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DESIGN THINKING APPROACH IN VIRTUAL LEARNING ENVIRONMENTS: TRENDS, IMPACTS, AND CHALLENGES

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Abstrak

Transformasi digital dalam pendidikan telah membuka peluang baru untuk menciptakan pengalaman belajar yang lebih interaktif, personal, dan fleksibel. Salah satu model pedagogis yang saat ini mendapat perhatian adalah pendekatan Design Thinking (DT). Namun, format virtual itu sendiri berpotensi untuk melemahkan salah satu prinsip utama model DT, yaitu prinsip berbasis pengalaman. Seiring meningkatnya minat dalam penerapan DT dalam konteks pembelajaran virtual, beberapa studi telah mencoba untuk meneliti efektivitasnya, hasil pembelajaran, dan hambatan yang dihadapi. Hasil tinjauan literatur sistematis menunjukkan bahwa penerapan pendekatan DT dalam Lingkungan Pembelajaran Virtual (VLE) tidak hanya dimungkinkan tetapi juga berpotensi untuk mempercepat transformasi pendidikan menuju model yang lebih kolaboratif, berpusat pada manusia, dan berorientasi pada solusi. Namun, keberhasilannya bergantung pada kesiapan teknologi, kemampuan fasilitator, dan inovasi pedagogis. Hasil tinjauan literatur sistematis menunjukkan bahwa pendekatan DT efektif dalam meningkatkan keterlibatan dan motivasi belajar bahkan di VLE. Pendekatan ini mampu menciptakan pengalaman belajar yang lebih aktif, kolaboratif, dan bermakna, bahkan dalam situasi daring dan asinkron. Kolaborasi virtual dapat difasilitasi secara kreatif melalui struktur DT. Bahkan tanpa pertemuan fisik, proses DT tetap dapat dilakukan secara efektif dengan dukungan teknologi digital dan metode pembelajaran yang tepat.

Kata kunci : Design Thinking, Learning Technology, Virtual Learning Environments..

Abstract

The digital transformation in education has opened up new opportunities to create more interactive, personalized, and flexible learning experiences. One pedagogical model that is currently receiving attention is the Design Thinking (DT) approach. However, the virtual format itself has the potential to undermine one of the main principles of the DT model, namely the experience-based principle. As interest in the application of DT in virtual learning contexts increases, several studies have attempted to examine its effectiveness, learning outcomes, and barriers encountered. The results of a systematic literature review indicate that the application of the DT approach in a Virtual Learning Environment (VLE) is not only possible

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but also has the potential to accelerate the transformation of education towards a more collaborative, human-centered, and solution-oriented model. However, its success depends on technological readiness, facilitator capabilities, and pedagogical innovation. The results of a systematic literature review show that the DT approach is effective in increasing engagement and motivation to learn even in VLEs. This approach is able to create a more active, collaborative, and meaningful learning experience, even in online and asynchronous situations. Virtual collaboration can be creatively facilitated through the DT structure. Even without physical meetings, the DT process can still be carried out effectively with the support of digital technology and appropriate learning methods.

***Keywords**: Design Thinking, Learning Technology, Virtual Learning Environments.*

I. Introduction

The digital transformation in education has opened up new opportunities to create more interactive, personalized, and flexible learning experiences. Instructional issues faced by learner from ancient times to the modern era are obtained through observing various recent phenomena (Indrajit, Wibawa, and Suparman 2020). One pedagogical model that is gaining increasing attention in this context is Design Thinking (DT), an approach that focuses on a deep understanding of user (in this case, learner) needs, cross-disciplinary collaboration, and creative solutions based on prototyping and iteration. As learning moves to virtual spaces, both synchronously and asynchronously, there is an urgent need to evaluate how DT approaches can be effectively applied in such virtual environments. The DT process consists of different phases that are passed through sequentially, but iteratively. Referring to Lewrick, DT consists of six phases, namely: understanding, observing, determining perspective, ideation, prototyping, and testing. At the end of the cycle, Lewrick added “thinking” as one of his phases (Lewrick, Link, and Leifer 2018). One very popular framework is the framework from the Stanford d.school which combines the steps of the “understanding” and “observing” processes into “developing empathy” so that the Stanford d.school identifies five phases of DT: empathizing, defining, ideation, prototyping, and testing. There are also other simplified design thinking cycles such as in Global Information Technology at Kanazawa Technical Collage which simplifies the DT process into four phases, namely: empathy, analysis, prototype, and co-creation (Lewrick, Link, and Leifer 2018). In contrast to that, based on Meinel, DT has six phases, namely: understand, observe, point of view provides the basis for envisioning and evaluating possible solutions in the ideate, prototype and test activities (Meinel, Leifer, and Plattner 2011).

The use of information and communication technology has brought significant changes in the learning process. Many higher education institutions are now starting to take steps to fully utilize the learning potential of VLEs to encourage active student involvement in the learning process (Susilawati, Wibawa, and Situmorang 2024). Virtual learning environments (VLEs) have now become an integral part of modern educational practices, especially since the COVID-19 pandemic accelerated the adoption of online platforms for distance learning. VLEs can be understood by key stakeholders as “cloud learning environments” that provide valuable tools for them to

share information and learning materials, communicate, collaborate, and interact (Dayag and Faramarzi 2024). VLEs can be defined as immersive online learning environments that have a methodologically integrated learning system, providing open interactive dynamic learning processes in cyberspace using modern digital technologies that consider the individual educational characteristics of students, providing various functions for educators and learners (Dayag and Faramarzi 2024; Susilawati, Wibawa, and Situmorang 2024). In VLE, the online facilitator is described as the person responsible for responding to and guiding participants to complete the required tasks (Arifin, Wibawa, and Syahrial 2019). VLE development should emphasize that learner and course factors should be considered to build a learner-friendly online learning environment (Asip and Wibawa 2019).

In the context of virtual learning environments, DT promises to address challenges such as low student engagement, lack of collaboration, and gaps between teaching materials and real contexts, DT is expressed as a structured guide to help teachers integrate pedagogical knowledge and contextual issues, design practical and creative teaching activities, and increase their confidence in their teaching practice (Henriksen, Richardson, and Mehta 2017). However, the virtual format itself has the potential to undermine one of the main principles of the DT model, namely the experience-based principle (Minet et al. 2024). Effective DT processes rely on intensive and iterative interactions among end users, design thinkers, and other stakeholders. However, these interactions change fundamentally in virtual environments because participants are spatially separated and no longer interact face-to-face (Minet et al. 2024).

As interest in the application of DT in virtual learning contexts increases, several studies have attempted to evaluate its effectiveness, learning outcomes, and barriers encountered. However, there are not many comprehensive studies that systematically summarize the trends, impacts, and challenges of this model in virtual learning environments. Therefore, this systematic literature review aims to investigate how DT is applied in virtual learning environments, assess its effects on learning outcomes and participant engagement, and identify barriers and needs for future development.

The results of this study are expected to provide important contributions to the development of digital education theory and practice, especially in designing adaptive and inclusive DT-based learning models in the virtual era.

II. Method

The Systematic Literature Review (SLR) method was used in this study, which is a comprehensive and structured model used in academic and research environments to identify, assess, and synthesize relevant and existing research studies on a specific topic or research question that have been previously published (Page et al. 2021). esearch keywords are used to select appropriate literature sources to then be reviewed and identified in a structured manner according to the steps that have been set out in this Systematic Literature Review (SLR) method (van Dinter, Tekinerdogan, and Catal 2021). eporting of systematic reviews is considered to be biased and

interpretation of results tends to be subjective (Sinha and Montori 2006), herefore it is necessary to create Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to produce this systematic review (Moher et al. 2010).

Thome explains that there are three stages in the Systematic Literature Review method, namely: planning, implementation, and reporting (Thomé, Scavarda, and Scavarda 2016).

1. Planning. This stage involves determining the purpose of the literature review, developing a search protocol, selecting inclusion and exclusion criteria, and planning a data analysis strategy.
2. Implementation. At this stage, a search is conducted to identify studies that meet the established inclusion criteria. Then, quality assessment and data extraction from selected studies are conducted. The implementation stage is the implementation phase in SLR research. At this stage, the search for articles begins based on the criteria and relevance of keywords. The PRISMA model is used at this stage. This study utilizes the PoP application to search for relevant articles.
3. Reporting. The final stage is the preparation of a literature review report containing an explanation of the methodology used, findings, and interpretations and implications of the findings. The reporting stage is the final stage in the SLR method. At this stage, researchers document the results of the analysis and evaluation of the journal review in writing based on a predetermined format.

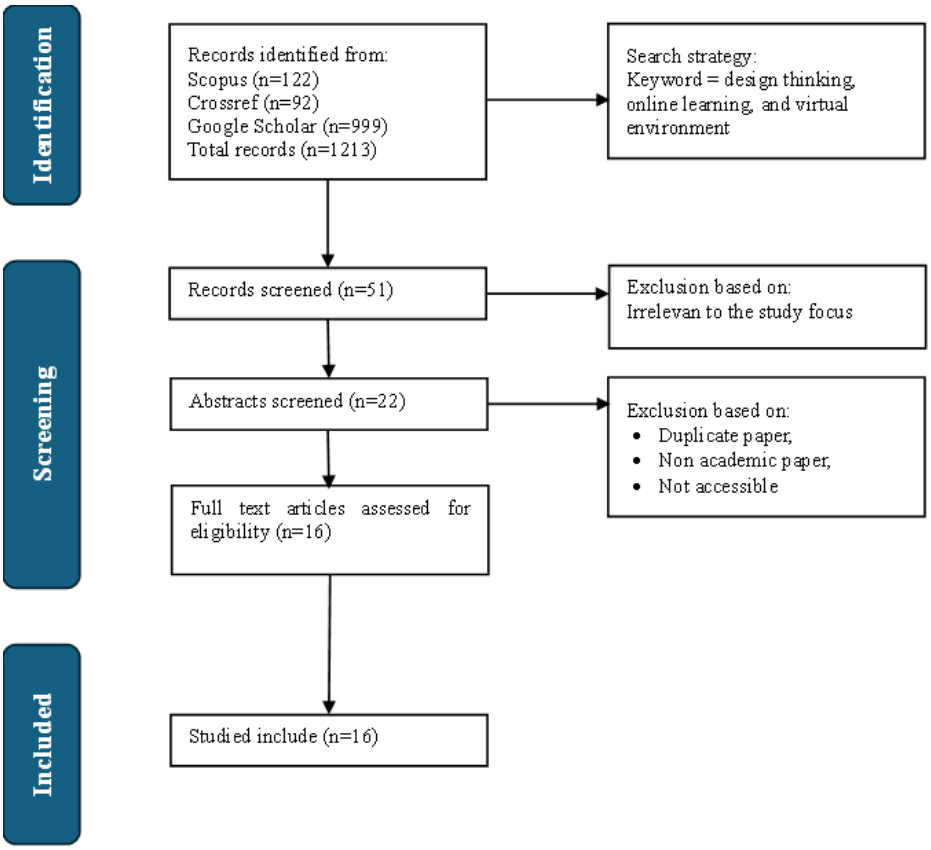

Figure 1. PRISMA Model for reduction articles

Based on the data taken from the systematic literature review, this study seeks to answer the following questions:

1. What is the trend of using design thinking approaches in virtual learning environments?
2. What are the design thinking processes used in virtual learning environments?
3. What is the impact of design thinking used in virtual learning environments?
4. What are the challenges of design thinking in virtual learning environments?

III. Result and Discussion

This section presents the findings based on each research question that has been previously proposed based on data from the literature review that has been obtained.

What is the trend of using design thinking approaches in virtual learning environments?

Based on the data from the literature review that has been obtained, we can see the trend of using the design thinking model in learning. There was an increase in the use of the design thinking model during the Covid-19 pandemic from 2021 to 2022, then there was a decline after the Covid-19 pandemic in 2022 and then there was an upward trend again in 2023 and 2024 (see Figure 2).

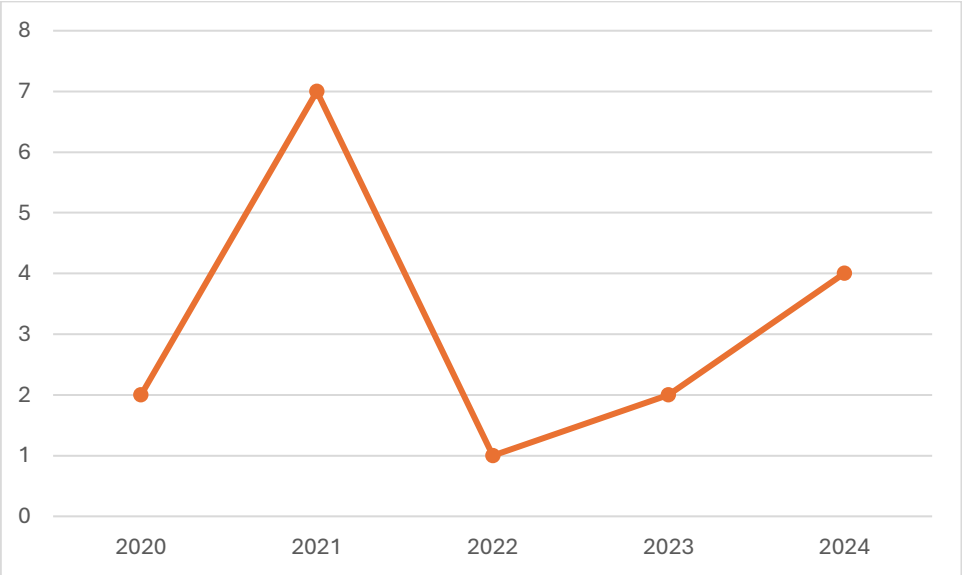

Figure 2. Trends in the use of design thinking models in virtual learning environments

Based on Figure 2 presented above, it can be seen that there is an increasing trend in the use of design thinking models in virtual learning environments from 2022 to 2024, and there is a possibility of an increase in the following years following the

increasing popularity of virtual learning environments (Dayag and Faramarzi 2024) and the great potential of virtual learning environments to overcome problems related to the lack of real classrooms.

Furthermore, if we look at the trend of using the design thinking model in virtual learning environments at the education level, based on data from the literature review, most of the use of the design thinking model in virtual learning environments is used at the higher education level. As much as 81.25% of the literature review data shows that the trend of using the DT approach in VLE occurs at the college level, as much as 18.75% at K-12. Furthermore, the trend of research approaches with the theme of using the DT approach in VLE is quite diverse, which can be seen in Table 1.

Table 1. Trends in education levels and research approaches in the use of DT approaches in VLEs

No.	*Author*	*Level*	*Research Approach*
1	L. Bader (Bader et al. 2020)	Higher Education	Exploratory qualitative
2	B. Perdana (Bosya Perdana and Tata Sutabri 2024)	Higher Education	Prototype-based design
3	J. Kim (Kim and Ryu 2023)	Higher Education	Quantitative comparative
4	J.M. Unger (Unger et al. 2021)	Higher Education	Descriptive case
5	A. Sriharan (Sriharan et al. 2021)	Higher Education	Participatory action
6	J.P. Stengel (Stengel, Jerpoth, and Yenkie 2021)	Higher Education	Quasi-experimental
7	M. Ivanova (Ivanova et al. 2024)	Higher Education	Descriptive qualitative
8	Y.A. Abdillah (Abdillah et al. 2024)	K-12	Design and development
9	A. Thakur (Thakur et al. 2021)	Higher Education	Descriptive narrative study
10	L. Severino (Severino et al. 2021)	K-12 (Preschool to Grade 2)	Iterative-based design
11	J. Huang (Huang et al. 2020)	Higher Education	Exploratory qualitative
12	M. Garcia-Vaquero (Garcia-Vaquero 2021)	Higher Education	Descriptive qualitative
13	G. Victorino (Victorino, Henriques, and Bandeira 2021)	Higher Education	Reflective narrative
14	S. Asai (ASAI, RAHMAWATI, and CHE HARUN 2023)	Higher Education	Collaborative case study

No.	Author	Level	Research Approach
15	A. Minet (Minet et al. 2024)	Higher Education	Qualitative study with in-depth interviews
16	C.G. Arbulú Pérez Vargas (Arbulú Pérez Vargas et al. 2022)	K-12	Project-based action study

When grouped based on research methods, research trends on the use of the DT approach in VLE can be seen in Figure 3.

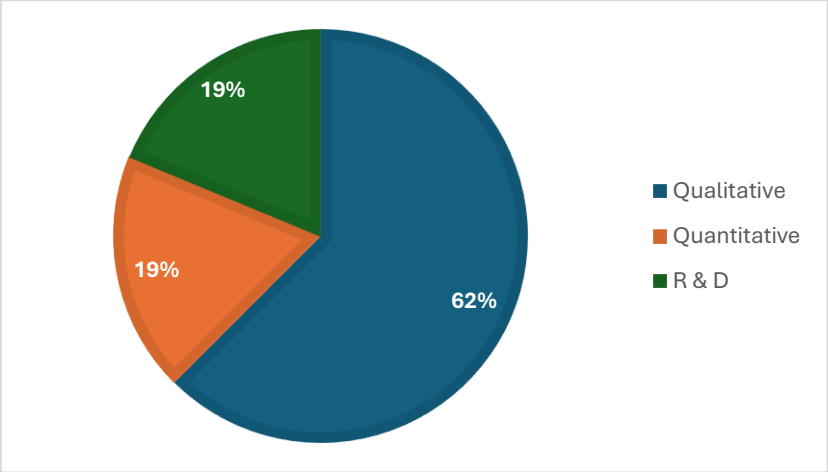

Figure 3. Research method trends in the use of DT approaches in VLEs

From Figure 3, research trends related to the use of the DT approach in VLE are mostly carried out using qualitative research methods. Based on data from the literature review that has been obtained, 62% use qualitative research, 19% use quantitative research, and 19% use research and development methods.

What are the design thinking processes used in virtual learning environments?

As explained earlier, there are many different processes related to the DT approach applied in VLEs. Some use four phases, five phases, or six phases with different process names. The DT process used, seen from the literature review data obtained, shows that these studies use a variety of different phases (see Table 2).

Table 2. DT processes used in VLEs

No.	Author	Design Thinking Process
1	L. Bader (Bader et al. 2020)	*Introduction of Round-Hypothesis Matrix-Persona in Context-Point of View-Brainwriting and Share.*
2	B. Perdana (Bosya Perdana and Tata Sutabri 2024)	*Empathize-Define-Ideate-Prototype-Test.*
3	J. Kim (Kim and Ryu 2023)	*Empathize-Define-Ideate-Prototype-Test.*

No.	*Author*	*Design Thinking Process*
4	J.M. Unger (Unger et al. 2021)	*Empathize-Define-Ideate-Prototype-Test.*
5	A. Sriharan (Sriharan et al. 2021)	*Empathize-Ideate-Prototype-Test.*
6	J.P. Stengel (Stengel, Jerpoth, and Yenkie 2021)	*Empathize-Define-Ideate-Prototype-Test.*
7	M. Ivanova (Ivanova et al. 2024)	*Discover-Define-Develop-Deliver.*
8	Y.A. Abdillah (Abdillah et al. 2024)	*Empathize-Define-Ideate-Prototype-Test.*
9	A. Thakur (Thakur et al. 2021)	*Empathize-Define-Ideate-Prototype-Test.*
10	L. Severino (Severino et al. 2021)	*Discover-Interpretation-Ideation-Experimentation-Implementation-Evolution.*
11	J. Huang (Huang et al. 2020)	*Empathize-Define-Ideate-Prototype-Test.*
12	M. Garcia-Vaquero (Garcia-Vaquero 2021)	*Empathize-Define-Ideate-Prototype-Test-Assess.*
13	G. Victorino (Victorino, Henriques, and Bandeira 2021)	*Group Formation-Inspire-Ideate-Implement-Final Pitch.*
14	S. Asai (ASAI, RAHMAWATI, and CHE HARUN 2023)	*Empathize-Define-Ideate-Prototype-Test.*
15	A. Minet (Minet et al. 2024)	*Empathize-Define-Ideate-Prototype-Test.*
16	C.G. Arbulú Pérez Vargas (Arbulú Pérez Vargas et al. 2022)	*Discover-Interpretation-Ideation-Experimentation-Evolution.*

Table 2 shows that 56.25% of the study data used the commonly used five-phase DT process, namely Empathize, Define, Ideate, Prototype, Test, one study used development with the addition of an Assess phase at the end of the process (Garcia-Vaquero 2021). The DT process with the Discover-Interpretation-Ideation-Experimentation-Evolution phase was found in two studies conducted in K-12, one study in Secondary School (Arbulú Pérez Vargas et al. 2022), and one study in Elementary Education (Preschool to Grade 2) with the addition of an Implementation phase after the Experimentation phase (Severino et al. 2021). The DT process with five different phases was found in a study conducted by Bader with the Introduction Round, Hypothesis Matrix, Persona in Context, Point of View, Brainwriting and Share phases that explored the experience of transforming the DT approach to a virtual environment through three virtual workshops (Bader et al. 2020), as well as a study conducted by G. Victorino with the Group Formation, Inspire, Ideate, Implement, Final Pitch phases that explored the experience of teaching DT online during the pandemic (Victorino, Henriques, and Bandeira 2021). There is one study that uses four phases in the DT process, namely Discover, Define, Develop, Deliver, conducted by M.

Ivanova, which explores interdisciplinary collaboration in virtual teaching using DT (Ivanova et al. 2024).

What is the impact of design thinking used in virtual learning environments?

Based on data taken from a systematic literature review, several impacts of using the DT approach in VLE are compiled as follows.

- Enhancing creativity, collaboration, innovation and problem solving despite virtual limitations

  The DT approach has encouraged creativity specifically for fulfilling design competencies and building technological solutions to solve problems (Arbulú Pérez Vargas et al. 2022), able to increase the adaptability of participants in virtual work and learning environments and strengthen creativity and digital collaboration (Bader et al. 2020). The DT approach in VLE also strengthens cross-cultural collaboration and encourages innovation (Unger et al. 2021). DT offers creative and innovative solutions to various complex problems that arise (Thakur et al. 2021), problem solving and prototyping within the design thinking framework are fresh and meaningful experiences for participants (Asai, Rahmawati, and Che Harun 2023). The results of the study indicate that the application of the DT approach can increase creativity and collaboration despite virtual limitations that have the potential to damage one of the main principles of the DT model, namely the experience-based principle. The DT approach can be transferred to a virtual context and can be an alternative especially if it is not possible to carry out direct face-to-face classes (Bader et al. 2020), although the study concluded that the experimental spirit showed more significant development in offline courses (Kim and Ryu 2023).

- Strengthen empathy and open thinking

  In the empathize phase, DT aims to develop a deep understanding of the latent needs of users. This understanding often requires the use of qualitative ethnographic research methods that allow design thinkers to observe users in their natural environment and fully immerse themselves in their experiences and perspectives. Therefore, this phase emphasizes the importance of embracing an open, curious, and empathetic mindset (Brown 2008). In particular, the application of the DT approach to synchronous online classes has been shown to be more effective in fostering empathy, integrative thinking, and open-mindedness (Kim and Ryu 2023). This proves that DT can strengthen students' empathy and open-mindedness even though learning is carried out in a VLE.

- Pedagogical transformation towards active, reflective, and student-centered learning

  Interpersonal skills (communication, empathy, and leadership skills) of learners are further developed through student-focused “active learning” implemented in

DT (Garcia-Vaquero 2021). The DT approach in VLE allows students to learn flexibly and enhance their cognitive abilities through online methods (Abdillah et al. 2024). The process of working with digital platforms for virtual collaboration gives students more freedom and responsibility in their personal workflow, especially in working with volunteers and teamwork (Ivanova et al. 2024), which can develop learning towards active, reflective, and student-centered learning.

- Adaptation of learning methods to technological advances
  Learning using the DT approach that has been successfully applied in several studies can improve the adaptation of learning methods to technological advances. Educators and learning designers can analyze several methods that can be used in VLE. Some learning methods may be suitable for application in VLE, and some may not. Rapid technological developments require rapid adaptation of learning methods, perhaps even with some adjustments or changes to learning methods. Therefore, researchers are encouraged to conduct research related to this.

What are the challenges of design thinking in virtual learning environments?

Based on data from the literature review that has been obtained, there are several things that are challenges in using the DT approach in VLE, namely: (1) **lack of interaction**, lack of physical and social interaction can hinder collaboration, comfort in learning, and empathy between participants (van Dinter, Tekinerdogan, and Catal 2021; Sinha and Montori 2006; Thakur et al. 2021), especially if the class is created in an asynchronous environment that causes limitations in real-time interaction (Moher et al. 2010; Stengel, Jerpoth, and Yenkie 2021); (2) **limitations in direct experiments and access to important resources** can be further challenges, especially in courses that require the use of physical laboratories to conduct direct testing (O'Leary 2004; Bosya Perdana and Tata Sutabri 2024; Ivanova et al. 2024; Abdillah et al. 2024; Huang et al. 2020); (3) **differences in culture, communication, and time zones** are challenges for global/international courses that can affect the effectiveness of collaboration in multicultural online learning (Thomé, Scavarda, and Scavarda 2016; Severino et al. 2021); and (4) **limited access to technology and the digital divide** can also affect participation in the DT process (Thakur et al. 2021). Not all students have the same quality of devices and networks which allow for unequal access to learning.

IV. Conclusion

The results of a systematic literature review show that the DT approach is effective in increasing engagement and motivation to learn even in VLEs. This approach is able to create a more active, collaborative, and meaningful learning experience, even in online and asynchronous situations. Virtual collaboration can be creatively facilitated through the DT structure. Even without physical meetings, the DT process can still be

carried out effectively with the support of digital technology and appropriate learning methods. The main challenges lie in the limitations of direct interaction, direct experimentation, technological barriers, and the digital divide. This is especially evident in higher education and cross-cultural contexts, where differences in time zones, device availability, and internet access can be barriers. The application of the Design Thinking approach in Virtual Learning Environments is not only possible but also has the potential to accelerate the transformation of education towards a more collaborative, human-centered, and solution-oriented model. However, its success depends on technological readiness, facilitator capabilities, and pedagogical innovation.

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