2021), satisfaction and motivation (Durak, 2021). However, the limitation of technology use in teaching must be considered. Jie and Sunze (2021) indicated several challenges teachers faced when using mobile technology for their teaching classroom, such as, innovative teaching methods, anxiety, extended teaching roles and the flexible environment.

The development of online platforms supported educational processes to enhance the communication, engagement, collaboration and motivations of students (Collazos et al., 2021). The online and web-based systems helped delivery information and services to learners and monitor teacher's classroom to overcome the limitations of traditional classroom. Thus, Collazos et al. (2021) suggested a set of guidelines to evolve online platforms which center on emotions and awareness aspects to support teaching and learning scenarios and communication. According to Lipponen (2002), computer-supported collaborative learning (CSCL) was identified as an effective approach in education to enhance the interaction and participation between learners and in a group (Chavez and Romero, 2012). CSCL facilitated to share and deliver knowledge and expertise in learning community (Dillenbourg and Fischer, 2007). Other studies also indicated the meaningful roles of CSCL in evolving learning outcomes (Sivapalan and Cregan, 2005); improving the learners' perception and collaboration processes (Chavez and Romero, 2012; Dillenbourg and Fischer, 2007); enhancing the deeply understanding of the influence of technologies for social interactions and learning outcomes (Dillenbourg and Fischer, 2007).

The collaboration in the learning environment is an important factor to boost and encourage the learning achievement. The previous study of

Collazos et al. (2006) mentioned that to enhance the collaboration of learners, the scenario of collaboration should be designed with three components, including, activities, people and objects. Following that, the objectives of activities and rules of tasks must be set up to boost the collaboration and create a specific guideline for members and group activities. Roles of members and tools supporting the communication and participation process must also be identified to provide opportunities for learners to solve problems and create effective collaborative learning environment. Thus, collaborative learning could be supported by computers through games, computer-based learning activities, quizzes, etc. to boost the interaction and share knowledge (Lipponen, 2002). Kumar et al. (2020) mentioned benefits of Google Classroom for teachers and students regarding to the improvement of motivation, confidence, communication, technology knowledge and skills, autonomous and creative learning, etc.; however, there are some challenges of interface, privacy, feedback, learning analytics, data storage, so forth influenced educational activities must be considered to enhance teaching management and learning outcomes. In addition, game-based learning has been applied widely in educational environment because it is meaningful to evolve learners' high order thinking ability, achievement, satisfaction, motivation promotion, knowledge, skills and learning attitudes and performance, and to provide effective learning environment (Alsadoon et al., 2022; Hwang et al., 2015; Yeşilbağ et al., 2020). Nevertheless, using games in the teaching classroom required teachers to take time to prepare and design appropriate activities, and to have the support of tools (Hwang et al., 2015).

3. Methodology

In order to have a pro-founding understanding and explore the inside nature of the teaching management in the digital learning environment at secondary schools, the qualitative method was used to gain the research objective. Researchers used two data collection approaches including interview and observation to discover participants' perceptions, views, feelings, and behaviors of teaching and learning activities.

3.1. Informants and research instruments

The key informants were teachers and students at junior high schools with Grade 7, 8 and 9 in three subjects (namely, Mathematics, Science and English). Chosen schools in Khon Kaen Province have participated in the Smart Learning Project from the beginning for three years. They were the first group of schools in this project.

The interviews were used to gain in-depth understanding of perceptions, perspectives, feelings and opinions of individuals of complicated topics or events. The purposes of interviews were to help researchers discover what informants think, feel and remember about events which need to be cleared and deeply understanding and straightforward ways from their minds (Pickard, 2007). Therefore, semi-structured interviews were carried out to get data pertaining to teaching management of teachers through an interview protocol.

The content of interview protocol focused on how teachers in KKU Smart Learning Project manage their classroom in the digital learning environment in three phases (i.e., before teaching, during teaching time and end of class), the application of the components of KKU Smart Learning in teaching activities and how to develop learners' competence. Besides, the advantages and disadvantages of the teaching process were also explored to improve the educational effectiveness.

In order to identify how teachers manage their teaching classroom in the digital environment, an unobtrusive observation was done. In the light of this, the observation scenario was designed and conducted in the classroom teaching at junior high schools in Northeast Thailand using KKU Smart Learning Project. We drafted an observation form in line with research purposes including three phases with the description of teachers' teaching activities. They were listed and described in observation form to facilitate to observe, take notes and record. Besides, comments,

evaluation and suggestions for the educational process relied on the observation were also shown.

3.2. Data collection and analysis

The data collection was conducted and got following results:

- For interviews, at each level of Grade 7–9, two teachers of every subject were chosen to interview. Consequently, 18 in-depth interviews were conducted based on their willingness.
- For observation, the researchers joined six classrooms at the chosen schools in Khon Kaen Province, Thailand. We chose two classrooms for every subject to observe by using a designed observation form. In the role of observer, the researchers wrote, described and took note of behaviors and phenomena that happened.

Then, the interview and observation data were done by using the automatic analysis with following steps (Jamieson, 2016):

(1) Data preparation and immersion

After interviewing, collected data were prepared as follow:

- Recorded files were given by code names;
- Transcribing audio-recorded files by using Microsoft Word;
- Editing and formatting data by removing no meaning, duplicated and repeated words;
- Translating formatted data from Thai language to English language;
- Translated data were re-edited to ensure the quality of data;
- Exporting data from word files into an excel file;
- Reading and thinking about the interview data to avoid the bias, then forming the ideas of themes.

Meanwhile, observation data were also analyzed into steps of the teaching process. Then, they would be combined with the interview data to code and category into themes.

(2) Coding

Data were coded and synthesized into themes based on the interview questions and observation form. Then, these themes were grouped into clusters that relied on the similarities of themes. An example of the coding process of data was shown on Table 1.

(3) Generating themes

The teachers' opinions were sought on the following six issues:

- Teaching preparation
- Teaching and learning activities
- Evaluating students' learning
- Developing students' competence
- Most important things in the teaching process
- Limitations of teaching practice

(4) Abstraction, theory generation

The prominent results would be synthesized and expressed in the specific parts of research results and discussions.

4. Research results

4.1. Teaching and learning preparation

In order to gain the teaching and learning objectives, teachers and learners prepared essential conditions before learning, such as, technologies, digital devices, learning and teaching sets under the guidelines of KKU Smart Learning and checked the teaching tools and equipment, internet to ensure the readiness of factors for teaching.

Table 1. The coding of collected data.

Raw codes	Main themes synthesized from raw codes	Clusters of themes
1. Before teaching		
+ <i>Learning preparation of teacher</i> - Textbooks, internet - Assignments and necessary materials - Digital devices	Teaching preparation	Teacher - Technologies - Learning contents - Infrastructure
+ <i>Learning preparation of students</i> - Their minds, learning spirit - Smart phones, Internet - Various learning materials	Learning preparation	Learners - Learning attitudes, Skills, Knowledge - Digital devices - Learning contents
+ <i>Stakeholders</i> - Administrator and staff of KKU - Computer teacher		Administrator/Staff Interaction - Technologies - Infrastructure - Supporting
+ <i>Evaluate the student's level</i> - Ask and answer of vocabularies - Pre-learning test - Playing games	Evaluating students' learning	Teacher - Students' evaluation Learners - Skills - Knowledge
+ <i>The most importance for teacher and students</i> - Readiness of teachers and students - Create learning atmosphere - Teaching materials, equipment and devices - Internet	Most important things in teaching process	Teacher and learners - Digital devices - Learning atmosphere - Technologies
2. During teaching time		
+ <i>Learning and teaching methods and activities</i> - Questioning and answering - Use Problem-Centered Learning - Students' and teachers' presentation + <i>Learning content</i> - Books, manual books, textbooks, worksheet, cut-ups, CDs, Power points, PDF, videos, student's textbooks - Use the video/media from Youtube + <i>Technologies and equipment</i> - Google Classroom - Media, platforms, and technologies provided by KKUSL - QR Code - Google Form, and Google Sheet	Teaching and learning activities - Methods - Contents - Technologies	Teacher - Teaching methods - Technologies - Teaching contents - Infrastructure Learners - Digital devices - Learning styles - Learning attitudes
+ <i>Developing learners' knowledge, skills and attitudes</i> - Encourage them to talk, argue and use it in daily life - Organize student-centered teaching activities + <i>Promoting learning</i> - Giving opportunities to communicate, get more information - Use games to enhance their knowledge	Developing and promoting students' competence	Teacher - Teaching methods - Technologies Learners - Learning attitudes - Skills - Knowledge
+ <i>Evaluate students</i> - Students' feedback, - A post-test - Examination or do assignment/homework	Evaluating students' learning	Teacher - Students' evaluation Learners - Knowledge and skills
+ <i>Most importance during teaching time</i> - Learning atmosphere - Readiness of the students and teachers - Interests of students	Most important things in teaching process	Teacher and learners - Learning atmosphere - Technologies - Learning attitudes
3. End of class		
+ <i>Assign homework/work assignments/test</i> - Taking videos and upload in Google Classroom - Limited homework or no homework + <i>Manage self-learning</i> - Google classroom - Line group	Teaching and learning activities	Teacher - Technologies - Learning management Learners - Digital devices - Contacting
+ <i>The most important things after class</i> - What knowledge/content students got - Happiness in learning - Improve knowledge and skills	Most important things in teaching process	Learners - Learning outcomes - Learning attitudes

- Digital devices, especially smart phones were installed KKUSL applications and connected Internet;
- Learning contents (i.e., lectures, media, power point, CDs, games, worksheet, books, forms, links, video clips or other sources to link the lesson); and designed learning activities for students to create creative ideas and interested in learning;

- Teaching methods. Teachers often have a meeting with other teachers to discuss and share teaching methods, contents, media and games, etc. used in the teaching class.
- Facilities. A smart classroom with adequate experiment equipment, tools, projector, sensor, laptop, tablets, etc.

Some teachers shared as follows:

Before the classroom, there is a preparation of equipment, materials relating to the content of the teaching. What contents we teach, what equipment we will prepare so that students can understand the content and get their knowledge as much as possible... There are projectors, computer, various contents to prepare to see the environment, which steps will be presented... and how to know students' understanding... how to change or add more knowledge to help students learn and understand more... (ET2).

...Before the teaching classroom, there are textbooks, power point, equipment, and media prepared, and the internet system is also considered to ensure its effectiveness... Teaching materials, contents, methods and activities are prepared and designed to create creative ideas, active learning environment and interests for students in learning... (ET5).

Furthermore, teachers pointed out that it is important for students to prepare their mind and learning spirit.

What the students need to prepare is to prepare their minds before learning. Because if students have good learning spirit, it will help them learn effectively. (ET1)

4.2. Teaching and learning activities

Teaching and learning activities were conducted through three stages, namely, before teaching, during teaching time and end of class.

(1) Before teaching

In order to deploy educational process smoothly, teachers not only prepared learning contents, technology, infrastructure, but also set up Line group, Zoom, Google Meet, Google Classroom, and prepared a laboratory or virtual laboratory for online teaching and checked students' attendance in the classroom.

Before delivering the lesson, teachers often promoted students' learning motivation by organizing games/quizzes through smart phones, or using videos, digital media, questioning and answering to create a comfortable learning atmosphere and interests for students to join in lessons. In other words, some teachers also used a pre-learning test through Google Form sent in Line group or Google Meet/Zoom to measure how much basic knowledge students have before learning. Besides, teachers could observe or interview to explore which students interested in learning to adjust next lessons.

(2) During teaching time

The main targets of KKU Smart Learning Project are to improve learners' knowledge, skills and attitudes; therefore, teachers used various teaching methods to create an active learning environment and to develop students' competence. One of the most interesting things of this project is students allowed to use smart phones in the classroom. There are some teaching approaches could be considered as follows:

In English course, teachers often focused on:

- Lecturing and questioning. Teachers used Power Point designed, websites, videos, audio recordings, photos to give examples for their lesson, then have relevant questions to develop students' interaction.
- Student presentation/Group discussion. Teachers would give a topic or situation, then students discuss in a group and record a video clip by using smart phones, and send it to the teacher via Line group. Other groups would check peers' video clips and assess; or students could write on the white board and present their products.

In *Mathematic course*:

- Mathematics is quite difficult, so teacher would use Power Point of KKUSL to teach and lead students into the lesson by asking; then students answered questions from the situations and expressed their opinions by summarizing ideas.
- Students could use smart phones to search more information on the Internet.
- Using Geogebra program to aid in formulating and providing geometric conjectures.
- Scan the QR code in the book to link information to learn more.

Meanwhile, *science teachers* centered on following methods:

- Teachers showed video clips or did an experiment, then students used LabQuest or other equipment to practice with friends. This teamwork promoted students' communication, problem-solving thinking and critical thinking.
- Using problem-solving approach by giving a problem or a situation through a video/an image or questions, then students used smart phones to search information, discuss with friends and share their opinions or make video clips. Besides, students needed to take away from peers' view and compared their results to other groups.
- Using an application (KKU iNote) and Augmented reality (AR) tool to access objects, artifacts or media to learn more.
- Teachers used digital media, virtual laboratory or a simulation application through smartphones to support teaching.

During learning time, teacher and students had good interactions through assignments, answering questions, presentation, solving problems, sending links and documents and correct students' learning. Besides, in online learning case, teachers recorded a video and uploaded to Google classroom for students in case they could not join in classroom. Then, students could do homework and sent them to teacher via Line group and uploaded on Google Classroom.

(3) End of class

This is a stage to consolidate students' knowledge to know how much they got after learning. Hence,

- Teachers used Kahoot/Quiz or post-test to summarize the main points of lesson and checked the students' level;
- Students recalled the contents learned and transformed them into a mind mapping and presentation or uploaded to Google Classroom.
- For assignment or homework, students could use smartphones to search information sources, then presented which students have learned from.
- After the classroom, students could communicate to teacher via Line, Messenger, Facebook, etc.

Most teachers confirmed that they rarely gave homework for students after learning time because they tried to finish their lessons and assignment during teaching time.

Teaching process of teachers under KKU Smart Learning also had the participation and support of stakeholders (i.e., KKU Smart Learning staff, advisors, administrators, etc.) to manage, supervise and assess the methods, contents, students' level, quality, effectiveness and outcomes of learners.

4.3. Evaluating students' level

Teachers used different evaluation ways to measure and evaluate students' level, for instance, a pre-test and post-test through Google form, playing games by using Kahoot or Quizzes, questioning and answering.

Evaluation methods helped teachers understand their students' understanding, knowledge and skills concerning the lessons before learning to adjust and add teaching contents appropriately. An English teacher said that

The test will be prepared similar to a game for students to answer. This test asks students some questions relating to the lesson... It helps me know students' basic knowledge, then I will adjust in line with their competence. However, the test is not always tested before learning. It will be conducted in case students have different level in the classroom. Because some students have good knowledge and they knew already, and others don't know much. Therefore, I will test to know, then adjust teaching contents. (ET1)

Meanwhile, another teacher expressed that

... I will not test before teaching because we already know our students individually... Therefore, we don't assess that way, because we evaluated students' knowledge by observation or participating in learning activities of students as a supplementary teaching method... (ET4)

Teachers confirmed that evaluation methods would enhance students' learning motivation and create an enjoyable learning environment.

Most of them will be important questions for students to answer. The student can use smart phone to answer or use a program. This motivate and stimulate the students' learning motivation. Besides, students can play games to help teacher know the pre-learning knowledge of students. (ST2)

In other words, students could make videos, do assignments or summarize main points of lesson by using mind mapping, answer questions or do a test. These ways aimed to know how much knowledge students got after learning, as well as their feedback to help teachers have in-depth understanding of their students' level to design lessons properly for next teaching.

4.4. Promoting learning motivation and developing students' competence

Enhancing learners' knowledge and skills is one of the most important targets of teachers in KKU Smart Learning Project. Hence, they used different approaches to evolve learners' understanding and thinking skills to solve inter-relevant problems in daily life.

Research results indicated that teachers of three subjects used some similar methods to develop and promote learning attitudes and performance. In this light, most teachers focused on various teaching methods to evolve problem-solving, information searching, analytical and creative thinking skills for students. For example:

- Encourage students' learning by giving opportunities for students to have and answer questions, and providing information channels to link to lessons;
- Give compliment for students when answering;
- Encourage students use technology and smart phones to search, learn and create new ideas;
- Playing games to stimulate their knowledge;
- Developing problem-solving skills by providing real situations close to their daily life;
- Encourage students manage their group to divide the duties for members, discuss and present results together.

However, English teachers focused on using technology to help students build their knowledge through maps, videos and audio and stimulate English use in daily activities. Mathematics course has been designed to build games which links to problems and connect real situation. Meanwhile, in science, teachers encouraged students practice as much as possible to improve their skills.

When asked how to develop learners' knowledge, skills and attitudes while teaching, an English teacher noted that

In developing skills, knowledge and attitudes, it depends on teaching activities. Therefore, we will organize student-centered teaching activities. I will ask students to express their attitudes by talking about what they want, presenting their knowledge about issues, encouraging them to share what they want to do, what they want to be, then teachers will focus on those issues for students to practice... What they like or dislike will be adjusted and improved in the teaching process. (ET3)

4.5. Most important things in teaching process

It is necessary for teachers to recognize which things were important in each teaching stage to enhance teaching effectiveness and develop learners' competence.

The readiness of teaching and learning in the classroom was the most important in the before learning stage. Regarding this, students needed to prepare their learning spirit, and teachers must create a comfortable learning atmosphere for students to learn. Besides, students must be promoted learning attitudes.

Creating an enjoyable learning environment, the understanding of students' personality and ability, funny learning activities and the connection between students and teachers played important roles during learning time. In addition, teaching methods must be easy to understand, attract students' attention and learning interests, and develop their knowledge and skills of teamwork, communication and solving problems.

The learning atmosphere is the most important because every day we meet eight hours... Therefore, we must create a flexible learning atmosphere all time... and learning environment must be adjusted to students want to go to the classroom or focus on the lessons...and let them know that they are important to everyone in the classroom. (ET1)

Students must have the readiness and interest to study at that hour. Besides, during the learning time, they have to interact with the teacher. If they have any questions, they can feel free to ask and teacher need to answer and explain more. (MT2)

Teachers want to enhance the learning atmosphere with the adequate equipment in the classroom because in this room the students will be the main people and their readiness are not similar. Therefore, the availability of well-equipped classrooms will be important. Besides, the most important thing of students is probably the willingness to receive and supplement knowledge that teachers deliver. (MT3)

Meanwhile, it could be considered how much knowledge students got after learning, then teachers needed to summarize what students learned, helped them to consolidate, take note and memorize main points of lesson. Besides, teachers could assess students' learning outcomes, as well as adjusted and revised teaching contents in line with their level for next lessons. Furthermore, students must also be motivated to complete their assignments and homework in this stage.

Furthermore, the standards of smart room were also necessary for teaching and learning activities in each learning stage, such as, digital devices, projectors, laboratory, tools, equipment. Another highlighted result was mentioned by teachers concerning the preparation of smart phone and the Internet, media and teaching contents to enhance the learners' understanding, communication tools or equipment to connect learning activities and to motivate learning needs. The good preparation would support better and ensure teaching activities take place smoothly and enhance the learning quality.

4.6. Highlights and limitations of KKU smart learning in teaching practice

When asked what teachers think of KKU Smart Learning in developing learners' abilities (knowledge, skills, attitudes), teachers said that the learning contents of this project were very interesting. Teachers could

design teaching activities to attract students' attention, adjust appropriate contents, develop learners' creative thinking, analytical thinking and problem-solving thinking, and improve skills (i.e., teamwork, presentation, communication, coordination, cooperation) and positive learning attitudes and spirit.

In addition, contents were designed close to learners' context with reality situations and problems, then students could apply their knowledge to solve problems and improve skills in daily life. Media, technology, applications and digital devices were also integrated in lessons helped enhance teachers' digital literacy and technology use skills of students.

Personally, I think that KKKU Smart Learning is a learning management activity and technology that leads to the expected performance of learners, helps students gain knowledge in the curriculum. At the classroom level, they can learn and develop their own learning skills through teaching and learning processes and promote their critical thinking. Besides, they can be self-learned through applications, technology or media provided in every activity... It also has appropriate activities and exams along with the content. (MT1)

It's a good innovation and can develop the students' critical thinking, but it should be suitable for the students who are ready to receive knowledge that KKKU Smart Learning provided. For skills, this project helps students think more easily and quickly. (MT3)

This project allows students to use a lot of media. However, students had to be skilled in using technology. During learning time, students have a thinking process before answering the question. When students present information, it will help develop their communication skills. Besides, technology is connected to our life skills, so it helps improve students' life skills. (ST1)

Besides, students have been allowed to use smart phones in the learning classroom which encouraged their learning motivation and needs, promoted an active learning where students feel free to talk, share and create their ideas to peers; as well as teachers could design and create an enjoyable learning atmosphere.

On the other hand, the use of KKKU Smart Learning Project with the application of technologies, platforms, applications, etc. in teaching created some challenges for teachers. Some teachers did not have digital literacy to use in designing lectures, managing classroom, accessing to information sources and using applications for teaching. In the light of this, they must join in the training to enhance their technology knowledge and skills which they have not learned in the past. Besides, teachers needed to learn more technologies to adapt to and use them in teaching process.

In term of students, this project required students to use smart phones during learning time; however, some students did not have this device. Moreover, the use of platforms and application were also difficult for them because of limited technology skills. Another limitation could be mentioned concerning the concentration of learning when using smart phones, sometimes they did not pay attention or had short attention on teachers' teaching because of the interesting of games, videos, media, etc. on the internet.

Schools also lacked infrastructure to deploy active learning activities in smart room, or the slowly internet speed also impacted the accessibility, information searching and organization of learning activities and effectiveness of students, especially, online learning environment which students must face with in the Covid-19 pandemic.

5. Discussions

The classroom management of teachers in this study showed that teachers had well preparation of learning contents, teaching activities, technologies and infrastructure before teaching. In addition, learning activities were designed to facilitate to increase the interaction and collaboration between students and teacher. Teachers knew how to deal

with problematic situations which students faced with in learning time, for example, lack of digital devices, internet connection, etc., as well as observed to identify the students' characteristics and levels. Moreover, they used various approaches to promote and assess learners' competence and provided opportunities to their students to create videos and present them for peers and promoted learning motivation for learners. This finding supported the study of Campbell et al. (2020), who indicated that student-created video supported to improve learners' interaction, behavior, cognition, inspiration, motivation and self-efficacy.

However, some problems concerning the application, internet connection and voice could happen suddenly and impacted their teaching. It can be said that the support of technologies helped teachers manage learners' learning appropriately in both of online and onsite learning and improve the collaboration amongst students. The perspectives of Seufert et al. (2022) of the applications of virtual reality-based settings helped enhance the classroom management competency of pre-service teachers consolidated the results of this study. 'Teachers' self-efficacy in classroom management only relates to students' enjoyment in class across time when it meaningfully affects teaching behavior in class as perceived by students' (Hettinger et al., 2021, p.5). Sutton et al. (2009) emphasized that during teaching time, teachers not only observed students' learning process and responding, but also adjusted their emotions and behavior accordingly. Teachers needed to establish the rules and boundaries, and expressed expectations, provided guidelines for learners to limit unexpected behaviors and navigate their students, as well as perceived the necessary role of restructuring the classroom environment (Hepburn et al., 2021; Rakoczy et al., 2007). In the digital environment, the interaction between teachers and learners played important roles in learning community to create positive learning atmosphere by using technology to boost and encourage the knowledge construction, and student-centered orientation (Jie and Sunze, 2021).

Interestingly, the use of computers or digital devices in learning activities, such as, group discussion, teamwork, student presentation, video making, experiments, problem solving, games or quizzes increased the collaboration of students to boost their interaction or engagement in learning and enhance the understanding. This finding also supported to previous studies of the important roles of mobile learning for learning activities relating to develop collaboration, discussion, feedback, search for and share information and create learning products (Sophonhiranrak, 2021); the support of computer for boosting the collaborative learning ability of students (Lipponen, 2002), learning outcomes and instruction (Dillenbourg and Fischer, 2007); knowledge building and sharing (Dillenbourg and Fischer, 2007; Lipponen, 2002).

The prominent findings of this research also emphasized the teacher's roles in designing and organizing teaching activities to create an active and enjoyable learning environment and enhance the educational quality. Of that, teachers used various teaching methods and capitalized on technology and smart phones to motivate learning activities. Shieh et al. (2013) indicated that learning activities should start from students' perception and teachers should guide students to establish correct self-concept for properly understanding of problems and to absorb and create experiences with active attitudes and accurate approaches so that individual's perception could be changed by learning activities.

Yuan-Yi et al. (2017, p.64) mentioned some features need to be clarified when studying the learning behavior, for instance, 'learner's learning preference, predicting the learning needs of the learners, analyzing the learners' appropriate learning resources, learning tendency, and learning path'. As a result, the learners had different learning styles by learning speed, assignment completion; therefore, teachers could design teaching activities based on context and learning progress. In the study of Davidson et al. (2019), it is indicated that learning styles of students could be mentioned in two approaches. Such that, deep learning focused on paying attention to understand and use strategies by applying relevant ideas and evidence. Meanwhile, surface learning primarily relied on memorizing and accepting the lecture contents without understanding and having critical thinking. However, based on the

findings of this study, it can be said that teaching contents and methods were designed to improve learners' pro-founding understanding of relevant issues and applied them to solve problems in daily life and enhanced their creative thinking and analytical thinking.

Accordingly, Daouk et al. (2016) emphasized the important implications of classroom organization in active learning environment, in which teachers needed to focus on creating learning situations to enhance learners' active roles during learning process, such as, engaging in lesson, questioning and answering, discussion, etc. In addition, they must also be developed their competence and deploy active learning strategies to enhance teaching effectiveness.

Furthermore, the application of games or quizzes in learning activities was reviewed as a useful tool for teacher to boost learning motivation, check learners' competence and enhance their learning outcomes in this study. These results confirmed the previous evaluation of Hwang et al. (2015) that game-based learning approach helped improve learning motivation and satisfaction, and learning achievement (Chen and Hsu, 2020); learning interests, changes of behavior, cognitive development and knowledge construction (Hussein et al., 2021).

In other words, this study mainly focused on exploring the basis of learning and teaching activities in three teaching phases and the ways to promote students' learning motivation and competence instead of analyzing the classroom management competence of teachers to learners' behaviors. Secondly, elements regarding the smart environment, smart technologies, technology platforms were not mentioned specifically. Technologies were just indicated as one of basic elements to support teaching process. Thirdly, the research just conducted the interviews and observations with teachers and students at secondary schools using KKU Smart Learning Project without extending to participants at other schools in Thailand. Finally, aspects of gender and age of students could influence the learning motivation, attitudes and outcomes that were not explored in this study. Therefore, future research should specifically focus on:

- (1) The effectiveness of classroom management through the support and application of technology to identify and deal with unexpected behavior and enhance the learning performance;
- (2) A comparative study should be conducted at other secondary schools to clarify the similarity and difference of students' competence, teacher's roles, technologies, learning environments and learning achievement, then design well-rounded model to apply to these schools and improve the quality of education in Thailand;
- (3) The factors influencing classroom management should be also examined to identify practical situations to support and remove barriers in teaching processes;
- (4) Exploring the correlation between the learners' characteristics (i.e., gender, age, learning styles, attitudes, motivation, habits, interests, etc.) and learning achievement.

6. Conclusion and recommendations

One of prominent features of classroom management in digital learning environment of this research was the use of technology, application, learning contents and digital devices to design and carry out learning activities to create a good learning atmosphere and active learning, enhance learners' higher order thinking skills (creative thinking, analytical thinking, and problem-solving thinking) and improve learning motivation and attitudes. Teachers prepared their teaching contents and planning, technology and teaching methods appropriately, solved problematic situations, and organized learning activities to motivate students' learning. However, there are some limitations regarding to digital literacy, internet system, smart phones and teaching activities impeded the deployment of educational process in the classroom. Hence, in order to improve the effectiveness of teaching and learning activities, it is important to adjust following factors:

- (1) Students need stimulation and support of their learning, and the development of intellectual skills for the future to help them not loathe learning, but also not prefer uninteresting learning atmosphere.
- (2) The teacher is the most important person in the learning development process. A teacher must therefore be well motivated. The teacher's motivation is the fact that students love to learn and find it successful to learn. Therefore, teachers must be trained to be able to design instructions that suit their students, and able to use digital technology and modern tools for their instruction. If teachers have good teaching competency, they will be able to build good learning competency to their students.
- (3) The infrastructure (i.e., technologies, equipment, tools) for supporting learning must be there. Administrators should know and understand what technologies are good, what are suitable, what are worth investing, how can they avoid being deceived from buying things that cannot be effectively used.
- (4) Social media are good tools to build the learning community. Students love to use Lines, Facebook, Tweeter for showing and sharing or posing a critical issue. Therefore, these channels should be provided to support teachers' learning.
- (5) There should not be fixation on any teaching approaches, or that for specific techniques such like A, B, C and one should follow this and that. This will worry teachers with rules and regulations. Instead, teachers should be allowed to find their own teaching style freely. Anything that is active learning will do, which do not deviate from the content, pedagogy, and learning environments.
- (6) A set of guidelines should be designed by technology designers for using in classroom to support and enhance the effectiveness of learning activities. Components of this guideline should include elements of learning community, tasks and resources. Regarding this, the characteristics and roles of people (i.e., teacher, students, administrators, stakeholders, etc.), the participation and interaction taking place in learning processes should be identified. The tasks should show the participation level of members, planning process, activities, schedule, information of members' duties and teaching scenario. In addition, the information and use guidelines of resources (i.e., tools, apps, learning contents) could be provided to help participants complete their tasks. It is also necessary to indicate the steps and implementation process, the anticipation of problematic situations and solutions to deal with.

Declarations

Author contribution statement

Lan Thi Nguyen: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Issara Kanjug, Grichawat Lowatcharin, Teeradej Manakul, Kornwipa Poonpon, Weerachai Sarakorn, Anucha Somabut, Niwat Srisawasdi, Saksuriya Traiyarach: Contributed reagents, materials, analysis tools and data.

Kulthida Tuamsuk: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

The authors do not have permission to share data.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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References

- Ahmed, M.M.H., Indurkha, B., 2020. Investigating cognitive holding power and equity in the flipped classroom. *Heliyon* 6 (8), e04672.
- Akhraf, O., Benfares, C., Hmina, N., 2020. Collaborative approaches in smart learning environment: a case study. *Procedia Comput. Sci.* 175, 710–715.
- Alfoudari, A.M., Durugbo, C.M., Aldhmour, F.M., 2021. Understanding socio-technological challenges of smart classrooms using a systematic review. *Comput. Educ.* 173, 104282.
- Alsadoon, E., Alkhwajah, A., Suhaim, A.B., 2022. Effects of a gamified learning environment on students' achievement, motivations, and satisfaction. *Heliyon*, e10249.
- Budhrani, K., Ji, Y., Lim, J.H., 2018. Unpacking conceptual elements of smart learning in the Korean scholarly discourse. *Smart Learn. Environ.* 5 (1), 1–26.
- Campbell, L.O., Heller, S., Pulse, L., 2020. Student-created video: an active learning approach in online environments. *Interact. Learn. Environ.* 1–10.
- Casanova, D., Huet, I., Garcia, F., Pessoa, T., 2020. Role of technology in the design of learning environments. *Learn. Environ. Res.* 23, 413–427.
- Chang, W., 2002. The impact of constructivist teaching on students' perceptions of teaching and learning. In: Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, LA. Retrieved 7 April 2021, from: <https://files.eric.ed.gov/fulltext/ED476252.pdf>.
- Chang, Y.C., 2010. Students' Perceptions of Teaching Styles and Use of Learning Strategies. Retrieved 7 April 2021, from: https://trace.tennessee.edu/cgi/viewcontent.cgi?article=1835&context=utk_gradthes.
- Chavez, J., Romero, M., 2012. Group awareness, learning, and participation in computer supported collaborative learning (CSCL). *Procedia-Soc. Behav. Sci.* 46, 3068–3073.
- Chen, Y.L., Hsu, C.C., 2020. Self-regulated mobile game-based English learning in a virtual reality environment. *Comput. Educ.* 154, 103910.
- Cheung, S.K., Phusavat, K., Yang, H.H., 2021. Shaping the future learning environments with smart elements: challenges and opportunities. *Int. J. Educ. Technol. Higher Educ.* 18 (1), 1–9.
- Churcher, K.A., Asiedu, L.O., Boniface, B.S., 2016. Teachers teaching styles and students study habits on academic achievement in mathematics among junior high schools in Upper East Region of Ghana. *Int. J. Educ. Admin.* 8 (1), 31–51.
- Cole, A.W., Lennon, L., Weber, N.L., 2021. Student perceptions of online active learning practices and online learning climate predict online course engagement. *Interact. Learn. Environ.* 29 (5), 866–880.
- Collazos, C., Guerrero, L., Pino, J.A., Stahl, G., Ochoa, S., 2006. A model and a game for investigating and designing collaborative learning environments. In: *Simpósio Internacional Informática Educativa (SIIIE 2006)*. Leon, Spain. Retrieved 3 May 2022, from: <https://citeseerx.ist.psu.edu/viewdoc/download?>
- Collazos, C.A., Fardoun, H., AlSekait, D., Pereira, C.S., Moreira, F., 2021. Designing online platforms supporting emotions and awareness. *Electronics* 10 (3), 251.
- Dai, Z., Sun, C., Zhao, L., Li, Z., 2021. Assessment of smart learning environments in higher educational institutions: a study using AHP-FCE and GA-BP methods. *IEEE Access* 9, 35487–35500.
- Daouk, Z., Bahous, R., Bacha, N.N., 2016. Perceptions on the effectiveness of active learning strategies. *J. Appl. Res. High Educ.* 8 (3), 360–375.
- Davidson, P., Roslan, S., Omar, Z., Abdullah, M.C., Looi, S.Y., Neik, T.T.X., Yong, B., 2019. Validation of competing structural models of inter-relationships in the teaching–learning ecosystem for two Malaysian STEM courses. *Asia Pac. Educ. Rev.* 20 (1), 15–36.
- Dillenbourg, P., Fischer, F., 2007. Computer-supported collaborative learning: the basics. *Z. Berufs-und Wirtsch.* 21, 111–130.
- Durak, H.Y., 2021. Preparing pre-service teachers to integrate teaching technologies into their classrooms: examining the effects of teaching environments based on open-ended, hands-on and authentic tasks. *Educ. Inf. Technol.* 26, 1–23.
- Fayez, A.N., Ghabban, F.M., Ameerbakhsh, O., 2021. Advantages and challenges of smart learning in higher education institutions in Saudi Arabia. *Creativ. Educ.* 12, 974–982.
- Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., Wenderoth, M.P., 2014. Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci. USA* 111 (23), 8410–8415.
- García-Tudela, P.A., Prendes-Espinosa, P., Solano-Fernández, I.M., 2021. Smart learning environments: a basic research towards the definition of a practical model. *Smart Learn. Environ.* 8 (1), 1–21.
- Glock, S., Kleen, H., 2019. Teachers' responses to student misbehavior: the role of expertise. *Teach. Educ.* 30 (1), 52e68.
- Hao, Q., Barnes, B., Jing, M., 2021. Quantifying the effects of active learning environments: separating physical learning classrooms from pedagogical approaches. *Learn. Environ. Res.* 24 (1), 109–122.
- Hepburn, L., Beamish, W., Alston-Knox, C.L., 2021. Classroom management practices commonly used by secondary school teachers: results from a Queensland survey. *Aust. Educ. Res.* 48 (3), 485–505.
- Hettinger, K., Lazarides, R., Rubach, C., Schiefele, U., 2021. Teacher classroom management self-efficacy: longitudinal relations to perceived teaching behaviors and student enjoyment. *Teach. Teach. Educ.* 103, 103349.
- Hochweber, J., Hosenfeld, I., Klieme, E., 2014. Classroom composition, classroom management, and the relationship between student attributes and grades. *J. Educ. Psychol.* 106 (1), 289–300.
- Hofman, J., 2022. Classroom management and teacher emotions in secondary mathematics teaching: a qualitative video-based single case study. *Educ. Inq.* 1–17. AHEAD-OF-PRINT.
- Hussein, M.H., Ow, S.H., Elaihs, M.M., Jensen, E.O., 2021. Digital game-based learning in K-12 mathematics education: a systematic literature review. *Educ. Inf. Technol.* 1–33.
- Hwang, G.J., Chiu, L.Y., Chen, C.H., 2015. A contextual game-based learning approach to improving students' inquiry-based learning performance in social studies courses. *Comput. Educ.* 81, 13–25.
- Hwang, G.J., Fu, Q.K., 2020. Advancement and research trends of smart learning environments in the mobile era. *Int. J. Mobile Learn. Organisat.* 14 (1), 114–129.
- Jamieson, S., 2016. Analyse qualitative data. *Educ. Prim. Care* 27 (5), 398–402.
- Jie, Z., Sunze, Y., 2021. Investigating pedagogical challenges of mobile technology to English teaching. *Interact. Learn. Environ.* 1–13.
- Korpershoek, H., Harms, T., De Boer, H., Van Kuijk, M., Doolaard, S., 2016. A metaanalysis of the effects of classroom management strategies and classroom management programs on students' academic, behavioral, emotional, and motivational outcomes. *Rev. Educ. Res.* 86 (3), 1e38.
- Kumar, J.A., Bervell, B., Osman, S., 2020. Google classroom: insights from Malaysian higher education students' and instructors' experiences. *Educ. Inf. Technol.* 25 (5), 4175–4195.
- Lipponen, L., 2002. Exploring foundations for computer-supported collaborative learning. In: Stahl, G. (Ed.), *Proceedings of Computer Supported Collaborative Learning 2002*, Boulder, Colorado USA, January 2002, vol. 2, pp. 72–81.
- Mei, B., May, L., 2018. Reflective renovation: insights from a collaborative and active learning space project evaluation. *Australas. J. Educ. Technol.* 34 (6), 12–18.
- Mitchell, B.S., Hirn, R.G., Lewis, T.J., 2017. Enhancing effective classroom management in schools: structures for changing teacher behavior. *Teach. Educ. Spec. Educ.* 40 (2), 140–153.
- Pickard, A.J., 2007. *Research Methods in Information*. Facet Publishing, London.
- Praetorius, A.-K., Klieme, E., Herbert, B., Pinger, P., 2018. Generic dimensions of teaching quality: the German framework of three basic dimensions. *ZDM: Int. J. Math. Educ.* 50 (3), 407–426.
- Radović, S., Marić, M., Passey, D., 2019. Technology enhancing mathematics learning behaviours: shifting learning goals from “producing the right answer” to “understanding how to address current and future mathematical challenges”. *Educ. Inf. Technol.* 24 (1), 103–126.
- Rakoczy, K., Klieme, E., Drollinger-Vetter, B., Lipowsky, F., Pauli, C., Reusser, K., 2007. Structure as a quality feature in mathematics instruction of the learning environment vs. a structured presentation of learning content. In: Prenzel, M. (Ed.), *Studies on the Educational Quality of Schools. The Final Report on the DFG Priority Programme*. Waxmann, Münster, pp. 101–120.
- Seufert, C., Oberdörfer, S., Roth, A., Grafe, S., Lugin, J.L., Latoschik, M.E., 2022. Classroom management competency enhancement for student teachers using a fully immersive virtual classroom. *Comput. Educ.* 179, 104410.
- Shieh, C.J., Liao, Y., Hu, R., 2013. Web-based instruction, learning effectiveness and learning behavior: the impact of relatedness. *Eurasia J. Math. Sci. Technol. Educ.* 9 (4), 405–410.
- Sivapalan, S., Cregan, P., 2005. Value of online resources for learning by distance education. *Int. J. Innovat. Sci. Mod. Eng.* 14 (1), 23–27.
- Sophonhiranrak, S., 2021. Features, barriers, and influencing factors of mobile learning in higher education: a systematic review. *Heliyon* 7 (4), e06696.
- Sutton, R.E., Mudrey-Camino, R., Knight, C.C., 2009. Teachers' emotion regulation and classroom management. *Theory Into Pract.* 48 (2), 130–137.
- Tuamsuk, K., 2019. Executive Summary: KKU Smart Learning Project Operations. In: Paper submitted to the Minister of Education, Thailand (Unpublished).
- Unal, E., Cakir, H., 2021. The effect of technology-supported collaborative problem solving method on students' achievement and engagement. *Educ. Inf. Technol.* 26, 1–24.
- van Driel, S., Wolff, C.E., Crasborn, F., Brand-Gruwel, S., Jarodzka, H., 2022. A coding scheme to clarify teachers' interactive cognitions in noticed classroom management situations from an actor's perspective. *Teach. Teach. Educ.* 111, 103602.
- Vaseghi, R., Ramezani, A.E., Gholami, R., 2012. Language learning style preferences: a theoretical and empirical study. *Adv. Asian Soc. Sci.* 2 (2), 441–451.
- Yeşilbag, S., Korkmaz, Ö., Çakir, R., 2020. The effect of educational computer games on students' academic achievements and attitudes towards English lesson. *Educ. Inf. Technol.* 25, 5339–5356.
- Yuan-Yi, Q.I., La-Mei, W.A.N.G., Zhang, Y.Z., 2017. Research on online learning behavior analysis from the perspective of learning analysis. In: *2017 International Conference on Education Science and Education Management (ESEM 2017)*, pp. 61–68. Retrieved 31 December 2020, from: <http://www.dpi-proceedings.com/index.php/dtssehs/article/view/15062>.
- Zhao, X., Wang, J., Wang, M., Li, X., Gao, X., Huang, C., 2020. A new model for assessing the impact of environmental psychology, e-learning, learning style and school design on the behavior of elementary students. *Kybernetes* 50 (2), 512–527.