

PAPER

Collaborative Digital Learning as a Virtual Learning Environment on Mathematics

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ABSTRACT

Collaborative digital learning (CDL) has been a trend since the 4.0 era and has grown in popularity in the aftermath of the COVID-19 outbreak. This study is a literature review that aims to examine the existing literature on CDL and virtual learning environments (VLEs), with a specific focus on their application in mathematics classes. The data was collected by compiling all published articles from the past five years and then analyzing the information to draw conclusions. Content analysis approaches were utilized for descriptive and thematic data analysis. The findings of this study indicate that the use of computer-based learning (CBL) as a VLE has been successfully adopted and is quite useful in remote learning, particularly during the COVID-19 pandemic. Based on these findings, it is recommended to develop a CBL VLE to assess its impact on mathematics education in schools, especially on metacognitive abilities in problem-solving.

KEYWORDS

computer-based learning (CBL), virtual learning environment (VLE), mathematics

1 INTRODUCTION

Even though the concept of student-centered learning (SCL) was developed over two decades ago, its application has become much easier with the emergence of information technology. Utilizing a collaborative learning paradigm will tremendously aid students in accelerating and deepening their knowledge acquisition process. This objective will be expedited through the use of technology in collaborative learning. Technological advancements have made students equal in terms of knowledge contribution. When connected to the internet, they have an equal opportunity to share ideas, information, experiences, and skills.

Education is evolving and becoming more advanced, interconnected, networked, and digital due to technological advancements. These evolving circumstances require students to develop new and modified competencies. Education must adapt to changing learning demands. Students must prepare for this by participating

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in a technology-focused teaching and learning process and gaining practical experience [1].

In the era of the 4.0 revolution, collaborative digital learning (CDL) is essential in education. Users of digital learning systems. Simple platforms for DL, such as Google Drive, Dropbox, and Microsoft OneDrive, are commonly used to store and update documents, allowing all members of a collaborative team to access them. More comprehensive solutions, such as Google Docs and Office 365, facilitate CDL directly on the Internet, without the need for downloading or uploading during the change process.

Education is undergoing a significant transformation in the digital era, which is still evolving rapidly. To address the challenges of the digital era, collaborative learning is becoming an increasingly important learning strategy. To enhance understanding in distance education (DE), it's important to analyze students' socio-affective profiles in the virtual learning environment (VLE) when developing technological and research resources to support the teaching and learning process [2]. On the one hand, online distance learning streamlines and adapts the learning process. However, it leads to learning loss within a specific period of instruction and diminishes students' enthusiasm for developing a collaborative mindset. In general, online learning platform providers have supported collaborative activity capabilities, but they have not effectively supported interaction [3].

The research findings of [4] indicate that virtual live learning environments (VLLE) in the metaverse can serve as a public interaction tool via mobile applications for both university students and the general public. This is because new technology has been developed and applied to existing media and technology in a manner that can create an environment approaching actual learning conditions, thereby fostering a limitless learning society. According to research by [5], the incorporation of a digital educational tool called WordTrek into the classroom instruction process enhances students' motivation, interest in vocabulary, and utilization of the lexicon. [6] created a digital learning game that can be controlled by a card prototype. As a result, all students enjoyed the game and expressed their appreciation for the use of the cards. This demonstrates that the collaborative nature of this game is highly promising, as students consistently work together to find answers. According to research [7], online learning implementation encompasses all objectives, and the online assessment environment is designed to maintain integrity, leading to successful procedures.

Due to the proliferation of smart devices, online education has transitioned from desktop to mobile environments. A smart device-based online education system offers the advantage of enabling users to learn online from any location. Data synchronization enables users to collaborate on content in real-time from any location by sharing files using cloud storage [8].

[9] This article discusses idématch, a digital, web-based, and non-commercial platform founded by University College Zealand, which collaborates with businesses, governments, and individuals. This is done to encourage students, public and private sector organizations, as well as national governments, to translate ideas into practical solutions through innovation, collaborative learning design, and cross-disciplinary thinking.

Simulations, game-based learning, virtual learning environments, and virtual worlds are expected to play a dominant role in educational technology in the future. This technology aims to provide genuine learning experiences and help students develop a deeper, more sophisticated, and more contextual understanding. [10] developed a virtual laboratory to investigate the impact of VLEs, which are not

limited to cyberspace but can also be extended to other aspects of digital educational technology.

The purpose of this study is to conduct a comprehensive review of the literature on computer-based learning (CBL) and VLE, with a focus on mathematics education. As a result, the formulation of this research problem contains the following elements:

1. How summarize the findings of CL research?
2. How summarize the findings of DL research?
3. How describe the CDL research findings?
4. How describe the findings of LE research?
5. How describe the VL research findings?
6. How describe the VLE research findings?
7. How to define CDL and VLE research findings on ML?

2 METHODOLOGY

The research method used in this study is a literature review. This research method involves identifying, reviewing, evaluating, and interpreting all available research. In accordance with research [11], this method was used to conduct a systematic review and identify journals.

This research began with data collection, which involved gathering all research related to mathematics learning problems, analyzing data in articles, and drawing conclusions. Researchers collected journal articles from Google Scholar, Research Gate, SINTA, DOAJ, and Scopus. The collected articles are related to the research keywords CDL, VLE, and mathematics.

Articles were selected from the last 10 years, specifically from 2013 to 2023. The researcher selected 30 appropriate articles and then identified the variables in the research, namely CDL, VLE, and mathematics. The data obtained is presented in tabular form and analyzed. Analysis was conducted on CDL, VLE, and mathematics variables. This includes definitions, characteristics, strengths, and weaknesses, as well as their application in mathematics learning. Researchers can draw conclusions based on the analysis that has been conducted.

3 RESULT AND DISCUSSION

3.1 Collaborative learning

[12] argues that the establishment of collaborative learning begins with a philosophical perspective on the concept of learning. A person must have a partner in order to learn. Collaborative learning can unlock opportunities for excellent learning methods. According to [13], collaborative learning is grounded in Vygotsky's zone of proximal development theory and Dewey's communication theory. This approach posits that learning activities are sociocultural practices facilitated through interactive communication activities (collaboration), leading to active reflective learning. As a result, collaborative learning becomes more focused on cultural practices, which involve cognitive activities with cultural content rather than simply cooperative connections. This shift emphasizes the social aspect of learning as a process of creating meaning and building relationships.

[13] proposes a learning approach known as collaborative learning. Learning, he believes, must "transcend boundaries and leap" through collaboration. According to

Sato, collaborative learning is the process of learning that occurs within groups. The objective is not to foster unity through group activities but rather to encourage students in groups to explore diverse viewpoints or concepts presented by each individual in the group. Learning does not occur in isolation but rather as a result of diversity or differences.

Collaborative learning is a method of learning in which students work together in a group or team to achieve predetermined learning objectives. Interactions among students in collaborative learning are intended to foster cooperation, communication, joint problem-solving, and the enhancement of social skills. In contrast to traditional learning, collaborative learning emphasizes shared responsibility and active participation from all group members.

The collaborative learning model is a student-centered and creative approach to learning. During the learning process, the collaborative learning paradigm is expected to enhance student engagement, social connection, and creativity. According to [14], collaborative learning is a student-centered learning model based on interactional theory. According to this concept, learning is a process of constructing meaning through social interaction.

A collaborative activity is one in which two or more people work together to learn or attempt to learn something. Not only do students learn from each other, but teachers must also learn from one another to improve the quality of education. A teacher not only enhances students' knowledge but also cultivates their teaching skills in the current scenario and conditions [15].

According to [16], collaborative learning is when two or more people learn or attempt to learn something together, as opposed to learning alone. This indicates that individuals engaged in collaborative learning utilize the resources and talents of others in their group, including seeking information, evaluating each other's ideas, and monitoring each other's work. As a result, this collaborative learning approach emphasizes cooperation, social interaction in the learning process, and information exchange within groups, focusing more on student-centered process skills.

Students construct their knowledge by testing their ideas and experiences, applying them to new situations, and integrating new information with their existing knowledge. Students actively construct knowledge, both individually and in social contexts. Individuals often assimilate higher mental functions in knowledge production through conversation or collaboration before incorporating them. In this scenario, collaborative learning is essential to help students develop a deeper understanding. Students can support each other through intellectual coaching in collaborative learning, enabling them to tackle progressively more complex problems. This task will be challenging if students work independently.

According to [17], partnering involves collaborating with others. As a result, students in collaborative learning are not learning in isolation. Students who engage in collaborative learning will benefit from each other's resources and skills. For example, when it comes to seeking information, reviewing ideas, and monitoring each other's work.

Learning through the collaborative approach will result in small, diverse groups. [13] agrees, stating that "small a mix are formed with groups of four men and women." To solve a problem assigned by the teacher, the students will engage and collaborate in these small groups. The presence of interaction and cooperation in each group when addressing a problem leads to active learning involving students.

Collaborative learning achieves its most significant aspect by engaging students in task-related material and keeping them focused [14]. Students will first be given a sharing assignment as a guide to building their knowledge based on the material

presented before they are given a problem-solving task. [13] expressed a similar viewpoint, stating that collaborative learning in schools is structured using two types of materials: shared or common materials (at the textbook level) that all students must understand, and then challenges are presented with advanced or surpassing materials (beyond the textbook level).

[18] defined the characteristics of collaborative learning. The framework includes: (1) Active learning, which means that students participate in a constructive and interactive process of interaction and negotiation in problem-solving tasks; (2) Group participation, which is a group of 3–4 students asking questions, justifying opinions, listening to others, and reaching consensual answers through negotiation; (3) The instructor's role in assigning assignments and providing guidance based on the material; and (4) Learner diversity.

When students discuss an issue, they consider the ideas contributed by each group member as personal decisions; in other words, in conversations, each individual keeps their thoughts private [13]. That is why there is a distinction between collaborative and cooperative learning methods.

In theory, collaborative learning is expected to promote active, in-depth learning, the development of ideas and teamwork, the acceptance of diversity, and the improvement of interpersonal skills, all of which are anticipated to enhance the learner's overall foreign language competency. The explanation is simple: collaborative learning can maximize the learner's three key competencies, namely cognitive, emotional, and psychomotor skills. Students with higher abilities assist students with lower talents in the collaborative learning approach, and vice versa. Students who feel less capable are supported by more capable students, creating a collaborative learning environment [19].

Collaborative learning, involving task sharing and interactive activities, is beneficial not only for students with a high level of academic aptitude but also for those who grasp concepts more easily. In other words, collaborative learning benefits students with low academic abilities [14]. According to several experts, the collaborative approach is an innovative learning model that places students at the center of learning (student-centered) by emphasizing social interaction, cooperation, and information exchange in small groups, prioritizing success. The presence of jump material indicates a process.

Collaborative group work activities can help students acquire skills faster. The goal of collaborative learning is to encourage students to seek diverse perspectives and ideas from each participant in the group. This demonstrates that studying together involves a two-way learning interaction, as there is a reciprocal relationship that helps students understand the information studied [13].

Collaborative learning encourages student conversation and engagement with the content that has been delivered, allowing greater opportunities for students to be active participants in the learning process in class. The availability of debates and additional space is expected to enhance students' understanding and mastery of learning materials. The collaborative learning paradigm is a type of learning in which students engage in active and collaborative learning to learn from one another.

Students' diverse comprehension abilities are engaged in collaborative learning activities. To facilitate the learning process, two types of activities are utilized: collaborative tasks in small groups for discussing information relevant to the learning objectives and individual tasks aimed at enhancing students' abilities. In addition, students can enhance their emotional and physical abilities [20].

The collaborative learning paradigm enables each group member to learn from one another, which can influence student motivation to learn. For example, if there are

students in a group who are hesitant to express their ideas, they can learn by observing their peers who do, which can motivate other students to participate like their friends. Through cooperative learning activities in small groups, the collaborative learning model aims to enhance the academic performance of students with lower proficiency levels. Not only that, but collaborative learning can also ensure that students with strong academic abilities perform better when engaging with learning materials [13].

Students engage in collaborative learning by documenting their observations of the content under study and then developing relevant ideas or concepts related to the material being studied. One of the key features of collaborative learning is the promotion of meaningful learning. Teachers will encourage students to take responsibility for their learning, foster creativity, and enhance cognitive learning [21]. Teachers emphasize the integration of students' intellectual, social, and emotional learning in the collaborative learning process [14]. Selecting the proper subject matter, methodologies, and media is crucial in the learning process and forms part of the learning approaches employed. In addition, teachers address the challenges that students face [22].

Collaborative learning is a strategy that can be utilized to enhance learning activities. This collaborative learning method is exactly what students need to prepare for the era of globalization. Students are encouraged to cooperate, learn from one another, assist one another, and progress together by using this strategy. In addition, students from diverse origins and experiences are taught to respect one another and address existing differences. It is believed that if children are accustomed to collaborating in the classroom and comprehending the differences that exist, they will be able to interact effectively even when encountering individuals with diverse mindsets and backgrounds. In addition, students are expected to meet the demands of today's globalization [23].

According to [24], students taught using the collaborative learning model achieved very high average learning result scores, while students taught using the lecture technique achieved poor average learning outcome scores. Based on the findings of this study, it is evident that students who are taught using a collaborative model outperform students who are taught using traditional methods.

3.2 Collaborative digital learning

Collaborative learning is focused on the success of the process. When combined with digital-based learning, this approach allows learning to take place anywhere and at any time, making the exchange of ideas or thoughts more convenient. Activities in digital-based collaborative learning include generating ideas, offering critiques, posing questions or comments, and contemplating the feedback. Blogs, WhatsApp groups, mailing lists, and websites designed for digital discussions can all be used as tools. This approach to learning surpasses traditional methods in terms of developing the ability to acquire knowledge, understand it, articulate ideas, and respond to others' ideas. Aside from that, learning allows teachers to more easily examine each lecture participant's learning process.

The primary concept behind collaborative learning is consensus, which is achieved through group cooperation rather than competition, emphasizing collective achievement over individual greatness. Because collaborative learning is a philosophy of interactive learning through cooperation, it can be utilized not only in the classroom but also beyond, particularly through digital devices [25].

The emphasis on collaborative learning highlights the ability to receive or give instructional content on portable personal devices, such as smartphones and tablets. Educational content refers to digital learning materials, such as text or media that

are accessible on personal devices. Most scholars and educators consider digital learning to be the direct successor of e-learning.

Collaborative learning is based on the idea that learning is inherently a social endeavor in which students interact with one another. Digital learning technology gadgets enable collaborative learning to occur anywhere and at any time, provided there is an internet connection. It is believed that by doing so, student learning outcomes will improve.

When we work and learn with other people, we are collaborating. In practice, collaborative learning occurs when students work together in pairs or small groups to achieve shared learning objectives. The research group consists of individuals with varying abilities and personalities. As a society, we now live entirely with digital technology. Learning can occur anywhere and at any time, thanks to advancements in digital technology.

One of the tools necessary to enhance collaborative learning performance is digital gadgets. As a result, several hardware and software components need to be integrated with the user to facilitate effective information delivery for the successful advancement of collaborative learning using digital devices. To facilitate CDL, multiple devices must be utilized.

Collaborative digital learning applications should enable the sharing of knowledge and media via digital devices. Media features include discussions, chats, and an interactive quiz. Questions and responses, whether in groups or individually, are essential components of digital collaborative learning tools.

Users of collaborative digital learning can access computer-based content via digital devices. Students can access educational materials on their digital devices once they have gained access to the learning platform via their devices. If they choose to work with other students, they will access the collaborative system and interact with them. A database will be utilized to store user interactions and communications in a digital-based collaborative learning system.

The CDL system enables students to communicate with other students and teachers via digital devices from anywhere and at any time. CDL offers numerous advantages, including an independent learning environment, mobility, connectivity, and social engagement. As mentioned earlier, digital devices can be valuable tools for collaboration, enabling students to share knowledge and engage in learning activities.

Furthermore, it is anticipated that CDL will enhance students' motivation to explore their abilities and share and collaborate with other students in order to achieve mutually agreed-upon learning objectives. Sharing and acquiring knowledge can be challenging in traditional collaborative learning, but it is not a problem when using technology. CDL systems enable timely access to learning content and necessary information, reducing cognitive burden during assignments and enhancing interactions with diverse users and other information systems.

3.3 Virtual learning

Various interpretations of virtual learning exist, which depend on the perspective from which it is conducted. Virtual learning is often associated with other terms and concepts such as e-learning, online learning, distance learning, web-based learning, and so on.

Students can revisit their learning exercises based on their progress using the virtual learning approach. After completing a course, a student can take a basic test of the software they created. If they answer correctly, then they can move on to the next lesson. Those who perform well can progress more quickly, while those who

perform poorly can be given additional time. As a result, all students can successfully complete the course, meaning they have mastered the required competencies.

Virtual learning utilizes computers as learning tools, offering a diverse range of learning options such as: (1) stories; (2) practice exercises; (3) tutorials; (4) simulations; and (5) games (including animation and video). Students can fully harness human potential to process information by utilizing various models and presentations of material, including verbal forms (words) and pictorial forms (images).

Robert Gagne developed the cognitive learning theory of the information processing model, significantly influencing virtual learning in the 1960s and 1970s. The idea is that “learning is a crucial aspect of development.” Virtual learning reflects a concept of the human memory system that resembles the memory system in computers. This information processing refers to the brain’s handling, retention, and recall of knowledge. Mental events are considered to be the conversion of information from stimulus to reaction.

Virtual learning, also known as online learning, is a form of technology-assisted education. The learning process will be more manageable in virtual classrooms, and students can also have a positive impact on their learning due to advancements in technology. To effectively implement virtual learning, it is essential to have strategies in place that engage participants and enhance productivity in the learning process. One such strategy is the use of gamification in virtual learning [26].

Virtual learning is a teaching and learning method that occurs in a virtual environment using e-learning technology or in a physical location dedicated to virtual learning activities. Both teachers and students can monitor the evolution of the learning process, which is evident in virtual learning. This technology is primarily used for remote education but can also be utilized as additional support in face-to-face classes [27].

3.4 Learning environment

The learning environment encompasses all the factors that influence the behavior of individuals involved in the learning process, particularly teachers and students, who play a crucial role in shaping the learning experience within a school setting. A positive learning environment has a significant impact on the growth and development of teachers and students at school [28].

As defined by [29], the learning environment encompasses any setting that impacts the learning process, including both physical and social environments. The learning environment encompasses all the situations, circumstances, and facilities utilized in the learning process [30]. A person can acquire an education through direct and indirect means within a learning environment that is influenced by both the natural and social environments [31].

According to reference [32], a conducive learning environment is both challenging and stimulating while also providing a sense of comfort and fulfillment, thus enabling the achievement of learning objectives. Overall, the learning environment comprises physical, social, and intellectual elements, as well as values and relationships with educators [33].

Based on the preceding description, it is possible to infer that the learning environment is a setting where the teaching and learning process takes place. The learning environment can influence the success of a learning process. The learning environment encompasses not only the physical elements within the learning space but also the individuals present. The location also functions as a learning environment.

The Dundee ready education environment measure (DREEM) instrument can be utilized for evaluating the learning environment [34]. DREEM consists of 50 evaluation items. Perceptions of the learning environment as perceived by students.

This measure is divided into five subscales: perceptions of instruction, perceptions of lecturers, perceptions of academic abilities, perceptions of the learning environment, and perceptions of the social environment.

The educational or academic environment influences students' attitudes, knowledge, skills, progress, and behavior. The curriculum and the assessment of student learning outcomes are used to evaluate the quality of instruction. The higher the quality of an institution's teaching, the more willing its students are to study. Teaching [35] can be observed in learning resources, methods, media, materials, and learning processes. The use of structured learning processes, media, methodologies, and a variety of learning resources can enhance students' motivation to engage effectively with lessons [36].

A person's ability to concentrate is influenced by their learning environment. Concentration will be easier to achieve in a conducive and comfortable study environment. A learning environment that is noisy, busy, messy, poorly lit, and has a poor layout, on the other hand, will impede concentration and learning.

3.5 Virtual learning environment

Learning environments have undergone significant evolution in the last 50 years, largely due to advancements in information and communication technologies [37]. The learning environment encompasses the various physical locations, settings, and cultures in which students learn. Classrooms, businesses, laboratories, museums, natural areas, modes of transportation, and houses are some examples. Most learning environments are intentionally designed or adapted to facilitate progress toward specific learning goals, often by incorporating learning materials, assignments, assessments, feedback, and support.

According to [38], virtual learning is the process of digitizing traditional education. Virtual learning has become increasingly popular with the advancement of information and communication technology [39]. People can learn from anyone at any moment. This is the hallmark of digital-based learning in the age of knowledge. The implementation of virtual learning takes into account the following five factors: (1) type of learning model; (2) learning system components; (3) learning device components; (4) selected online platform; and (5) size and volume of data used.

In VLEs, devices are categorized based on information and communication technology (ICT) by hardware type (notebook, tablet PC, PDA, cell phone, or smartphone) and wireless communication technology (GSM, CDMA, WiFi, IEEE 802.11, Bluetooth, etc.). Digital learning systems must be developed to accommodate a wide range of digital learning applications that use a variety of languages, platforms, and technologies. The middleware structure in a learning system must support the fundamental framework for student learning activities. In any geographically distributed context, systems must be designed to be used across a variety of device types and communication providers. To enhance students' learning, various types of media and streaming files will be utilized. To develop this system, a user-centered design approach will be required to meet learning objectives, ensure functionality, and ensure appropriate wireless connectivity for learning modes on digital devices.

The use of a VLE can inspire and engage students, especially those who may feel insecure about participating in class discussions and perceive themselves as falling behind their peers. Students will have equal opportunities to express their thoughts and think critically using the VLE. Those who may not have the chance to contribute in class will feel respected as they will be given the opportunity to do so electronically. Students have access to more intense interactions and extensive

conversations, even if they do not participate at the same time. This also provides them with an equal opportunity to share their viewpoints [40].

The term “blended” refers to a student’s ability to learn from both in-person and technology-based lessons. In a world where digital literacy is essential, creating a VLE can be challenging for teachers. They need to be aware of the devices available to students and consider the objectives they must accomplish in a VLE [41]. However, there are different types of learning and e-learning technologies, including multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer-based training (CBT), computer-assisted instruction (CAI), Internet-based training (IBT), web-based training (WBT), online education, and virtual education [42].

[43] identified four critical factors during VLE development testing: engagement in discussion forums, face-to-face interaction via video conferencing, time management, and prompt issue resolution with feedback. Furthermore, the test results indicate that students are content, motivated to finish practice questions, and consistently complete the learning process on time, showing a 20.40% improvement.

3.6 Mathematics learning

Mathematics is defined as “an exact science in which the learning process involves numerous formulas, numbers, and mathematical symbols” [44]. Mathematics is incorrect. A scientific subject requires students to understand and apply concepts during the learning process. Mathematics learning is closely connected to abstract concepts that are developed logically. Abstract concepts in mathematics are designed to be utilized as a mental workout to comprehend the significance of structures, relationships, and symbols and subsequently apply the derived concepts to real-world situations in order to effect behavioral change.

The teacher’s ability to organize and implement learning in the twenty-first century is supported by the 4C characteristics [45]. Mathematics should be taught to all elementary school students (SD) to equip them with a diverse set of skills, including the capacity for rational, analytical, critical, and artistic thinking, as well as the ability to collaborate [46]. In general, the goal of primary school mathematics instruction is for students to become proficient in using mathematics. Mathematics is a compulsory subject at all levels of education. Mathematics is a subject that teaches students how to think in a methodical, rational, and logical manner [47].

Mathematics is seen not only as an individual thinking process but also as a communication that requires discussion. Thinking, sharing ideas among students, and reflecting are the fundamental activities of mathematical learning. This requires collaboration between teachers and students, as well as among peers, to develop a deep understanding of the materials in mathematics learning. On the other hand, time and space limitations hinder the collaborative process. This issue can be mitigated by utilizing digital technology that can be accessed at any time and from any location. As a result, digital-based collaborative learning is advocated throughout the mathematics learning process [14].

4 CONCLUSION

Collaborative learning occurs when two or more people learn or attempt to learn something collaboratively. When people engage in collaborative learning, they utilize each other’s resources and talents, as opposed to solitary learning. Digital learning

refers to any form of education that involves the use of technology or instructional practices that effectively utilize technology. It involves the utilization of a wide range of methods, including, blended and virtual learning. CDL is a form of cooperation that involves using digital devices to achieve learning goals among students and teachers, as well as between fellow teachers and students.

Virtual learning refers to the educational process that occurs in a virtual classroom in cyberspace over the Internet, aiming to overcome the limitations of time and space that separate students and teachers by utilizing computer-based media. The learning environment encompasses all the factors that influence the behavior of individuals involved in the learning process, particularly teachers and students, who play a crucial role in driving the learning process in school. A VLE, is a web-based platform for digital learning that is widely used by many educational institutions. VLE often allows users to be better structured into groups and roles, provides resources, activities, and interactions within a program, offers various assessment stages and participation reports, and has some level of integration with numerous other institutional systems.

Teachers strive to assist students in expanding their understanding of mathematical concepts, enabling them to enhance their skills and proficiency in the subject matter. Based on these findings, it is recommended to develop a CDL VLE to assess its impact on mathematics education in schools, especially on metacognitive abilities in problem-solving.

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