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Constructing a Relationship Model of Influencing Factors to Optimize the Implementation of Blended Learning: An Exploratory Sequential Design

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ABSTRACT

Objective: During the COVID-19 pandemic, Chinese secondary schools embraced the practice of blended learning (BL) on a large scale. Although secondary school teachers are aware of BL's potential benefits in improving student-learning outcomes, its implementation remains challenging. Thus, the prime objective of the study analyzed the factors influencing Chinese secondary school teachers' BL implementation using an exploratory sequential design. **Method:** The study has employed mixed method in the qualitative phase, 13 secondary school teachers participated in the interviews. A thematic analysis was conducted to identify seven influencing factors and generate one relationship model. In the quantitative phase, the qualitative results were validated by 365 primary and secondary school teachers who participated in the 2020 Information Technology Upgrade Project 2.0 (ITU2.0). **Results:** The results are as follows: student ability, teaching resources, and BL curriculum positively affected workload; teaching resources positively affected student ability; teaching resources and student ability positively affected teacher-student interaction; teaching ability, student ability, and teacher-student interactive behavior directly influenced teacher motivation; teaching ability affected BL curriculum design; and teacher-student interactive behavior positively affected teaching ability. **Implications:** The results provide insights into the factors influencing secondary school teachers' BL implementation; Chinese educational and school administrators can use the findings to promote BL development in secondary schools and policy formulation. **Novelty:** The study is among the pioneer on the issues related to Implementation of Blended Learning.

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1. Introduction

With the development of education informatization, blended learning (BL), as a teaching and learning model that integrates face-to-face teaching and virtual lectures (Al-Ayed & Al-Tit, 2021), has become one of the latest concepts in technology-supported teaching and learning processes (Al-Salman & Haider, 2021). In China, BL research has particularly maintained continuous momentum (An et al., 2021). Chinese educational authorities issued a series of documents in as early as 2012 to facilitate the creation of a smart educational environment and promote the widespread use of new learning methods, such as flipped classrooms and MOOC courses in the education domain (Andujar & Nadif, 2022). Given the aid of government promotion, BL has been used as an effective model to integrate emerging technologies and curricula and to improve the quality of education in universities and colleges in China (Anthony et al., 2022). During the COVID-19 pandemic, online teaching and learning have become important initiatives to ensure educational instruction, and BL has reached the enormous scale of educational practice in Chinese secondary schools. According to the China Education Research Network, during the pandemic, more than 78% of students were satisfied with teachers' attitudes toward online teaching and the level and effectiveness of online teaching in primary and secondary schools in Guangdong Province, China. Moreover, over 64% of the students were satisfied with the content of online learning resources, learning platforms, classroom recording methods, and classroom live-streaming methods (Antwi-Boampong, 2021). The online teaching competencies of secondary school teachers in Guangdong Province, China were tested and the advantages and potential of BL were confirmed. However, despite the Chinese government's support for BL in secondary schools, few researchers have examined its development based on secondary school teachers' experiences. These teachers practice BL in passive situations and acknowledge its potential benefits for student achievement; however, they are unwilling to actively adopt this model in their future courses. The teachers are pressured to ensure student advancement; schools and administrations must allow them more time to study and adapt to the BL model. As a new instructional model, the online component of BL requires significant investment of teachers' time in its design (Archibald, Graham, & Larsen, 2021). Therefore, secondary school teachers are reluctant to give up traditional teaching to ensure student advancement. The quality of blended curriculum design (Ashraf et al., 2022) and reliable learning platforms (Attard & Holmes, 2022) also influence teachers' BL adoption. Therefore, this study used model design to explore the factors that influence BL implementation and adoption by secondary school teachers in Guangdong. This study is the first to explore the factors influencing the BL experiences of Chinese secondary school teachers. A qualitative method was used for data collection to uncover relevant factors, followed by a quantitative investigation to validate the cause-effect relationships among the resulting factors. The BL-Influencing Factors Scale used during this study can provide a reference and test approach for secondary schools to promote BL practices from teachers' perspective. The research questions in this study were as follows: (1) What factors influence Chinese secondary school teachers' BL implementation? (2) What causes these factors?

The remainder of this paper is organized as follows. Section 2 describes the sequential exploratory design used in this study. Section 3 presents the study results, including the relationship between the relevant influencing factors that emerged from the qualitative study. We then reflected on the findings to validate and refine them. Section 4 discusses

the results of integrating qualitative and quantitative data and provides the reasons for these influences. Section 5 summarizes the findings, provides suggestions for future research, and addresses the limitations.

Teaching Resources (TR), Teaching Ability (TA), Teacher-Student Interactive Behavior (TSIB), Teacher Motivation (TM), Students Ability (SA), and Workload (W). Five individual relationship groups between the factors obtained from the in-depth interviews are presented in the literature results.

2. Literature Review

2.1. Teaching Resources and blended learning curriculum design (BLCD)

The adoption of blended learning curriculum design (BLCD), which aims to integrate conventional face-to-face teaching with online resources, is experiencing a growing trend in educational institutions (Singh et al., 2022). The integration of digital tools alongside traditional teaching strategies within the classroom setting holds promise for enhancing both the educational quality imparted to students and their academic performance. Considerable scholarly investigation has been conducted regarding the potential of BLCD to enhance educational benchmarks. The results of a meta-analysis conducted by Belur et al. (2023) indicate that blended learning demonstrates greater effectiveness when compared to both in-person and online-only instructional approaches. This discovery offers additional substantiation for the efficacy of integrating traditional pedagogical approaches with the incorporation of digital resources within the educational setting, resulting in enhanced academic achievements among students. Despite the numerous advantages associated with BLCD and TR, several challenges must be effectively addressed prior to their complete implementation. A prominent issue of concern pertains to the insufficient training and support offered to educators in relation to the proficient utilization of digital resources. Based on the research conducted by Antwi-Boampong (2021), there is a potential lack of sufficient teacher preparedness in effectively harnessing the advantages offered by blended learning environments. Consequently, this inadequacy diminishes the favorable impact that such environments can have on students' academic performance. According to Haryani et al. (2021), the alignment of TR with the curriculum and the incorporation of diverse learning styles are crucial factors in the creation of high-quality TR. This phenomenon persists despite the fact that digital resources provide a higher level of adaptability and the opportunity to participate in interactive exercises. Insufficient or inadequately designed teacher resources (TRs) can impede the effectiveness of blended learning.

Ensuring equitable access to technology and digital resources poses a substantial barrier that must be addressed prior to achieving widespread adoption of BLCD. Katz, Jordan, and Ognyanova (2021) posits that disparities in students' learning experiences and outcomes may arise due to unequal access to classroom devices and internet connectivity. The prioritization of BLCD implementation should be centered around the eradication of the digital divide and the promotion of equitable access to technology, with the aim of mitigating the exacerbation of pre-existing educational disparities. Further investigation is warranted regarding the evaluation of students' progress and achievements within blended learning settings, as this represents a crucial area of study. There is a potential for traditional assessment methods to disregard the personalized learning opportunities facilitated

by BLCD. Antwi-Boampong (2021) have demonstrated the necessity for new methods of evaluation in blended learning due to the inherent emphasis on individualization and collaboration. Notwithstanding the extant literature emphasizing the favorable influence of BLCD on student engagement and academic performance, further empirical investigations are warranted to examine the enduring consequences of BLCD.

2.2. Teaching Ability and blended learning curriculum design (BLCD),

A plethora of studies have demonstrated that possessing proficient teaching skills is imperative for effectively utilizing BLCD. Szymkowiak et al. (2021) emphasized the importance of educators adapting their instructional methods in order to effectively utilize the potential benefits offered by online resources. Achieving such a high degree of adaptability necessitates the possession of a wide range of skills, encompassing proficiency in diverse technological tools, a comprehensive comprehension of pedagogical principles, and the ability to cultivate learning-friendly classroom settings. In the context of a blended classroom, the presence of a competent teaching ability (TA) can facilitate the utilization of blended learning course design (BLCD) strategies, thereby enhancing the educational experience of students and fostering increased student engagement.

In order to enhance their teaching abilities within a BLCD framework, it is imperative for educators to actively engage in high-quality professional development and training. The study conducted by Archibald et al. (2021) revealed that teachers' proficiency in integrating digital resources into their instructional practices was enhanced through targeted training in instructional technology and blended learning strategies. This conclusion was corroborated by the discoveries made by the authors. The provision of adequate training to educators in preparation for the dynamic nature of blended learning enhances their capacity to deliver lessons of exceptional quality. This phenomenon increases the probability of students attaining their educational objectives.

One notable benefit of incorporating a blended learning curriculum is the capacity to individualize the educational experience for every student. Zhai, He, and Krajcik (2022) posit that educators with elevated levels of teaching ability demonstrate enhanced proficiency in discerning the distinct learning styles and requirements of their pupils. This allows educators to adapt their instructional approaches to suit the unique needs of each student. This individualized teaching method promotes increased student engagement, leading to enhanced academic achievement. Nevertheless, in the event that educators are lacking adequate TA to address the diverse requirements of their students, the attainment of its maximum effectiveness by BLCD may be hindered. Nevertheless, the implementation of BLCD and the cultivation of teaching proficiency pose certain challenges. Tusiime, Johannesen, and Gudmundsdottir (2022) asserts that the effective incorporation of technology in educational settings can be impeded by various challenges, such as educators' reluctance to embrace change and the need to acquire additional technological competencies. Achieving a balanced integration of online and in-person interactions necessitates the possession of adept pedagogical skills to ensure the preservation of coherence and consistency throughout the student's educational journey. In summary, the current corpus of research highlights the importance of Instructor Competence in influencing the degree of achievement attained by Blended Learning Programs.

2.3. Teacher-Student Interactive Behavior (TSIB), and blended learning curriculum design (BLCD)

Blended learning environments prioritize the importance of interactions between educators and learners. Chan and Lam (2023) underscored the significance of ensuring that these interactions maintain a high standard in order to foster student engagement and cultivate a conducive learning environment in the classroom. The efficacy of BLCD relies on the capacity of educators to foster interactive dialogues, deliver prompt feedback, and address inquiries and apprehensions expressed by learners. In the context of a blended learning curriculum, novel prospects arise for engagement and collaboration between the learner and the educator. Attard and Holmes (2022) argue that educators have the ability to expand their interactions with students beyond the physical boundaries of the classroom through the effective utilization of digital tools. The utilization of asynchronous communication tools, such as online discussion forums and email, can facilitate a more flexible and personalized educational experience for each student. These tools facilitate ongoing dialogue and provide assistance. According to Maduli-Williams (2023), maintaining a harmonious equilibrium between online and in-person interactions is crucial to mitigate the potential erosion of the interpersonal bond and rapport that ensues from teacher-student relationships. Implementing this measure will effectively mitigate the risk of losing the valuable personal connection and rapport that naturally evolves between educators and their students.

Furthermore, Seyfarth (2019) asserts that the efficacy of student-teacher interactions within a blended learning setting is contingent upon the teachers' proficiency in technology and their ability to adapt to diverse digital resources. When educators possess proficiency in the digital realm, they possess the capacity to leverage the vast array of resources at their disposal to enhance student engagement, expand students' information accessibility, and deliver more personalized attention. When formulating a curriculum that incorporates blended learning, it is feasible to consider the unique learning preferences and interests exhibited by each student. Teachers have the potential to employ technology as a means of differentiating their instructional methods, thereby providing support to struggling students and simultaneously offering more advanced content to those who are more proficient (Martin et al., 2019). The implementation of an individualized strategy within a blended learning environment has been found to enhance both student participation and performance.

2.4. Teacher Motivation (TM) and blended learning curriculum design (BLCD)

Nevertheless, ensuring productive interactions between students and teachers in the context of blended learning can pose a significant challenge. Based on the research conducted by Siah et al. (2022), instructors face challenges in efficiently allocating their time and delivering meaningful feedback to students in large online cohorts. Moreover, in the event that educators lack sufficient access to technology or digital resources, it may pose challenges in their ability to sustain consistent engagement with their students. The motivation of educators is an essential factor in ensuring the successful implementation of blended learning. Based on the research conducted by Anthony et al. (2022), it has been determined that educators who exhibit high levels of motivation are more inclined to engage in the exploration and implementation of innovative pedagogical approaches, such as the integration of blended learning methodologies. When educators are faced with a substantial amount of time management responsibilities, it serves as a catalyst for their increased drive to create interactive digital instructional materials, foster collaborative assignments, and

provide personalized support to every student. Conversely, the successful implementation of blended learning strategies in schools may be hindered by a lack of motivation among the teachers in those educational institutions. Teachers who experience burnout or lack confidence in their technological abilities may exhibit a certain degree of resistance towards incorporating digital tools into their instructional practices (Phan & Pham, 2023). This phenomenon may potentially result in a reduction of opportunities for students to acquire novel skills. As a consequence of this, the overall efficacy of blended learning may be compromised, thereby limiting the extent to which certain students can derive benefits from its advantages.

2.5. Students Ability (SA) and blended learning curriculum design (BLCD)

In blended learning environments, considerable emphasis is placed on the aptitudes and preferences of individual students. Students at all levels of student affairs have the opportunity to customize their blended learning experience to suit their unique needs. Based on the study conducted by Bligh (2022), it has been found that carefully designed blended learning environments hold the potential to support students with diverse abilities in making progress at individualized rates. Blended learning possesses numerous potential benefits; however, its implementation may pose difficulties for students lacking technology access or proficiency (Tobin & Hieker, 2021). Blended learning possesses the capacity to yield various advantages for students. An exacerbated disparity in resource allocation has the capacity to further accentuate pre-existing disparities in academic attainment among students.

2.6. Workload (W) and Teacher Performance and blended learning curriculum design (BLCD)

It is imperative to acknowledge the temporal obligations of educators within blended learning settings. In the study conducted by Naylor and Nyanjom (2021), it was found that the instructional effectiveness of educators may be compromised when they experience excessive workload due to the integration of online components and the management of both face-to-face and virtual interactions. Instructors may encounter difficulties in efficiently allocating their time to fulfill the demands of online course preparation, grading, and delivering prompt feedback to students. Effective professional development and support have the potential to mitigate the impact of teachers' workload on their professional responsibilities. In the study conducted by Shamsuddin and Kaur (2020), it was observed that educators may encounter various difficulties when implementing blended learning approaches. Nevertheless, the researchers suggest that acquiring training in time management and instructional design could potentially enhance their ability to effectively navigate these challenges and attain positive outcomes. The provision of sufficient institutional support and access to resources has the potential to alleviate the workload burden placed upon teachers.

3. Materials and Methods

The research questions in this study originated from the resistance and dilemmas encountered by secondary school teachers in Guangdong, China during BL implementation. In-depth interviews with secondary school teachers revealed relevant factors influencing their BL adoption. The study began with the principles of constructivism and emphasized multiple perspectives to obtain teachers' insightful interpretations of the factors influencing BL. The relevant factors revealed by the qualitative research results became the basis for the questionnaire dimensions and

indicators in the scale design process, thus achieving "Joint 1" between qualitative and quantitative research. In the quantitative phase, the potential factors influencing BL implementation shifted to a post-positivist philosophical position. Moreover, the causal relationships among the factors that influenced BL implementation in courses undertaken by secondary school teachers were identified. Then, the quantitative findings of the influential factor relationships were reflected in the qualitative study, achieving "Joint 2" in the mixed-method research. Thus, the research context and objectives dictated the adoption of an exploratory sequential design.

Figure 1 illustrates the implementation process of the exploratory sequential design used in this study, which consists of three phases. Phase 1 was qualitative; this phase used transcendental phenomenology and focused on describing participants' experiences. The research process empowers each participant with an in-depth interpretation of their personal experiences through the interviewees' interactive meanings. The researcher participated in interviewing and summarizing secondary school teachers' understanding of BL practice experiences from the context and events associated with the phenomenon based on the problem statement and research questions. Phase 2 followed a quantitative design; the findings of this phase provide the basis for reconstructing and testing the relational model of BL influencing factors. Finally, phase 3 involved the integrated interpretation of qualitative and quantitative data.

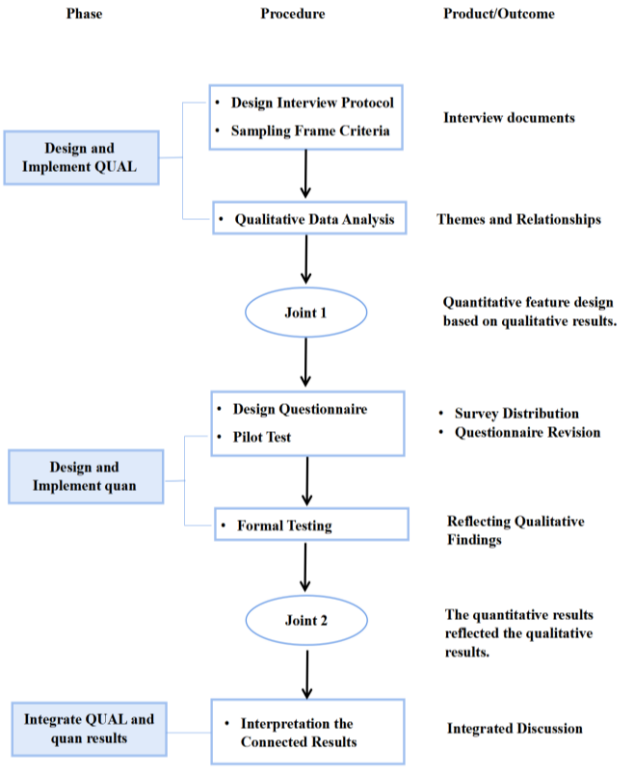

Figure 1. *Research design process.*

3.1 Participants

Teachers who participated in the 2020 Guangdong Province Secondary School Teachers' Information Technology Upgrading Program 2.0 (ITU2.0) were selected for the overall study. These teachers were recommended by urban and rural secondary schools; all teachers had good IT literacy skills. Their participation in the training intended to help them better utilize the advantages of IT in the courses they taught. Primarily through the COVID-19 pandemic, these teachers successfully implemented BL and had rich practical experience in BL, which was beneficial in this study. The qualitative phase ended with 13 interviews. The principle of saturation was used in the qualitative research phase, and we stopped conducting interviews after theoretical saturation was reached. The quantitative phase was divided into two parts. The pilot test used the Rasch Model to improve questionnaire quality. The number of valid data samples for the pilot-test phase was 100. A formal questionnaire was administered to collect 447 data points. After cleaning the data, 365 valid data points were obtained. Throughout the study, the investigators informed the participants of the study objectives, protected their personal information, and obtained approval for the study from the Human Research Ethics Committee of Putra Malaysia (Ethics No. JKEUPM-2022-063).

3.2 Instrument Development

Prior to the qualitative study, a semi-structured interview protocol was developed based on the research questions and objectives to guide the data collection process and subsequent analysis.

The quantitative phase was based on the results of previous interviews with secondary school teachers' BL experiences, combined with relevant literature, including Al-Ayed and Al-Tit (2021), Haron et al. (2021), and Huang et al. (2021), Ibrahim and Nat (2019), Matosas-López, Aguado-Franco, and Gómez-Galán (2019), and Taghizadeh and Hajhosseini (2021) developed the questionnaire, "Survey on factors of BL adoption and implementation." The questionnaire was based on a five-point Likert scale (5-strongly agree, 4-agree, 3-fairly, 2 = disagree, and 1-strongly disagree).

3.3 Data Analysis

The qualitative data analysis software ATLAS.ti 22 was used to represent the interrelationships between the influencing factors. Quantitative data analysis was divided into two phases. Phase 1 was for the scale's pre-testing, and the scale's quality was achieved using the Rasch model. All data were analyzed using the Rasch measurement software (WINSTEPS version 4.7.1). Phase 2 was for the formal testing of the scale. According to the qualitative research phase findings, the initial model of the relevant factors was established, and the cause-effect relationship between the factors was verified using path analysis.

3.4 Trustworthiness and Credibility

To ensure the reliability of the qualitative study results, the collated interview documents were sent back to the respondents for confirmation to ensure that their experiences were accurately represented. After the coding was completed, peer experts validated the coding manual. The participating school teachers were not involved in subsequent quantitative studies. Three quantitative research experts validated the scales during the quantitative research phase.

4. Results

4.1 Themes and Relationships

Raw data from the interview transcripts were coded, resulting in 32 codes. Quotes from academic literature and interview transcripts were combined to categorize similar themes in the dataset. The qualitative study resulted in 21 subcategories in seven categories. The seven categories were Blended Learning Curriculum Design (BLCD), Teaching Resources (TR), Teaching Ability (TA), Teacher-Student Interactive Behavior (TSIB), Teacher Motivation (TM), Students Ability (SA), and Workload (W). Five individual relationship groups between the factors obtained from the in-depth interviews are presented in the literature results.

4.1.1 Relationship Group 1

BLCD affected TSIB and W during the BL process. The openness of teaching resources and advanced technology used in BL implementation allow immediate interaction between teachers and students, even in different learning spaces. However, facilitating teacher-student interactions is a challenge in BL implementation (Dhawan, 2020). Haron et al. (2021) also showed that teacher-student interaction in BL has limitations, mainly because teachers need time to adapt to the new classroom interaction model with the advent of digital technology. Participant R05 stated, "I spend a long time designing student interactive activities." Participant R04 also emphasized: "When I design teaching activities, I begin to think about the arrangement of teacher-student interaction activities. This process is complicated, and my expected goals is often not achieved". Thus, teachers must consider interactive course materials for online and face-to-face instruction in instructional design to facilitate TSIB activities in BL.

4.1.2 Relationship Group 2

TR affects SA, TSIB, and W. The TR in this study includes the network environment, online platforms, and resource platforms. Students' ability includes the competence to learn independently using technological tools. Poor networking in the BL process can make it difficult for students to have a good experience with technology engagement activities and can even create negative perceptions (Fu, Zhu, & Mai, 2021). The open network environment poses a significant challenge to students' independent learning skills and poor time management skills in BL (Hair et al., 2019). Additionally, BL is a new pedagogical paradigm for secondary-school students. New technologies and learning platforms appeal to students and are demanding in terms of operational skills. They need time to "adapt and familiarize themselves with the platform" (C02, C04, C05). Therefore, a stable online environment, personalized digital resources, and an easy-to-use learning platform influence student performance.

4.1.3 Relationship Group 3

TA affected TM, BLCD, TSIB, and TR. The TA in this study included expression ability, ICT information literacy, observation ability, and organizational ability. Seven teachers stated that the training had a positive effect, and that they could increase their confidence in the future application of technology after successful BL implementation (Participants

C02, C03, C04, C05, C06, R01, and R03). Second, pedagogical competencies affect the effectiveness of BLCD. Some instructors were familiar with common blended education approaches. Teachers must use learning platforms to complete course design and find and upload teaching resources. The TSIB process reflects teachers' organizational and presentation skills. Teachers' design also influences the effectiveness of TSIB. Haron et al. (2021) also supported this view by arguing that the BL process presents challenges for teachers' pedagogical skills because teaching and learning involve continuous interactive communication and changing patterns of interaction.

4.1.4 Relationship Group 4

TSIB increased teachers' W. In BL, the freedom to learn online leads to the less spontaneous participation of learners in interactive activities. Teachers must devote more effort toward the effectiveness of interactive activities. In addition, TSIB manifests in teachers' timely responses to students seeking help. Participants C05 and R01 stated that a heavy workload refers to the feedback and guidance of students' work after class. Moreover, this relationship arises because Chinese secondary schoolteachers work differently. Chinese teachers must monitor students' learning dynamics after class and actively contact parents. Therefore, the TSIB influences W.

4.1.5 Relationship Group 5

SA affects TSIB and W. As the online portion of BL provides students with a degree of autonomy and freedom, they need to exercise more self-control online. In particular, for middle school students, uneven operational skills lead to inefficient BL activities, especially in teacher-student interactions (C04, C05, and R03). Second, participant R03 explained "because the student does not have the means to complete the content independently, she needs to spend time repeating it in the physical classroom." In other words, student abilities affect teachers' workloads.

Combining the above analysis of the relationship groups among the BL influences, Figure 2 shows the relationship between factors resulting from the qualitative analysis.

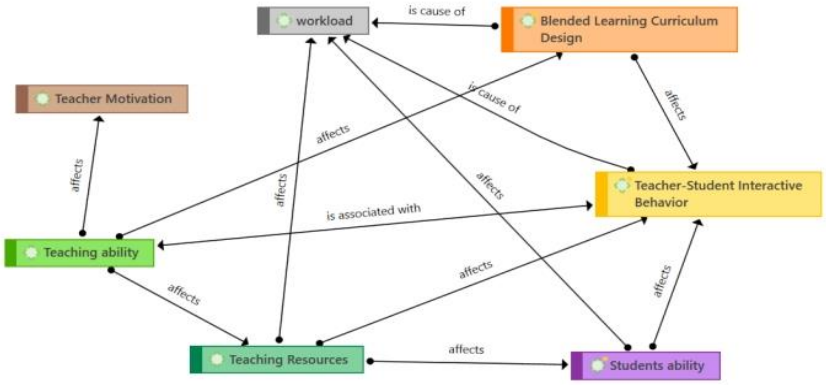

Figure 2. *Influence factors relationship.*

4.2 Reliability and Constructs Validity Analysis

This pilot test employed the Rasch model to validate a questionnaire developed based on the qualitative study results. First, it determined whether the data collected from the participants and items were reliable. The data in Table 1 show that the values of Pearson Reliability coefficient were all greater than 0.70, and the p-values were lower than 0.05, indicating a significant difference. The results indicate that the designed scale, in which the option classification and Rasch model are sufficiently fit to complete the item analysis, follows the Rasch model. Second, the scale structure was optimized by combining the item fit analysis results with Cronbach's alpha coefficient analysis of internal consistency and reliability. In the Rasch model, the rating scales (Likert /survey)—with valid ranges of infit and outfit between 0.6 and 1.4 as shown in the results (Infit and Outfit) in Table 2, Q1 (Infit=2.352, Outfit=2.456), Q38 (Infit=1.902, Outfit=2.019), Q39 (Infit=1.698, Outfit=1.650, Q45 (Infit=1.586, Outfit=1.766), Q56 (Infit=1.526, Outfit=1.919), and Q60 (Infit=1.510, Outfit=1.700)—were not easily predicted for the corresponding test categories BLCD, TSIB, TM, and W. However, the fit statistics should help identify problematic items and individual performance rather than just deciding which items should be removed from the scale. Therefore, scale testing was combined with Cronbach's alpha coefficients to determine the absolute reliability of the items. If each construct's Cronbach's alpha coefficient was more significant than 0.7, the items were considered highly reliable. The more items there are, the higher the internal consistency alpha coefficient. Suppose the internal consistency of an item is good. In this case, the new alpha coefficient after removing an item was lower than the original one. If the opposite was true, the item had poor internal consistency with other items, with a conceptual consistency alpha coefficient of 0.800. TM-level conceptual consistency alpha coefficient was 0.898. The consistency alpha coefficient at the workload level was 0.809. This indicates that BLCD, TM, and W had relatively high internal consistency. In the category of TSIB, the value of the conceptual consistency coefficient α was equal to 0.699, which can be considered acceptable.

For the BLCD category, the new alpha value after removing Q1 (Cronbach's alpha value 0.840) was greater than the alpha value before removing Q1. In the TSIB category, the new alpha values after removing Q38 (Cronbach's alpha = 0.762) and Q39 (Cronbach's alpha = 0.761) were greater than the alpha value before removing Q1. The Cronbach's alpha was greater than the pre-deletion value (0.699). In the W category, the new alpha value, after deleting Q56, was more significant than the pre-deletion alpha value of 0.809. Moreover, the new value of alpha after deleting Q60 was greater than the pre-deletion alpha value of 0.824, indicating that Q56 and Q60 have poor internal consistency with other question items. By combining the results of Infit and Outfit in the Rasch model in the previous section, deletions of Q1, Q38, Q39, Q56, and Q60 can be considered. In the TM category, the new Cronbach's alpha value for Q45 was 0.907, similar to the original alpha coefficient value of 0.898 without deleting Q45. Although the results of Q45 for Infit and Outfit in the Rasch model did not easily predict the TM dimension, Q45 was retained because of its standardized internal consistency of 0.900 for the teacher motivation dimension.

Table 1

Constructs reliability test.

Category	Items	Person Reliability	MADaQ3	p	Infit	Outfit	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
BLCD	Q1	0.778	0.138	<0 .001	2.352	2.456	0.840	0.800
TSIB	Q38	0.724	0.352	<0 .001	1.902	2.019	0.762	0.699
	Q39				1.698	1.650	0.761	
TM	Q45	0.854	0.177	<0 .030	1.586	1.766	0.907	0.898
W	Q56	0.794	0.229	< .001	1.526	1.919	0.830	0.809
	Q60				1.510	1.700	0.824	

*Note. MADaQ3= Mean of absolute values of centered Q_3 statistic with p-value obtained by Holm adjustment; Ho= the data fit the Rasch model; Infit = information-weighted mean square statistic; Outfit= Outlier-sensitive mean square statistic.

The revised questionnaire entered the formal testing phase of the quantitative study. The revised questionnaire comprised 55 items, and 365 valid responses were obtained. The number of valid questionnaires was more than five times the number of items, and the sample size was more than 300, which was suitable for factor analysis. When conducting factor analysis, KMO indicator values greater than 0.9 are suitable (perfect) for factor analysis. KMO indicator values greater than 0.8 are advantageous (meritorious) for factor analysis. Table 2 shows that the KMO values for all seven categories were more significant than 0.8. This suggests that the sampled data met the prerequisite requirements for the factor analysis. The AVE values corresponding to the seven factors were greater than 0. 5, and the CR values were greater than 0. 7, indicating good convergence of the data for this analysis (Haron et al., 2021).

Table 2

Constructs validity test.

Constructs	KMO	CR	AVE	Factor loading
BLCD	0.898	0.921	0.566	0.785~0.916
TR	0.842	0.827	0.705	0.749~0.887
TA	0.908	0.906	0.618	0.814~0.925
TSIB	0.873	0.913	0.779	0.798~0.896
TM	0.899	0.946	0.746	0.851~0.902
SA	0.846	0.876	0.702	0.868~0.900
W	0.878	0.872	0.534	0.707~0.899

4.3 Model Fit Measurement and Path Analysis

The original hypothesis in Table 3 shows relationships between the factors in the qualitative analysis. After the initial step of model building, it was necessary to test the indicators of model fit based on the data. In general, value-added fit indices include NFI, CFI, and TFI values, which are generally maintained between 0 and 1. The closer the values are to 1, the better the fit of the model (Haryani et al., 2021). Combining the initial model fit index values in Table 5, we can see that the initial model had a cardinality freedom ratio of 31.193, AGFI of 0.529, NFI of 0.896, and CFI of 0.899, which did not meet the fitness criteria. However, the model may be further modified; therefore, it is necessary to continue

modifying and improving the model by integrating index data. After model modification, each index value was tested. The results revealed that all the indices of the modified model improved, as shown in Table 4. The modified model had a chi-squared freedom ratio of 2.622, GFI of 0.991, RMSEA of 0.067, AGFI of 0.969, NFI of 0.991, and CFI of 0.995. These fit indicators were within a good and acceptable range of fit; therefore, the model was no longer modified.

To this end, this study established a relational model of the factors influencing the adoption of BL by secondary school teachers. Figure 3 shows that the study achieved Joint 2, which is explained in section two, the quantitative findings reflect the qualitative findings. The overall model reflects the interactions among the factor variables BLCD, TR, TA, TSIB, TM, SA, and W, which influence each other.

Table 3

Model regression coefficients summary.

	Original hypothesis					Refining the hypothesis				
No.	Hypotheses and pathways			*p*	Standardized coefficient (β)	Hypotheses and pathways			*p*	Standardized coefficient (β)
H1	SA	→	W	0.022	0.143	SA	→	W	0.005	0.150
H2	TSIB	→	W	0.013	0.188	Reject				
H3	TR	→	W	0.000	0.427	TR	→	W	0.000	0.490
H4	BLCD	→	W	0.001	0.148	BLCD	→	W	0.000	0.159
H5	TR	→	SA	0.000	0.599	TR	→	SA	0.000	0.909
H6	TA	→	TM	0.000	0.831	TA	→	TM	0.000	0.290
H7	SA	→	TSIB	0.000	0.703	SA	→	TSIB	0.000	0.939
H8	TA	→	TSIB	0.021	-0.270	TA	→	TSIB	0.000	-0.574
H9	TR	→	TSIB	0.000	0.403	TR	→	TSIB	0.000	0.549
H10	BLCD	→	TSIB	0.120	-0.073	Reject				
H11	TSIB	→	TA	0.000	0.830	TSIB	→	TA	0.000	0.981
H12	TA	→	TR	0.000	0.409	Reject				
H13	TA	→	BLCD	0.000	0.662	TA	→	BLCD	0.000	0.732
Derived Hypothesis and Pathways						BLCD	→	SA	0.000	-0.330
						SA	→	TM	0.000	0.400
						TSIB	→	TM	0.000	0.283

Table 4

Model fit indices.

Fit indices	Recommended value	Initial Model Fit Indices	Modified Model Fit Indices
$\chi 2/df$	*<3*	31.193	2.622
GFI	*>0.9*	0.865	0.991
RMSEA	*<0.10*	0.288	0.067
RMR	*<0.05*	0.035	0.008
CFI	*>0.9*	0.899	0.995
NFI	*>0.9*	0.896	0.991
TLI	*>0.9*	0.734	0.986
AGFI	*>0.9*	0.529	0.969

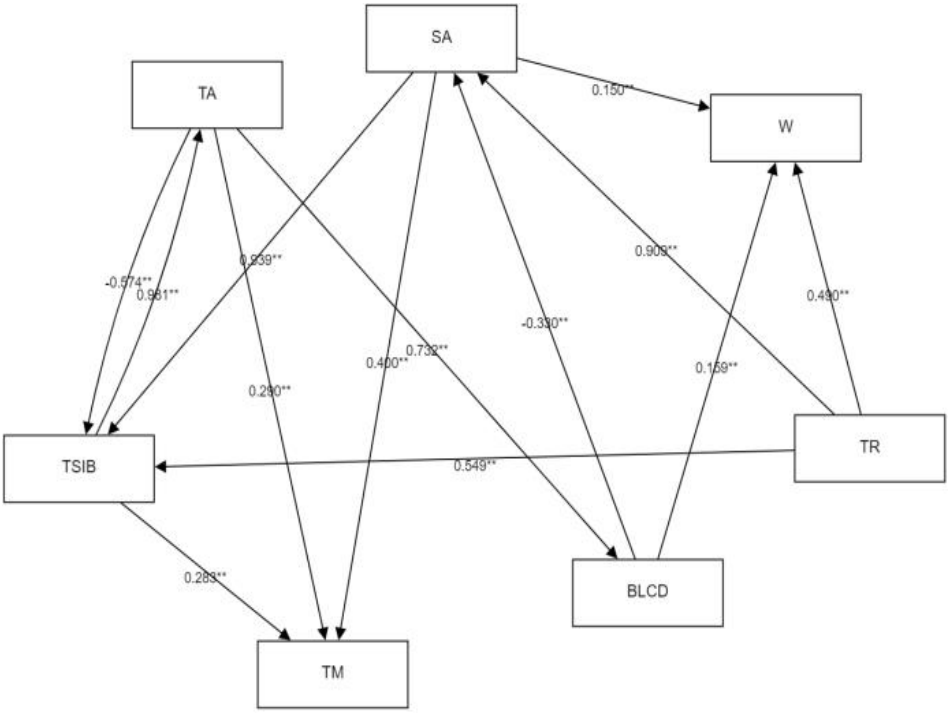

Figure 3. *Influence factors path analysis results.*

The standardized estimates and significance levels of the structural assumptions between the factors are presented in Table 4 and Figure 3, respectively. A higher path coefficient value in the influencing factor model indicates a positive influence relationship between the two-factor variables, while a negative value indicates no positive relationship between the two-factor variables. Therefore, SA (H1), TR (H3), and BLCD (H4) have a positive effect on Workload, and the values of the path coefficients β shown in Figure 3 are 0.150, 0.490, and 0.159, respectively; the p-values are all less than 0.01, which reach the significant level.

TR has a positive effect on SA (H5), β=0.909, p<0.01. The path coefficient of the relationship between the influence of BLCD on SA factors is -0.330 (p=0.000<0.01). This indicates that BLCD has a negative effect on SA. This is mainly because, in a BL environment, BLCD includes the effective use of media, course content, design methods, and the creation of time sequences. The more accessible these elements are in design, the less demanding they are in terms of student competencies.

SA(H7) and TR (H9) have a positive effect on TSIB activities, with path coefficient values of β = 0.939, p < 0.01, and β = 0.549, p < 0.01, shown in Table 4. This indicates that SA had a more significant effect on TSIB activity. High self-regulation and computer skills may facilitate TSIB. TR also affects TSIB activity. The path coefficient of the relationship between TA and TSIB row (H8) as an influencing factor was -0.574 (p=0.000<0.01). This is because, in the BL environment, TA does not directly lead to TSIB. TA, including expressive

skills, ICT information literacy, and observational and organizational skills, does not directly lead to TSIB. Learning behaviors and interactive learning activities between teachers and students occur only when they perceive the knowledge and platform as helpful for learning.

TA(H6), SA, and TSIB positively affected TM, and the values of the path coefficients β shown in Figure 3 were 0.290, 0.400, and 0.283, respectively; the p-values were less than 0.01 and reached the significant level. Furthermore, there was a positive effect of TA on BLCD (β=0.732; p<0.01) and TSIB on TA (β=0.981; p< 0.01).

Based on the path analysis results, the next section discusses the reasons for these factors in detail.

5. Discussion

BL is a new learning and instructional model for students and teachers. Teachers need to guide students to realize that part of their learning process must be conducted online, including access to learning materials and adopting independent learning strategies. Teachers do not have sufficient time to master and learn the technology for implementing BL (Huang, 2019). This leads to a high workload and time-consuming factors affecting teachers' adoption of BL learning (Huang et al., 2021). The workload burden exhibited by applying BL practices in universities is primarily reflected in the need for teachers to schedule and design BL lesson plans on various platforms. In contrast, at the secondary level, it is reflected on three levels: the course preparation process, daily work, and tutoring after class. Participants C01, C02, R02, R04, and R06 acknowledged that they needed long hours to prepare for courses, including searching for and designing resources. Participants C05 and R01 emphasized that they needed to spend their time after class to guide students. In addition, the pressure on Chinese secondary school teachers to advance to higher education has resulted in busy days for these teachers. The quantitative study showed that the path coefficients β for SA, TR, and BLCD on workload were 0.150, 0.490, and 0.159, respectively. The path coefficients showed that SA had a greater impact on workload than TR or BLCD. Teachers must consider whether the target learners have the skills to actively and effectively use the selected digital resources. Teachers had to repeat the teaching tasks when student competencies did not meet the BL requirements. It supports Participant R03's view that "the heavy workload lies in the repetitive teaching work." Additionally, this study revealed that secondary school teaching resources included Network Environments, Online Platforms, and Resource Platforms. When Chinese secondary school teachers implement BL, resource platforms are separated from learning platforms. Therefore, designing and promoting quality and comprehensive platforms for the construction of teaching resources will effectively reduce teachers' workload due to online course design.

Many scholars believe that students' IT mastery and self-regulation ability (Huang et al., 2022) affect their BL effectiveness. Teachers may also abandon the adoption of BL because of doubts about SA. However, it is clear from numerous studies that teachers' concerns about SA are present at both secondary and university levels. New teaching models supported by technology do not fully enable students' abilities to be met before practice. Therefore, TR in the quantitative phase of this study had a positive impact on SA, whereas BLCD had a negative impact on SA. Therefore, the construction of a BL

environment plays a crucial role in SA. A smooth online environment and easy-to-use online platform can provide a good learning experience for students. Teachers who focus on accessibility and inclusiveness of BLCD during instructional design and provide clear online learning instructions to students will, to an extent, reduce their requirements for students' competencies.

Ibrahim and Nat (2019) stated that teacher motivation affected BL adoption, which is consistent with the findings of the interviews in this study. Teacher motivation in this study consists of two components: intrinsic and extrinsic (Ibrahim & Nat, 2019). Intrinsic motivation includes teachers' confidence, beliefs about teaching, and recognition of the value of technology in teaching and learning activities. Extrinsic motivations include campus cultural support, resources, training, teacher well-being, and job satisfaction (Ifinedo, 2017). The quantitative findings show that TA, SA, and TSIB positively affect TM, with SA having the highest path coefficient of 0.400. This indicates that SA has the most significant impact on TM. The interviewed teacher Participant R03 also highlighted that "The students' abilities greatly influenced my implementation of the blended learning model." In contrast, the TA influenced the TM. Participant R03 positively supported this view, "the successful implementation of blended learning makes me more confident in my teaching abilities and more receptive to new teaching models." In addition, teachers' ICT literacy affected their confidence in implementing BL. This result supports the views of Rasheed, Kamsin, and Abdullah (2020). Finally, TISB had a significant positive impact on teachers' motivation to adopt BL. The change in how interactive activities are realized in BL makes teachers reluctant to abandon the traditional face-to-face communication (TSIB) method. In turn, the effectiveness of TSIB affects teachers' willingness and confidence to continue adopting this teaching mode. This finding was consistent with that reported by Haron et al. (2021).

The TSIB is a contradictory factor in BL implementation. First, the use of the Internet and new technologies in the BL process has increased the forms of interaction among students, teachers, and students, making interactive communication easier (Participants C06, R03, and R04). However, Chan (2019) demonstrated a significant need for more scope of TSIB and interpersonal communication during BL courses. The teachers interviewed in this study (Participants C02, C03, C05, R05, and R07) agreed with this view. Additionally, the quantitative phase of this study revealed that SA and TR positively affected TSIB activity. TSIB in BL can only occur with the assurance of learning devices and BL environments (Lee & Yuan, 2018). Therefore, the lack of independent learning ability and the unavailability of reliable and easy-to-use teaching and learning resources make interactive BL activities difficult.

The typical features of BL are new technologies that provide students with personalized learning experiences and flexibility for teachers to implement online and offline instruction. However, the rapid pace of technological updates must give teachers more time to integrate technology into their curriculum. Poor teacher digital literacy and a lack of training in BL have become obstacles to implementing BL (Maduli-Williams, 2023; Martin et al., 2019). In this study, 84.6% of the teachers interviewed mentioned TA, which primarily included expression ability, ICT information literacy, observation ability, and organizational ability. They believed that teachers could only have these competencies to better Participant C04, C05, R03, R04, and R05 agreed with the previous scholars "blended

learning training content should be added to teacher development training." It would be better if the training content were more practical. The quantitative study showed that TSIB affected the path coefficient of TA by 0.981. Therefore, positive or negative development of TSIB activities directly reflects high or low levels of teachers' pedagogical competence.

The complexity of BLCD influences secondary school teachers' adoption of BL. The BLCD process cannot be performed without incorporating new technologies, and course design must consider accessibility and inclusiveness (Matosas-López et al., 2019). However, the need for sophisticated pedagogical and instructional designs is the biggest challenge to the application of BL in China (An et al., 2021). In the quantitative analysis, the value of the pathway effect of TA on BLCD reached 0.732, indicating that instructional competencies can help mitigate the impact of BLCD on teachers' willingness to adopt BL models. Participant R04 also acknowledged that in BL, "teachers should be able to design instruction systematically." Teachers with better pedagogical skills will consider how to design instructional activities regardless of the technology/model used in their actual teaching. However, teachers need to recognize that students have different levels of ability and that instructional design is not about how much technology is used or how complex the activities are but rather about ensuring that students can learn meaningfully. It is essential for school administrators to recognize that few teachers are familiar with new technologies and common BL approaches. A professional development training program for teachers' preparation to teach in BL can effectively reduce the impact of BLCD on teachers' willingness to adopt BL.

6. Conclusions

This study is the first to model the relationships between the factors related to teachers' adoption of BL from the perspective of Chinese secondary school teachers. The seven factors and interrelationships explored in this study were identified through interviews with secondary school teachers during the qualitative research phase. The relational model was verified during the quantitative research phase. The results provide a clearer picture of the factors that influence secondary school teachers' adoption of BL. The path of the final model of the interrelationship of the factors influencing BL showed that the direct result of TR led to teacher workload stress, poor student performance, and an inability to facilitate practical TSIB activities. BL requires a stable network environment, a learning platform with a good user experience, and easily accessible digital resources to motivate students to favor and use them. Students were aware of the availability and usefulness of technology in BL to promote their competence.

Furthermore, from the teacher's perspective, SA is the leading cause of increased workload, the effectiveness of TSIB, and even TM. Among these, SA had the most significant impact on TSIB. Thus, TR is a core factor influencing teachers' adoption of BL. The three causal variables leading to TM showed that TA, SA, and the effectiveness of TSIB are the main factors affecting TM in patients with BL. This study explored the influencing factors and interrelationships that affect teachers' adoption of BL, and designed and developed an instrument for measuring the relationship between BL influencing factors. However, this study could have been more extensive in terms of the selection and number of sample sources owing to geographical constraints in China, which affected the overall impact factor model results. Therefore, the results of the relationship model of the

influencing factors will provide a theoretical reference for the subsequent development of BL and enhance the participation of secondary school teachers in applying BL in the future.

Author Contributions

Supervision, Muhd Khaizer Omar; Validation, Noor Syamilah Zakaria and Nurul Nadwa Zulkifli; Writing – original draft, Lin Wang. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

Ethics was approved by the Ethics Committee for Research involving Human Subjects of University Putra Malaysia (JKEUPM; approved JKEUPM-2022-063).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Conflicts of Interest

The authors declare no conflict of interest.

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