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Exploring the Management of Virtual Learning Environments: Insights from Senior High School Practices

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Abstract:
This study examines the strategic management of Virtual Learning Environments (VLEs) in upper secondary schools through an interpretive qualitative approach. Data were collected via semi-structured interviews with school principals, teachers, and IT staff, and analyzed using NVivo software. The analysis revealed six core themes: visionary leadership, integrated development strategies, the creation of digital learning resources, pedagogical and classroom adaptation, supervisory mechanisms, and technical challenges. Visionary leadership within schools emerged as a critical driver of digital innovation and the cultivation of future-ready skills among both students and educators. The findings underscore the importance of designing VLEs that are responsive to the dynamic pedagogical, technological, and administrative demands of contemporary education systems. This study highlights the need for school leaders to facilitate digital transformation through capacity building and the promotion of a collaborative digital culture. Moreover, the integration of adaptive instructional strategies and real-time monitoring mechanisms within Learning Management Systems (LMS) is shown to significantly enhance instructional quality and learner engagement. The study offers practical implications for educational leaders, policymakers, and practitioners by providing a comprehensive empirical framework for the sustainable development of VLEs that promote equity, innovation, and lifelong learning in the digital era.

Keywords: Management, Virtual Learning Environment, Senior High School

1. Introduction

The rapid advancement of technology has significantly transformed organizational work processes, leading to disruption across various organizational units. Disruption in this context is conceptualized through the notion of the digital vortex, in which the education sector ranks among the top eight industries most threatened by such transformation (Yokoi et al., 2019). According to a report by the World Economic Forum (2020), 50% of organizations are expected to accelerate task execution through automation, 84% plan to expand the digitalization of their workflows, and 83% are shifting towards remote work arrangements. These developments present a critical challenge for the education sector to innovate in order to remain competitive. Leaders are thus encouraged to implement digital transformation within their institutions (Gerth & Peppard, 2016) and to prepare students with future-ready skills, particularly in utilizing and advancing technological capabilities (Pettersson, 2018).

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As an effort to develop education that can adapt to technological advancements and digitalization, schools can establish virtual learning environments (VLEs) (Rashid et al., 2021). A VLE refers to an online learning environment in which teachers and students are separated by time, space, or both, and instructors deliver course content through course management applications, multimedia resources, the internet, and video conferencing (Piccoli & Ahmad, 2001). VLEs are defined as computer-based environments that facilitate interaction and engagement among participants while providing broad access to various learning resources (Rashid et al., 2021).

With appropriate technologies, VLEs can be beneficial and effective in multiple ways, as they offer rich content, interactive features, and learning flexibility (Surkhali & Garbuja, 2020). VLEs improve students' accessibility by allowing them to study anytime and anywhere, engage in asynchronous discussions with peers, and receive real-time feedback on assessments (Ahmady et al., 2020). Personalized learning also supports student diversity by enabling access to multiple pathways for understanding the same content (Daniel, 2020). Many online learning programs have proven successful, with students often reporting enjoyment in online learning, and some teachers observing increased student engagement compared to traditional classrooms (Zhu & Liu, 2020).

School responsiveness plays a crucial role in building trust among students and parents regarding the effectiveness of online education (Rasmitadila et al., 2020). Research has shown that students respond differently to virtual learning, and their learning outcomes often depend on the range of alternative learning options available to them (Kuhfeld et al., 2020). Variations in school systems and their capacity to design and implement virtual learning environments have widened the gap in educational service delivery (Reimers & Innovation, 2020). The absence of an established virtual learning environment remains a significant barrier to the effective implementation of distance learning (Harapan, 2020).

A recent study conducted in Spain revealed that 74% of surveyed students expressed dissatisfaction with their teachers' instructional approaches, while three out of five students felt that teachers rarely delved deeply into subject matter, offered academic guidance, stimulated engagement, involved learners actively, or followed up within study groups (Martín et al., 2021). This dissatisfaction reflects a broader issue concerning teacher readiness in adapting to digitally mediated learning environments. Kuhfeld et al. (2020) found that many students lacked confidence in their teachers' ability to effectively utilize digital tools such as images, audio, video, computer graphics, and response systems. Such limitations suggest a significant gap in digital pedagogical competence, which is essential in online and hybrid learning settings.

The root cause of this challenge lies in the insufficient development of online teaching competencies among educators. Almerich et al., (2016) emphasized that teachers must acquire a specific set of digital skills not only to plan and implement instruction but also to assess student learning effectively in virtual environments. The COVID-19 pandemic further underscored this gap, as schools worldwide rapidly transitioned to remote learning, exposing the varying degrees of teachers' preparedness and adaptability. A multi-country study by Trust and Whalen (2021) revealed that while some educators showed remarkable innovation and resilience, many struggled with digital pedagogy, technological fluency, and online classroom management. Similarly, research by König et al. (2020) highlighted that teachers with prior experience or training in digital learning environments were significantly more confident and effective in managing online instruction compared to their peers.

Moreover, the integration of digital tools in education demands not only technical proficiency but also a pedagogical shift. According to Mishra and Koehler's TPACK framework (2006), effective teaching in digital contexts requires a combination of technological, pedagogical, and content knowledge. Without these integrated competencies, teachers are likely to fall back on traditional didactic methods, even in virtual settings, thus diminishing the potential of virtual learning environments (VLEs) to offer personalized, interactive, and student-centered learning experiences. In line with this, a study by Cevikbas and Kaiser (2023) indicated that teachers who received structured professional development in digital pedagogies were more capable of designing engaging and inclusive virtual learning experiences.

To address these challenges, ongoing teacher training and institutional support must be prioritized. Building digital literacy alone is insufficient; educators must also develop reflective practice, adaptive expertise, and a growth mindset to continually evolve alongside emerging educational technologies. As education systems increasingly move toward blended and online modalities, ensuring teacher competence in digital instruction is not merely an option—it is a critical prerequisite for educational equity and quality.

To address the identified research gap, a preliminary investigation was conducted involving three senior high schools recognized for their successful implementation of Virtual Learning Environments (VLEs). The first case was a boarding school in Batu City, which integrated VLEs in response to the school's commitment to promoting self-directed learning. The primary aim was to provide personalized instruction tailored to each student's learning pace, needs,

interests, and talents. The second school, a partnership-based education institution, adopted VLEs as a strategy to enhance the efficiency of educational processes while broadening students' access to various learning resources. The third school, a boarding institution in Malang, employed a semester credit system that enabled students to select elective courses based on their interests and talents. The flexibility of class scheduling and resource access was significantly supported by the development of VLEs. Based on these initial findings, this study aims to explore the management of virtual learning environments in senior high schools, focusing on six key themes: (1) the principal's vision, (2) strategies for developing virtual learning environments, (3) instructional resource and media development, (4) classroom and pedagogical management strategies, (5) learning supervision, and (6) challenges in managing virtual learning environments.

2. Literature Review

A virtual learning environment (VLE) is a designed informational space that is not limited to distance education; rather, it is a social space that integrates a variety of tools, where the space itself is directly represented and overlaps with the physical environment in which students are not only active but also serve as agents in the learning process (Gyorgy, 2014). The role of students in VLEs extends beyond that of passive recipients of information. They progress through various roles: as performers of assigned tasks, seekers of feedback and further information, developers of ideas, creators of knowledge, contributors to the learning of others, and developers of personal awareness and skills (Lameras et al., 2012). VLEs are also referred to as web-based e-learning systems that simulate conventional face-to-face education by providing virtual access to classrooms, class content, assessments, homework, grades, evaluations, and external learning resources (Thah, 2014). Today, VLEs represent multifunctional systems that incorporate pedagogical, didactic, and methodological technologies, essential informational resources (such as knowledge bases, libraries, and electronic training materials), and modern software tools (Kerimbayev, 2015).

VLEs are characterized by the integration of complex computer devices and technologies that enable control over educational content and communication among participants in the learning process (Kerimbayev, 2015). These environments actively encourage students to identify resources that provide evidence to support their arguments and to share such resources with peers (Lameras et al., 2012). VLEs can facilitate both synchronous and asynchronous interactions. In synchronous systems, participants meet in real time, allowing teachers to conduct live sessions in virtual classrooms (Thah, 2014). Designing an environment in which students share goals—and where the goals transcend learning tasks to include the creation of a collaborative space for discussion, dialogue, and interaction—can lead to the development of authentic online learning communities (Lameras et al., 2012). Thus, VLEs have the potential to foster collaborative knowledge construction as well as the development of metacognitive awareness and process skills (Lameras et al., 2012).

Developing a successful VLE requires high levels of integration, availability, security, scalability, and reliability across all system components. To guide this development, the steps of the software development life cycle can be applied: (1) program planning, (2) requirements definition, (3) design and development, (4) integration and testing, and (5) installation and maintenance (Gyorgy, 2014). In the context of learning, VLEs can facilitate access to five types of learning technologies: (1) narrative media to support conceptual understanding (e.g., digital texts, videos, audio); (2) interactive media for investigation and exploration (e.g., digital libraries, web links); (3) communicative media for discussion and debate (e.g., discussion boards, online chats); (4) adaptive media for experimentation and practice (e.g., simulation-based instruction, virtual labs, quizzes with feedback); and (5) productive media for expression and presentation (e.g., blogs, wikis, digital artifacts) (Lameras et al., 2012). Learners can be engaged and stimulated through these various channels throughout the learning process (Gyorgy, 2014).

In developing a virtual learning environment, schools can establish a collaborative teaching team composed of the following roles: (a) content teachers, who are responsible for preparing course content and adapting it methodologically to align with the course profile; (b) virtual teachers, who are generally responsible for managing subject-specific content and serve as subject-matter experts in their respective fields; (c) daily teachers, who directly engage with students in virtual learning environments, managing and guiding both tutor teams and students in relation to subject content development; (d) instructional designers, who are responsible for designing subject structure, organizing content, and mapping proposed learning activities. These individuals work under the direction of content teachers and play a pivotal role within the instructional team; (e) face-to-face teachers, who support students in in-person sessions, helping them overcome specific difficulties; (f) multidisciplinary teams, which include experts in print, audiovisual, virtual, and digital media; and (g) coordinator teams, who ensure integration and communication among all team members (Borba et al., 2018).

To identify and utilize high-quality learning resources, several types of materials may be used: (1) pure resources—unedited materials, which are the most commonly used (e.g., articles, book chapters, PowerPoint slides,

animations); (2) combined pure resources—unedited materials integrated with other resources (e.g., raw materials combined with online or face-to-face discussions, or reflective essays); (3) adapted resources—materials that have been modified and repurposed to suit the specific teaching context; and (4) dynamic resources—electronically structured materials that allow interaction and contribution (e.g., editable and commentable content by students) (Gyorgy, 2014).

3. Research Methods

This study employed a qualitative approach using an interpretive methodology (Yin, 1996). The interpretive method was adopted to achieve the research objectives, as it allows for a detailed and in-depth exploration of the characteristics of a small group of participants. A phenomenological research design was applied, in which the researcher seeks to identify the essence of human experiences related to a specific phenomenon (Creswell, 2009). The collected data were analyzed using NVivo R1.4 software, and the theoretical framework was developed inductively.

The research was conducted in three senior high schools located in Malang Regency, all of which had developed Learning Management Systems (LMS) and were capable of establishing interactive virtual learning environments. In phenomenological research, purposive sampling is commonly used to select respondents who can provide rich and meaningful information. The participants consisted of school principals (n = 3) and teachers serving as curriculum supervisors (n = 3).

3.1 Data Collection Instruments,

Two interview protocols were developed to collect relevant data from the two respondent groups. The interview protocols were structured around six thematic areas related to virtual learning environments in senior high schools: (1) the principal's vision, (2) strategies for developing virtual learning environments, (3) development of instructional resources and media, (4) classroom and pedagogical management strategies, (5) learning supervision, and (6) challenges in managing virtual learning environments.

3.2 Data Analysis.

Data were collected through semi-structured open-ended interviews with school principals and teachers. An interview protocol was used to initiate the process and was then iteratively refined with tentative modifications to certain questions based on emerging responses, continuing until saturation was reached. All interviews were transcribed by the researcher. Data collection and analysis were conducted simultaneously. Given the time-intensive nature of interview data analysis, the transcribed data were analyzed using NVivo R1.4. An inductive data analysis technique was employed, adopting the approach proposed by Bogdan and Biklen (2007) and guided by Yin (1996), to develop emergent substantive theories through a continuous and iterative process.

4. Result and Discussion

4.1 Principal's Vision

The first emerging theme identified was the school's vision, which underpins the rationale for adopting a Virtual Learning Environment (VLE) system. This theme explores the principal's forward-looking goals in developing a virtual learning environment and their strategic orientation toward digital transformation in education. The role of the principal has evolved from merely providing structural leadership to embracing a broader mandate—motivating teachers and students to internalize and act upon the school's vision. Moreover, principals are expected to foster proactive practices that drive continuous innovation and improvement in teaching and learning. As such, school leaders must articulate the core purpose and urgency of building a robust VLE as a critical component of future-oriented education management.

> *Awal nya masih seperti sekolah lainnya, SMA Al Hikmah memakai pembelajaran langsung, teknologi IT hanya untuk browsing meteri. Sehingga pada tahun 2019 yayasan meminta untuk proses pembelajaran yang berbeda, sehingga disepakati bentuk nya boarding. Kami mencari format terbaru dalam proses pendidikan. kita menemukan data yang ditahun 2014 pertemuan di Doha Qatar yang nama pertemuannya World Innovation Summit for Education (WISE) 2014, para kebijakan dari berbagai dunia itu berkumpul dan mencari format pendidikan di masa depan hasilnya adalah 93% dari yang datang sepakat bahwa pembelajaran itu harus berubah dan 7 % yang merasa*

tidak perlu berubah. Perubahan nya arus besar nya seperti apa? Bahwa pembelajaran online akan menjadi no 1 ditahun 2030. Sumber belajar nya dari platform multimedia berbasis internet. sehingga terjadi pergeseran peran guru; yang sekarang sebagai penyampai materi, kelak peran guru berubah menjadi guiden dan mentor, sehingga ini akan merubah kurikulum dan strategi pembelajaran (peserta 3).

SMA BB menggunakan LMS yang kami sebut dengan AIS (Academic Information System) sejak tahun 2016 untuk guru. Untuk siswa AIS dimulai sejak 2018. Karena perkembangan teknologi yang sangat pesat seperti sekarang dan komunikasi yang dilakukan harus selalu sinkron, maka kepala sekolah dan seluruh guru dan staf serta siswa diharuskan untuk selalu memanfaatkan AIS secara maksimal dengan cara misalnya menggunakan untuk menguplod dokumen-dokumen yang diperlukan, nilai-nilai hasil ujian, tugas-tugas siswa, dan sebagainya. Sebaliknya, apabila diperlukan suatu dokumen, bisa langsung diunduh dari AIS. Hal tersebut dilakukan setiap saat sehingga seluruh sivitas akademika sekolah mempunyai budaya virtual untuk menggunakan AIS (peserta 2).

LMS sekolah kami dibuat untuk mempermudah stakeholder dalam memantau proses pendidikan yang dilakukan di sekolah, Orang tua dirumah mampu mengetahui secara berkala perkembangan anaknya, Siswa mampu mengetahui proses pendidikan dan materi ajar serta riwayat pendidikan selama di asrama, Manajemen mampu mengetahui proses yang berjalan secara realtime dan mampu memberikan keputusan secara cepat dan tepat (perserta 1).

4.2 The Principal's Vision in Digital Learning Environments.

The principal's vision plays a pivotal role in the development of digital learning environments. A leader's ability to clearly articulate the organization's mission and vision, coupled with ethical conduct, serves as a fundamental driver in motivating staff and building trust to achieve shared goals (Al-Khaldi et al., 2020). Principals often adopt a forward-thinking orientation in cultivating virtual learning ecosystems. Their vision encompasses equipping students with future-ready competencies, particularly in navigating and working within digitally mediated environments.

Teachers are also expected to adapt by transforming their roles—from traditional knowledge transmitters to facilitators, guides, and mentors. This paradigm shift necessitates a reconfiguration of instructional strategies, including the redesign of educational goals, curriculum, and co-curricular frameworks in alignment with e-teaching models. Principals must provide strong support to foster lifelong and self-directed learning, including psychological and professional encouragement to strengthen teacher networks and communities of practice for skill development (Chua & Chua, 2017).

Moreover, the formation of virtual learning environments significantly enhances the efficiency of school operations. Communication between teachers and students becomes more flexible and ubiquitous, while the transfer of documents and other administrative tasks can be facilitated seamlessly. Learning Management System (LMS)-mediated communication has a substantial impact on the instructional dialogue among principals, teachers, students, and parents, fostering more inclusive and responsive educational interactions (Collins & Berge, 2008).

4.3 Virtual Learning Environment (VLE) Development Strategy

The development of a Virtual Learning Environment (VLE) requires an integrated and systematic approach. It begins with assessing the needs of both students and teachers, followed by fostering online student learning communities, providing the necessary infrastructure and technological resources, and implementing comprehensive teacher development programs. These programs aim to enhance educators' capacity to effectively utilize technology to support and enrich the teaching and learning process.

Pembelajaran berbasis big data, anak itu dikondisikan belajar sesuai kebutuhan. Sehingga desain pembelajaran tidak pas jika berbasis RPP sehingga harus berubah berbasis modul. Guru harus mempersiapkan modul mulai dari kelas sepuluh hingga kelas dua belas secara bertahap. Siswa dapat belajar sesuai dengan kecepatan mereka. Pengembangan LMS yang kami beri nama "sekolahku" dikembangkan bekerjasama dengan pihak pengembang dari luar. Kebutuhan program di LMS kami kembangkan sendiri sesuai dengan kebutuhan strategi pembelajaran yang kami buat. Untuk tantangan nya diguru di tiga tahun pertama ini kami harus mengawal penuh dalam penyusunan modul ini. Karena kekuatan pembelajaran online ini adalah yang utama adalah dikualitas modul nya. Ketika tiga tahun ini berhasil maka kedepan kita akan sangat ebih akteratif dalam proses pembelajaran. karena tugas guru akan berkurang (peserta 1)

The development of a Learning Management System (LMS) requires the integration of multiple institutional units to ensure that the platform effectively captures and responds to the diverse needs of its users. Through this integrative approach, the virtual learning environment is expected to be optimized, enabling its full potential to support teaching and learning processes.

Manajemen pengelolaan dan pengembangan lingkungan virtual dimulai dari tim IT sekolah di pusat Jakarta dan bekerja sama dengan tim IT dari sekolah yang berada di Bandung, Semarang, Malang, dan Balikpapan. Dalam fasilitas nya setiap anak mendapakan macbook pada saat daftar ulang. Sehingga ini sangat membantu dalam proses pembelajaran. Sistem kami terintegrasi, ketika siswa masuk sekolah yang dapat diakses hanya AIS saja (peserta 2).

Untuk sarana IT kami terpusat di Surabaya yang mulai dari TK, SD, SMP, SMA dan Boarding dikembangkan terpusat (peserta 1).

Manajemen pengelolaan LMS di AIS (Academic Information System) dengan beberapa tahapan, yakni dengan bertanya kepada guru mata pelajaran mengenai masukan beberapa hal sebelum mengajar (lesson plan), selama mengajar (lesson time), dan setelah mengajar (evaluation). Dan di AIS kita juga sertakan survey/ feedback untuk parents dan murid agar mempermudah mereka memberikan masukan mengenai system yang kita gunakan (peserta 3).

The management of virtual learning environment (VLE) development requires a systematic and integrated process, beginning with a comprehensive needs analysis of future instructional design and learning strategies. Development must be carried out holistically by addressing the diverse needs of stakeholders—including teachers, students, administrators, and institutional management. The implementation of a virtual learning environment represents substantial transformation in the professional roles of educators. As Barajas and Owen (2000) noted, such transformation extends from instructional design to administrative and institutional levels, necessitating fundamental shifts in both academic and technical roles. With this integrative framework, it is expected that the virtual learning environment can be developed to its fullest potential.

4.4 Development of Learning Resources and Media

In the development of virtual learning environments, a variety of learning resources and instructional media can be utilized to support students' understanding, foster greater interactivity, and enhance communication within the learning process. The use of diverse media serves not only to accelerate the learning process but also to create more meaningful and engaging learning experiences. Such efforts are essential in transforming conventional instruction into a dynamic digital ecosystem that meets the demands of 21st-century education.

Tahap yang pertama adalah melakukan desain pembelajaran dalam tahap ini dilakukan perancangan instruksional yang meliputi analisis tingkat kesulitan dan pemetaan program, dilanjutkan dengan pengembangan yang terdapat dua tahapan yaitu pengembangan offline dan tahap pengembangan online. Pada tahap pengembangan ini terdapat tiga komponen utama yang harus dikembangkan dalam pembelajaran e-learning yaitu konten, interaksi, dan asesmen, selanjutnya itu tahap implementasi (deployment). Dalam tahap ini terdapat beberapa proses implementasi yakni mulai dari implementasi penggunaan aplikasi LMS, implementasi evaluasi pembelajaran, dan implementasi media komunikasi/interaksi (peserta 5).

Guru menuangkan pembelajaran semenarik mungkin di LMS, selain itu guru juga melampirkan informasi-informasi penting dan melaksanakan diskusi menarik dalam LMS yang mengharuskan siswa untuk mengaksesnya. Guru juga menggandeng orang tua untuk mendukung siswa berpartisipasi aktif dalam pembelajaran virtual menggunakan LMS (peserta 4).

The learning design can be accommodated from the module design created in the LMS as an effort to maintain interaction between teachers and students.

Dalam mengembangkan LMS sekolahku, sumber belajar dan media pembelajaran telah terintegrasi menjadi satu kesatuan dalam modul, dimana modul disusun berdasarkan prosedur pembelajaran yang menganut 5 M kurikulum 2013 yaitu melalui tahapan mengamati, menanya atau merumuskan masalah, mencoba atau mengajukan hipotesis, menalar atau mengumpulkan data dan membangun jejaring atau mengkomunikasi konsep, sehingga meskipun proses pembelajaran dilakukan secara online atau blended kemampuan ilmiah anak-anak akan tetap terasah (peserta 1).

Various learning resources can be used, either through available learning resources or by creating your own according to your needs. In designing media to explore the interaction between teachers and students through LMS.

> *Aktivitas yang dilakukan dalam LMS dan efektifitasnya Aktivitas pembelajaran, terdiri dari: Modul, dalam hal ini adalah konten materi pelajaran yang dikembangkan sendiri atau konten dari luar yang akan digunakan, Link, yaitu konten luar yang disarankan kepada siswa untuk dipelajari, Diskusi yang berbentuk komentar pada materi dan chat, Tugas, dalam hal ini adalah penyampaian pembelajaran dalam bentuk penugasan yaitu tugss terstruktur baik individu dan kelompok, Aktivitas evaluasi, terdiri dari: Tugas yaitu evaluasi melalui format penugasan secara individu dan kelompok Tes yaitu evaluasi melalui ujian/kuis secara online berupa pilihan ganda dan essay (peserta 5).*

> *Pembelajaran virtual di disesuaikan dengan keadaan kelas virtual yaitu dengan mewajibkan menggunakan modul dan PPT serta Quis interaktif seperti Quiziz atau mentimeter semua dokumen. Sehingga dalam perencaan harus melampirkan RPP, PPT, Modul dan Link Quiziz/Mentimeter, sedangkan dalam proses pembelajara kami menggunakan video converence yaitu ZOOm meeting untuk melakukan proses pembelajaran. Sedagkan dalam tahap evaluasi siswa diajak menggunakan Link Quiziz/Mnetimeter atau memanfaatkan LMS (peserta 3)*

The development of virtual-based learning resources and media can be carried out in various stages, starting with instructional design, which includes analyzing difficulty levels and mapping programs, followed by development, which consists of two types: offline development and online development, which in turn consists of three components: content, interaction, and assessment. The next stage is implementation, which includes implementing the use of LMS applications, implementing learning evaluations, and implementing communication or interaction media. This requires a transdisciplinary approach involving various disciplines, from subject matter specialists to instructional designers and system administrators (Barajas & Owen, 2000). In developing resources and media, teachers can use various learning resources, either through existing resources available on the internet or by creating their own according to their needs (Gyorgy, 2014).

4.4 Classroom Management and Pedagogical Strategies

In developing a virtual learning environment, it is necessary to adjust classroom management and learning strategies so that the learning process can run effectively. Various classroom management and learning strategies can be implemented in order to build a more effective virtual learning culture. The most important thing in developing virtual classroom management is how to prepare students to be independent in the learning process.

> *Sehingga membuat desain pembelajaran yaitu bridging house, nama nya kami menyebutkan BLC/Basic Leadership Camp. Anak ini mau diisi wadah nya harus kuat, ini kita berikan masa orientasi yang didesain selama 2 bulan penuh. Diajarkan bagaimana cara belajar dan membantuk budaya belajar benuansa kemandirian, tanggung jawab dan kedisiplinan (peserta 1).*

In preparing students to be able to learn independently, it is necessary to build awareness of what they need when learning, instill core concepts of learning materials, and provide feedback in analyzing learning achievement.

> *Memberikan siswa kesadaran tentang apa yang mereka butuhkan untuk belajar dan memahami. Memberikan siswa informasi yang mereka butuhkan untuk memahami dan belajar jika mereka ingin berhasil. Siswa diberikan tugas-tugas secara online yang memungkinkan mereka dapat menerapkan konsep-konsep yang dijelaskan kepada mereka di tahap konseptualisasi. Biasanya mengambil bentuk penandaan diri tes online yang kemudian memberikan para siswa dengan umpan bali berdasarkan respon mereka atau skor akhir. Memungkinkan siswa untuk berinteraksi satu sama lain untuk mendapatkan pemahaman umum dari topik dan dengan demikian mengambil beberapa tekanan dari tutor (peserta 5).*

> *Manajemen kelas disesuaikan dengan keadaan saat ini, mematikan kamera saat olahraga dianggap absen. Tidak mengenakan seragam olahraga juga akan mengurangi nilai. Keterlambatan pengumpulan tugas akan mempengaruhi nilai juga (peserta 3).*

The development of virtual learning environments necessitates the adaptation of both classroom management and instructional strategies. In the initial phase, it is essential to implement structured programs aimed at fostering student autonomy, responsibility, and discipline. Although students in both virtual and conventional settings demonstrate generally positive levels of self-regulated learning, learners in virtual classes exhibit higher autonomy. However, they still show weaknesses in setting personal learning goals and objectives compared to those in conventional classrooms (Sudiana et al., 2017). Effective instructional strategies should therefore focus on developing learners' metacognitive

awareness of their needs during the learning process, reinforcing the core concepts of the subject matter, and providing feedback to support reflective analysis of learning outcomes. During virtual teaching and learning activities, it is important to consider that certain didactic elements embedded in the environment will inherently shape the pedagogical functions and instructional dynamics (Barajas & Owen, 2000).

4.5 Instructional Supervision

Specific strategies are required to ensure effective supervision within virtual learning environments. This supervision aims to align the objectives of learning across planning, implementation, and assessment stages, ensuring consistency with the predetermined educational goals.

> *Kepala Sekolah mempunyai akses untuk masuk ke kelas-kelas Zoom untuk memonitor kelas dengan pelajaran yang sedang berlangsung serta akses ke semua dokumen baik yang diupload guru maupun staff sekolah serta penilaian kepada siswa maupun kinerja guru (peserta 2).*

With the LMS system, learning planning control is more organized, but there needs to be consistent monitoring in the collection of learning plans.

> *Adanya akun manaement sebagai kepala sekoh atau kurikulum untuk kontrol dokument dan dilaporkan secara berkala di grup dan guru yang bersangkutan agar tertib mengunggah bahan belajar di LMS. Serta adanya rekap kehadiran siswa untuk memantau keaktifan dalam mengikuti pembelajran online sehingga jika ada siswa yang jarang ikut pembeajran langsung didintaklanjuti oleh walikelas dan walisiswa (peserta 4).*

> *Supervisi pembelajaran melalui LMS terkait dengan modul dan pembelajaran online/offline dengan supervisi oleh dua orang. Laporan baik supervisi modul atau supervisi pengajaran semua langsung terupload di LMS masing-masing guru, sehingga mereka dapat melihatnya secara langsung. Sistem sudah secara langsung memaksa guru untuk menjalankan proses pembelajaran virtual ini, seperti jika modul nya jika belum jadi maka KBM nya gak akan jalan. Sehingga seluruh bagian perencanaan harus ada semua. Begitu juga, misalnya anak itu nilai kurang maka akan secara otomatis keluar analisis sehinga anak jika belum tuntas dapat mengulangi nya kembali bagian yang masih belum tuntas dan tidak diperbolehkan lanjut ke modul selanjutnya (peserta 1)*

Developing a virtual learning environment requires targeted strategies to ensure that instructional planning, implementation, and assessment are conducted in alignment with established goals. Technology serves as a critical component of e-mentoring and instructional supervision, with its use influenced by situational, social, and utility-related factors (DasGupta, 2011). The integration of technology facilitates principals in conducting effective supervision; for example, school leaders can access Zoom or other online classrooms to observe ongoing instruction, monitor planning documents, and review teaching implementation reports in real time via the Learning Management System (LMS). Furthermore, supervision reports—whether related to planning or implementation—can be submitted and reviewed instantly, enabling timely feedback and continuous improvement in instructional practices.

Negotiating a learning contract that outlines logistics, privacy boundaries, objectives, responsibilities, accountability lines, and mutual expectations is essential in many supervisory relationships. This becomes particularly important in virtual settings, where supervision may take place in spaces not typically designated for professional interactions and where the potential for external disruptions is significantly greater (Miller & Miller, 2020).

4.6 Challenges in VLE Management

Challenges in developing a virtual learning environment can have both positive and negative impacts, so a strategy is needed to build a learning environment during the COVID-19 pandemic. One of the obstacles is related to technical skills in using LMS, so special training is needed on how to use LMS in order to optimize all available applications and make the learning process more attractive.

> *Mengenai kemampuan teknis sangat disarankan diberikan workshop ataupun tutorial, namun harus jika dipertimbangkan waktu pelaksanaan dan durasi nya (peserta 3).*

One of the most persistent barriers to the effective implementation of virtual learning is the lack of adequate internet infrastructure, particularly in regions with limited technological development. The success of online education depends not only on digital readiness but also on the consistent availability of stable and high-speed internet connections.

When such infrastructure is inadequate, it leads to disruptions in instructional continuity, delays in content delivery, and overall frustration among learners and educators. Moreover, the capacity to troubleshoot technical issues—such as connectivity loss, platform crashes, or device incompatibility—becomes a critical determinant of learning success.

Recent empirical studies highlight the significance of these challenges. For instance, Adedoyin and Soykan (2020) underscore that poor internet connectivity was one of the most reported obstacles during the COVID-19-induced transition to online learning, particularly in low- and middle-income countries. Similarly, a cross-national study by Lall and Singh (2020) found that over 60% of students experienced frequent disruptions due to either network failures or lack of access to suitable devices. In Indonesia, a national study by Thaheem, et al. (2022) reported that both students and teachers cited unstable internet access as the top constraint in adopting Learning Management Systems (LMS) during remote instruction.

In addition, the ability to resolve technical issues in real time remains limited among many educators and students, who may lack adequate digital literacy or institutional support. Without dedicated IT support systems, minor technical problems can escalate into significant learning delays. As Almahasees, Mohsen, and Amin (2021) point out, the absence of technical support services in many schools has undermined user engagement and increased dropout rates from online courses.

To mitigate these issues, several strategies have been proposed, including public-private partnerships to expand broadband access (World Bank, 2021), integration of offline-compatible learning tools, and the provision of training for teachers and students in basic ICT troubleshooting. However, unless these infrastructural and technical gaps are systematically addressed, the promise of virtual learning as a scalable and inclusive educational model will remain limited.

> *Pembelajaran bergantung TIK dan listrik. Listrik mati maka sudah tidak bisa apa-apa karena semua nya ada di sini, sehingga kita siapkan jet set kita siapkan dua profider, infestasi di infrastruktur IT yang begitu besar juga (peserta 1).*

> *Kendala dari AIS (Academic Information System) ini hanya jika server down, guru dan staff mengalami kendala saat mengakses system ini (peserta 3)*

> *Sampai saat ini kendala tersebut masih bisa diatasi karena penggunaan beberapa gadget yang dimiliki seperti laptop, iPad, HP, tablet, dan sebagainya. Sehingga apabila satu perangkat terkendala, perangkat yang lain bisa digunakan (peserta 2).*

In order to develop an LMS for the process of developing a virtual learning environment, it is necessary to develop the LMS continuously to meet the needs of students and teachers so that the learning process is more effective.

> *Kita biasa mengadakan meeting sebulan sekali dengan teacher dan principal, untuk terus mengembangkan AIS (Academic Information System) menjadi system yang lebih bagus lagi (peserta 3).*

One of the primary challenges in the development of Virtual Learning Environments (VLEs) lies in their heavy reliance on robust Information Technology (IT) infrastructure. The quality of digital education is significantly dependent on the availability of high-speed internet, reliable Learning Management Systems (LMS), and adequate hardware for both students and educators. These requirements often necessitate substantial financial investments from educational institutions, especially in contexts with limited resources. Mahmood et al., (2022) argue that while the initial cost of IT infrastructure development can be high, a cost-benefit analysis often reveals long-term efficiencies, particularly in reducing recurrent expenditures on physical infrastructure and expanding access to education across geographical boundaries.

Moreover, the effectiveness of LMS in supporting online teaching and learning hinges not only on the technology itself but also on the technical proficiency of educators. Many teachers lack the skills necessary to utilize the full potential of LMS features, which include content management, assessment tools, communication channels, and analytics. This gap necessitates structured professional development programs to enhance digital pedagogy. Barajas and Owen (2000) emphasize that in the digital era, teachers are not merely content deliverers; they must also act as instructional designers, digital communicators, and integrators of media resources within their pedagogical practices.

The COVID-19 pandemic has further amplified both the urgency and potential of virtual learning. The global shift to remote instruction catalyzed unprecedented adoption of LMS platforms, presenting a pivotal moment for educational leaders to transform temporary solutions into sustainable systems. Recent studies affirm that the forced

transition to online learning during the pandemic accelerated digital literacy among teachers and students, creating a foundation for long-term virtual learning integration (Dong et al., 2020; Thaheem, et al. 2022). This momentum provides school leaders with a strategic opportunity to institutionalize virtual learning practices through continuous improvement, resource optimization, and stakeholder engagement.

To this end, the role of school leadership becomes crucial in fostering a culture of innovation and inclusivity. Collaborative efforts between school principals and IT teams should focus on iterative LMS development by integrating feedback from educators and learners. Sustained engagement with teachers—particularly in identifying pedagogical and technical needs—can enhance LMS customization, improve instructional design, and increase adoption rates. Furthermore, providing regular training and mentorship can ensure that digital tools are aligned with curricular goals and student learning outcomes. Ultimately, the development of a successful VLE requires not only technological investment but also visionary leadership and a participatory change management strategy.

5. Conclusion

The development of Virtual Learning Environments (VLEs) in senior high schools can be organized into six thematic strategies: (1) The principal's vision, which refers to the leadership's capacity to inspire both teachers and students to cultivate future-ready skills and enhance the effectiveness of the educational process; (2) Virtual learning environment management, which emphasizes an integrated development approach tailored to the needs of students, teachers, and educational administrators; (3) Learning resources and digital media, which involves a three-phase process—design planning, development, and implementation—to support interactive and meaningful learning; (4) Classroom and pedagogical management strategies, including student preparation to develop autonomy, essential learning skills, mastery of core concepts, and mechanisms for feedback; (5) Learning supervision, which utilizes digital technologies to improve monitoring accessibility and the delivery of timely feedback; and (6) Challenges and strategic responses during the COVID-19 crisis, which include addressing high implementation costs, overcoming technical skill limitations among educators, and leveraging the forced transition to virtual learning during the pandemic as a critical opportunity for systemic transformation.

5.1 Limitations and Implications for Future Research

Research on virtual learning environments (VLEs) remains relatively limited, highlighting the need for further investigations into various dimensions of VLE implementation. Future studies should explore in greater depth the strategies employed by teachers in designing effective virtual instruction, the forms of leadership required to foster and sustain digital learning environments, and the managerial practices necessary for administering VLEs effectively. Additionally, future research can be expanded across different educational levels, ranging from primary and secondary schools to higher education institutions, to provide a more comprehensive understanding of VLE development and its contextual variations.

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