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Original Article

Optimizing Nursing Education: The Integration of Design Thinking into Problem-Based Learning and Its Effects on Students' Learning Motivation and Satisfaction

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Purpose: The pedagogical paradigms of Design Thinking and Problem-Based Learning (PBL) advocate for learner-centric educational strategies, underpinning an emphasis on the execution of problem-solving methodologies. Specifically, these techniques enable students to cultivate capabilities in critical analysis, effective communication, and innovative ideation under the tutelage and facilitation of instructors. Moreover, the engagement of peer interactions, the dissemination of knowledge, and the practice of collaborative dynamics enhance the inspiration for learning. On the other hand, design thinking can foster creativity and innovation, encouraging students to approach problems from various perspectives, thereby promoting a more comprehensive understanding of the subject matter. This research seeks to investigate the potential implications of incorporating Design Thinking into PBL teaching methodologies on student engagement and gratification.

Methods: A quasi-experimental research model was utilized in this study. The experimental and control cohorts were students enrolled in the first and second semesters of the "Maternal Health Nursing" PBL course in 2021. An instructional approach combining PBL with Design Thinking was adopted for the experimental assemblage, while the control group's traditional PBL methodology was maintained. The tools for evaluation incorporated a learning motivation scale and a course satisfaction questionnaire administered pre and post-intervention, along with focus group interviews to evaluate learning outcomes.

Results: The research findings advocate that the amalgamation of Design Thinking within PBL instruction can enhance students' learning motivation and satisfaction. The results suggest that students' motivation in learning experiences notably improves when Design Thinking is integrated into the traditional PBL structure of the course.

Conclusion: The research highlights how this innovative approach can notably boost students' motivation and tap into their vast capabilities. Moreover, it recommends incorporating contingency plans for online instruction during the course planning stage, reflecting the dynamic nature of educational settings.

Keywords: PBL, design thinking, learning motivation, learning satisfaction, nursing students

1. Introduction

Problem-Based Learning (PBL) is defined as the acquisition of knowledge emanating from endeavoring to comprehend or resolve a problem (1). The origins of PBL are attributed to the pedagogical theories of John Dewey, who advocated for an adaptive learning content approach, facilitating

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students' learning through experiential and cognitive activities. Such an approach was envisioned to foster student curiosity, propelling exploration and creation.(2) Dr. Howard Barrows later advanced the idea that PBL empowers students to employ objective reasoning abilities to identify learning requirements when confronted with challenges (3, 4). Consequently, newly acquired knowledge is utilized to address these challenges. PBL is thus perceived as a student-centric, self-guided learning approach and a manifestation of constructivist learning(5). PBL teaching promotes an open, reflective, critical, and active learning approach, typically characterized by four attributes(6). It is posited that PBL could enhance the education of nursing students by enabling the application of theoretical knowledge to clinical practice, thereby fostering problem-solving skills and the ability to surmount clinical challenges (7). PBL stands as a pivotal pedagogical tool in fostering and refining professional skills integral to nursing, such as autonomous learning and collaborative learning(8). Nevertheless, extant research reveals discrepancies concerning students' satisfaction with PBL and the efficacy of the PBL approach (9-11).

On the other hand, Design Thinking (DT) is a human-centered, problem-solving methodology widely acknowledged across numerous disciplines, including higher education (12, 13). It emphasizes empathy, ideation, prototyping, and iterative problem-solving, providing a structured framework for understanding and addressing complex issues(14, 15).

Considering the multifaceted nature of knowledge and the ever-evolving complexity of clinical environments, it is imperative for students to engage in perpetual learning to keep pace with prevailing societal trends. When applied to a Problem-Based Learning (PBL) course, DT can offer a variety of benefits. The synergy of DT and PBL can enhance student engagement and facilitate a deeper understanding of the problem at hand(16). The focus of DT on empathizing and understanding user needs aligns well with PBL's student-centric approach, encouraging students to view problems from different perspectives and develop comprehensive, user-centric solutions(17, 18). Furthermore, the iterative nature of DT's process encourages students to prototype and refine their solutions continuously, fostering resilience and adaptability in the face of challenges(19). By emphasizing creativity and innovative thinking, DT can also foster a culture of curiosity and risk-taking within the PBL classroom, which can lead to more novel and effective solutions to problems (20). Therefore, integrating DT into PBL courses holds significant promise for enhancing student learning experiences and outcomes.

Given the potential benefits and growing interest in the amalgamation of Design Thinking (DT) and Problem-Based Learning (PBL), it becomes imperative to delve deeper into its impact within an educational setting. While PBL has been lauded for fostering student autonomy and DT for promoting creative problem-solving, the intersection of these two methodologies remains relatively unexplored. To this end, this study aims to empirically assess the effects of integrating DT into a PBL course, specifically regarding students' motivation and learning outcomes. It is critical to illuminate these areas as it can provide educators and institutions valuable insights about incorporating such an approach in their curricula, potentially leading to enhanced student engagement and educational outcomes.

Consequently, the objectives of our study are:
(1) To investigate whether the incorporation of Design Thinking into a PBL course influences student motivation for learning.
(2) To evaluate the effects of infusing Design Thinking into PBL instruction on the learning outcomes of students.

Literature

In the traditional PBL approach, the emphasis is on autonomous, student-centric learning. Within teacher-provided scenarios, students independently formulate queries for group discussion, which subsequently inform the group's consensus on learning objectives and methodologies, as well as potential solutions (1, 11, 21). The PBL model perceives teachers as facilitators rather than instructors, guiding students towards reflective learning post-session, and assisting in evaluating learning outcomes (3, 21).

Contrastingly, Design Thinking (DT) is a widely recognized approach for resolving complex problems

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across multiple disciplines, including higher education. Bruce Archer (1979) contended that "there exists a designerly way of thinking and communicating that is both different from scientific and scholarly ways of thinking and communication, and as powerful as scientific and scholarly methods of inquiry"(22) . Recently, Design Thinking has been deployed in healthcare to enhance patient experiences, clinical outcomes, and healthcare spending (23, 24). The integration of Design Thinking (DT) and Problem-Based Learning (PBL) within medical and nursing education is a burgeoning area of interest, offering a timely opportunity for further exploration. Both these approaches aim to resolve complex problems, but they differ in their methodologies.

PBL places emphasis on autonomous, student-centric learning. In PBL, students independently formulate queries within teacher-provided scenarios, leading to group discussions that guide the consensus on learning objectives, methodologies, and potential solutions (1, 11, 12). This model perceives teachers as facilitators rather than instructors, steering students towards reflective learning post-session and assisting in the evaluation of learning outcomes (3, 12).

On the other hand, DT, which Bruce Archer (1979) deemed a powerful inquiry method distinct from scientific and scholarly methods, is widely recognized across higher education and other disciplines for resolving complex problems (13). Recently, it has been deployed in healthcare to enhance patient experiences, clinical outcomes, and healthcare spending (14, 15).

The convergence of DT and PBL has become a promising educational strategy within the healthcare field. This innovative blend combines DT's emphasis on empathy, ideation, and iterative problem-solving with PBL's student-centric approach, which enhances students' abilities to think critically and devise innovative solutions for complex healthcare problems. Several studies have highlighted the effectiveness of this combined approach in different disciplines (25-28). For example, in their 2021 study, Archarya et al. demonstrated that the application of PBL+DT method effectively enhanced participants' problem-solving capabilities, augmented student motivation, and fostered superior collaboration and communication (27). Additional research in the field of engineering education has likewise indicated that combining Design Thinking and Problem-Based Learning can enhance cognitive learning domains, thereby empowering students to more effectively address complex engineering challenges in societal and environmental contexts (25). However, the synergy between Problem-Based Learning (PBL) and Design Thinking in the context of nursing education or medical education is an area that remains relatively underexplored in the existing body of research. Despite the increasing recognition of both PBL and Design Thinking as effective pedagogical approaches, their convergence as a combined educational strategy within the healthcare field has yet to be extensively investigated.

While there might be some individual studies that touch upon either PBL or Design Thinking within healthcare education, a comprehensive examination of the interplay between these two methodologies is still lacking. As nursing and medical education continue to evolve, there is a growing interest in fostering critical thinking, empathy, and innovative problem-solving skills in future healthcare professionals.

2. Methods

2.1. Study design

This research employs a quasi-experimental design involving four control groups and four experimental groups, with the objective of assessing changes in nursing students' learning motivation, satisfaction, and learning outcomes.

2.2. Participants

The study participants comprised third-year nursing students enrolled in the "Maternal Health Nursing" course. The sample, constituting 96 students distributed across two classes spanning two semesters in the 2021 academic year, was recruited for this quasi-experimental study. The study was endorsed by the Institutional Review Board (IRB) of Chung-Shan Medical University, Taiwan (IRB: CS2-21141). Participants were informed that their involvement in this study was entirely elective. Moreover, they were thoroughly educated on their rights and protections as subjects in this research. Those students who voluntarily chose to participate

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provided their agreement through written consent.

2.3. Measurements

Assessment of learning motivation was conducted using the modified Motivated Strategies for Learning Questionnaire (MSLQ), originally developed by Pintrich, Smith, Garcia, and McKeachie(29, 30). The Motivated Strategies for Learning Questionnaire (MSLQ) comprises 17 items, which are divided into two distinct domains: value and expectation. In addition, the instruments utilized to measure students' learning outcomes were the learning satisfaction scale and the teaching evaluation satisfaction scale, both of which were developed and administered by the academic institution that served as the venue for this study. Table 1 delineates the specific items incorporated within the Motivated Strategies for Learning Questionnaire (MSLQ) and the Learning Outcome Scale, which includes both the Satisfaction Scale and the Teaching Evaluation Satisfaction Scale). To evaluate changes in their motivation following the PBL sessions, all participants were required to complete a motivation survey both pre- and post-session. Learning satisfaction was measured once after the completion of the course. In an effort to augment the quantitative findings, we executed focus group interviews aimed at extracting in-depth insights into the students' learning experiences. A semi-structured interview guide was constructed to

Table 1. The modified MSLQ items:

Dimensions	Number of items	Items indicators
Motivation	17	Expectation + Value
Value	9	◆ Negative attitude toward the course. ◆ Preference for taking a challenging course. ◆ More interested in taking courses that satisfy one's curiosity. ◆ Satisfied with the grade earned. ◆ Prove one's ability to peers. ◆ Care about getting good grades. ◆ Learning what is taught in class. ◆ Applying what is learned to other courses.
Expectation	8	◆ Unable to apply what is learned in life. ◆ I will learn the course easily if I know how to study. ◆ I learn the course well because of hard work. ◆ Getting a poor grade is mostly due to poorly written test items. ◆ I feel confident to master the simple concepts of the course. ◆ I feel confident to understand the more difficult content. ◆ I feel confident to do well on assignments and tests. ◆ I feel unable to use new skills well. ◆ I believe I can get a good grade.
Satisfaction	15	Teaching + Learning Satisfaction
Teaching	8	◆ Satisfaction with the instructor's teaching attitude. ◆ Satisfaction with the instructor-student interaction. ◆ Satisfaction with an understanding of the course content. ◆ Satisfaction with the perceived respect. ◆ Satisfaction with the instructor's care about students' learning progress. ◆ Instructor's overall guidance. ◆ The richness of learning contents. ◆ Overall satisfaction toward the PBL class.
Learning	7	◆ Knowledge gained for work. ◆ Improvement of self-learning methods. ◆ Increase interest in learning. ◆ Perceived learning outcome of the PBL course. ◆ Make like-minded friends in the PBL class. ◆ Ability to deal with individual differences among peers. ◆ Interpersonal skills developed in the PBL class.

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facilitate the students in recounting their learning progression during the Problem-Based Learning (PBL) sessions.

2.4. Procedure

Within the Maternal Health Nursing course, two PBL cases were administered. For the initial PBL case, the experimental groups were subject to the DT-PBL methodology, whereas the control groups experienced the traditional PBL methodology.

The instructors for the experimental groups included the primary investigator and another senior nursing instructor, both of whom had completed extensive training in PBL and had prior experience in implementing DT pedagogy before the study's initiation. Prior to the initial session, the investigator and the instructor of the experimental group jointly discussed and integrated design thinking into the PBL case. In the control group, the instructors were experienced nursing educators with 4 and 15 years of PBL teaching experience, respectively. The Motivated Strategies for Learning Questionnaire (MSLQ) scale was employed to evaluate the students' motivation towards PBL before the first PBL discussion. And upon completion of the course, students' learning motivation and satisfaction were assessed utilizing the MSLQ scale and the satisfaction scale. Concurrently, focus group discussions were initiated as a part of the study. A convenience sampling method was employed, drawing participants from each class. This culminated in a total of 20 students actively participating in these focus group discussions. All interactions were recorded, subject to participants' consent, with each interview session enduring approximately 30 to 60 minutes.

2.5. Statistical analysis

We utilized descriptive and inferential statistical methods to analyze the data. We employed independent sample t-tests to examine the significance of differences between the experimental (DT-PBL) and control groups for continuous variables, while paired sample t-tests were used to analyze pre- and post-test scores within each group. All statistical tests were confirmed to meet their assumptions and analyses were conducted using SPSS 22.0 software.

3. Results and discussion

The majority of the students were females, accounting for 74% (n = 96), and were within the age bracket of 20–22 years old. This demographic composition aligns with the prevalent profile of nursing students at the university under study (Table 2).

3.1. Learning Motivation:

The findings from this study underscore the notable effect of integrating Design Thinking into Problem-Based Learning curricula on students' learning motivation. Specifically, the data indicates a discernible enhancement in the motivational aspects of students' learning experiences when the course incorporated Design Thinking into its traditional PBL structure.

The quantitative analysis of pre- and post-test scores (Table 3), derived from the Motivated Strategies for Learning Questionnaire (MSLQ), revealed a statistically significant increase in motivation scores for students in the experimental group exposed to the DT-PBL methodology compared to their counterparts in the control group utilizing traditional PBL techniques. While the control group, educated via traditional PBL, demonstrated an increase in motivation, the increase was not statistically significant. Interestingly, when we individually examine each component of motivation - value and expectation - both show a significant

Table 2.

N=96	N	%
Gender		
Female	71	74
Male	25	26
Age		
<20	0	
20-21	93	96.8
>21	3	3.1
Control Group	48	50
Experimental Group	48	50

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Table 3. Learning Motivation

Variable	Control Group			Experimental Group		
	Pre-test (N=48)	Post-test (N=48)	Statistical analysis	Pre-test (N=48)	Post-test (N=48)	Statistical analysis
	$\overline{X}$ ± S.D.	$\overline{X}$ ± S.D.	*p*			*p*
Learning Motivation	60.96 ± 4.09	61.31 ± 3.74	.296	59.51 ± 4.45	60.55 ± 4.82	.000***
Value	33.18 ± 2.71	32.55 ± 2.32	.017*	31.10 ± 2.66	32.02 ± 3.07	.001***
Expectation	27.78 ± 2.66	28.76 ± 2.50	.001*	25.47 ± 2.61	28.57 ± 2.53	.000***

* $p<0.05$; ** $p<0.01$; ***$p<0.001$

increase in scores. This suggests that the traditional PBL approach does impact certain aspects of student motivation positively. However, compared to this, our experimental group, which was taught using an integrated Design Thinking and PBL approach, showed a statistically significant increase in overall motivation. This demonstrates the added benefit of integrating Design Thinking into PBL in enhancing not only specific aspects of motivation but the overall motivational drive of students. These results, thus, lend support to the idea that a pedagogical approach combining Design Thinking with PBL can effectively stimulate student motivation to learn. This elevated motivation likely stems from the DT-PBL method's emphasis on critical thinking, creative problem solving, and collaborative work, all of which resonate with students' intrinsic interest in the subject matter and foster active engagement in the learning process. Furthermore, the integration of Design Thinking encourages students to view problems from multiple perspectives, empathize with various stakeholders, and innovate solutions - elements that promote a sense of purpose, autonomy, and mastery, all of which are key determinants of motivation as per Self-Determination Theory. In sum, the evidence suggests that embedding Design Thinking into PBL curricula may be an effective strategy for enhancing learning motivation among students.

3.2. Learning Satisfaction:

The study's findings also highlight the impact of intertwining Design Thinking into Problem-Based Learning courses on students' learning satisfaction. Notably, the data illustrated a substantial augmentation in the level of satisfaction reported by students when Design Thinking was incorporated into the standard PBL framework (Table 4).

Quantitative assessments, drawing from the institutional learning satisfaction scale and teaching evaluation satisfaction scale, yielded a statistically significant increase in satisfaction scores for students in the experimental group who experienced the DT-PBL approach, in contrast to the control group engaging in conventional PBL techniques.

However, it was noted that the control group,

Table 4. Learning Satisfaction

Variable	Control Group			Experimental Group		
	Pre-test (N=48)	Post-test (N=48)	Statistical analysis	Pre-test (N=48)	Post-test (N=48)	Statistical analysis
	$\overline{X}$ ± S.D.	$\overline{X}$ ± S.D.	*p*	$\overline{X}$ ± S.D.	$\overline{X}$ ± S.D.	
Learning Satisfaction	61.3 ± 9.7	66.2 ± 6.9	.020*	60.2 ± 10.9	70.5 ± 6.3	.000***
Teaching	35.5 ± 5.2	37.4 ± 3.5	.027*	32.4 ± 6.1	38.0 ± 3.4	.000***
Learning	29.8 ± 4.8	31.8 ± 3.9	.022*	27.2 ± 5.2	32.5 ± 3.9	.000***

* $p<0.05$; ** $p<0.01$; ***$p<0.001$

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which was taught through the traditional Problem-Based Learning (PBL) method, showed a significant increase in learning satisfaction. This demonstrates the effectiveness of the conventional PBL approach in enhancing student satisfaction. However, when compared to the experimental group, where the Design Thinking approach was integrated with PBL, the increase in satisfaction was smaller. Despite the proven effectiveness of traditional PBL methods, the integration of Design Thinking appears to provide an additional boost to learning satisfaction, indicating its potential value in the learning environment.

This heightened sense of satisfaction could be attributed to several factors inherent to the DT-PBL methodology. Firstly, by encouraging critical thinking, creativity, and collaboration, this approach more fully engages students in their learning process, thereby enhancing their enjoyment and satisfaction.

Secondly, Design Thinking cultivates empathy and a human-centered perspective, which allows students to perceive the direct, real-world implications of their learning, enhancing the relevance and meaningfulness of their education, thus increasing their satisfaction.

Thirdly, the problem-solving framework of Design Thinking, characterized by understanding, ideation, prototyping, and testing, offers students a clear structure to navigate complex problems, reducing anxiety and frustration often associated with ambiguous tasks, and thereby boosting their satisfaction.

Lastly, the iterative nature of Design Thinking, where feedback is constantly sought and incorporated, creates an environment where failure is seen as an opportunity for learning and improvement, rather than a deterrent. This shift in perspective, away from the fear of failure towards embracing learning opportunities, can significantly enhance students' satisfaction with their learning experience.

In essence, the evidence suggests that the infusion of Design Thinking into PBL curricula could be a beneficial strategy to improve learning satisfaction among students.

4. Discussion

During the experimental group's PBL discourse, educators utilized strategies and tools from the design thinking paradigm, aiding students in formulating a more comprehensive understanding of the client's needs and enabling the creation of lesson plans tailored more specifically to the client's requirements. This pedagogical approach appeared to resonate more deeply with the students compared to traditional information dissemination and discussion. It offered a nuanced understanding of the unique personas involved in clinical cases, going beyond the impersonal reading of patient descriptions in textbooks, thereby fostering a more profound connection to the learning material (23, 24, 31).

The study demonstrated that integrating design thinking into PBL significantly elevated students' learning motivation compared to conventional PBL. This finding indicates the potential for design thinking, alongside other innovative teaching strategies, to enhance other PBL curricula in the future. This is particularly pertinent during circumstances such as the COVID-19 pandemic, where a shift towards online teaching potentially attenuated student motivation (32, 33).

Comparative analyses of pre-test and post-test results, supplemented by qualitative student feedback, indicated significant differences in learning outcomes when employing design thinking in tandem with PBL. However, it should be noted that PBL courses represent a fraction of the overall curriculum. Future research might explore the benefits of innovative teaching strategies in other, non-PBL courses, for a more comprehensive understanding of their impact.

Student Feedback and Implications

The students' feedback was overwhelmingly positive towards the innovative pedagogy, and their engagement during PBL discussions bolstered the instructors' motivation for further course reforms. The students' openness towards, and appreciation of, these innovative approaches have not only contributed to the enhancement of the course but have also fueled my personal growth as an educator.

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A majority of students expressed favorable perspectives toward the novel PBL model (design thinking PBL). They reported diminished learning pressure and considered the new approach more engaging than traditional PBL. Overall, the students exhibited positive attitudes towards learning motivation and satisfaction resulting from the integrated teaching method. A minority of students indicated a perceived lack of depth in the discussions, suggesting that individuals could strive for more comprehensive engagement in the discussions, data organization, and analysis. Future iterations of the course should address these constructive criticisms to further improve the learning experience.

Due to the COVID-19 pandemic, a transition to online PBL was necessitated for lesson plan 1 in the first semester. Fortunately, the discussions were unaffected and the lessons were successfully completed. Students did not report any issues with the online PBL format, demonstrating the resilience and adaptability of the PBL approach in a remote learning context.

Generalizability of the study: As to the potential generalizability of our study results, our research was conducted in a diverse classroom setting, which parallels the diversity observed in many learning environments. Therefore, the results regarding the impact of design thinking integrated into PBL could likely be replicated in other similarly diverse environments. In addition, the design thinking principles and PBL practices that we incorporated into our intervention are not specific to a particular subject or discipline. They are versatile strategies that can be adapted and applied across a variety of academic fields. Hence, the benefits observed in our study could potentially extend to different disciplines that adopt a similar approach to integrating design thinking into PBL. Furthermore, the specific learning outcomes we focused on, such as problem-solving skills, creativity, collaboration, and self-directed learning, are universally desired outcomes in education. As such, improvements in these areas as a result of the design thinking and PBL intervention are of wide interest and relevance to educators in many contexts.

Limitations: In our quasi-experimental study on the Design Thinking and Problem-Based Learning (DT-PBL) course, there are several limitations to consider. First, the non-randomized assignment of participants to the control and treatment groups could have introduced selection bias, limiting the ability to establish causal relationships between the DT-PBL intervention and observed outcomes. Additionally, inherent differences in the groups that were not accounted for might have influenced the results. Second, the study was conducted in a specific context, and thus, its results might not be generalizable to other settings or populations. Also, given that DT-PBL courses can vary in their structure and implementation, the results may not apply to all PBL courses. Third, the quasi-experimental design itself lacks the full control of a true experimental design, which might introduce confounding variables affecting the validity of the findings. Lastly, we relied on self-reported measures for some data, which can be subject to response bias, potentially impacting the reliability of our results. Despite these limitations, the study provides valuable insights into the effectiveness of PBL courses, laying a foundation for future research in this area.

Strength of the study: This design enabled us to examine the impact of integrating design thinking into PBL courses in a real-world educational setting, which significantly boosts the ecological validity of our research findings. In addition, the quasi-experimental design provided us with the flexibility to implement and assess the PBL course in a manner that closely mirrors how it would be typically taught, allowing us to capture the natural interplay of variables within the educational context. This is crucial as it mirrors the complexities of real-life learning situations, providing insights that are directly relevant and applicable to practitioners. Furthermore, our approach enabled us to gather robust data on the effectiveness of integrating design thinking into PBL courses, creating a strong basis for further, more controlled studies. Even though we couldn't control every variable as in a true experiment, the design allowed us to identify trends, relationships, and potential causal connections, which are invaluable in contributing to the field's

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understanding of effective PBL practices.

5. Conclusions

In summation, the vast majority of students expressed favorable sentiments toward the fusion of design thinking with PBL pedagogy. The study results underscore that innovative teaching strategies can significantly augment students' motivation, thereby unlocking their immense potential. Additionally, this research suggests that the incorporation of contingency plans for online instruction is advisable during the course planning phase in response to the changing landscape of educational environments.

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