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# Validation of students blended learning course experience in Thai medical education

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**Abstract**

Blended learning is a widely used method in education to promote active learning and enhance students' learning outcomes. Therefore, evaluating the quality of blended learning courses requires an effective model for benchmarking, which can improve student satisfaction and is crucial for quality assurance in higher education. This study aimed to validate and examine student's blended learning course experience in Thai medical education using a quantitative research design. A total of 560 medical students from a large medical school in Thailand participated. Data analysis was conducted using Confirmatory Factor Analysis (CFA). The findings indicate that components and indicators were: (1) general skills with six indicators, (2) online sessions with five indicators, (3) clear goals and standards with four indicators, (4) good teaching with six indicators, (5) appropriate assessment with four indicators, and (6) appropriate workload with three indicators. The second order CFA demonstrated that the student blended learning course experience model had an acceptable fit with $\chi^2$ (249) = 1.148, $p$ = .056, RMSEA = .016, RMR = .005, SRMR = .05, GFI = .995, AGFI = .995, NFI = .961, and CFI = .995. These findings could contribute to the development of guidelines for designing a medicine bachelor's degree curriculum that incorporates blended learning methods.

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## Introduction

The dynamic field of medicine demands a dynamic approach to education, equipping future healthcare professionals with the knowledge, skills, and adaptability to navigate a complex and constantly changing landscape. Blended learning, a pedagogical strategy that merges traditional classroom instruction with online learning activities, has emerged as a powerful instrument in this endeavor (Wong et al., 2020). This approach offers several advantages over traditional methods, such as increased access to learning materials, accommodation of different learning styles, and potential improvement in critical thinking skills through interactive online components (Jebraeily et al., 2020; Luo et al., 2017; Makhdoom et al., 2013; Vallée et al., 2020; Westerlaken et al., 2019). Consequently, most higher education institutions have designed curricula based on a blended learning approach (Alammary et al., 2014; Mirriahi et al., 2015).

Quality teaching has become one of the most influential concepts in higher education. Governments have closely scrutinized the quality of teaching and learning in higher education institutions, focusing on undergraduate students' perceptions of teaching quality and learning experiences in many countries, including the US, the UK, and Australia (Andrew, 2010; Asonitou et al., 2018; Yin & Ke, 2017). Thailand's higher education system has implemented quality assurance mechanisms over the past decade to shift the focus from quantity expansion to quality enhancement. In 2015, the Ministry of Higher Education, Science, Research, and Innovation in Thailand initiated a five-year cycle for evaluating the quality of undergraduate teaching. The most standard criteria for educational quality assurance emphasize the reality of teaching practices, students' outcomes, and learning experiences. Within this context, evaluating the effectiveness of blended learning has become a critical area of focus (Ellis et al., 2016).

An evaluation of blended learning experiences and quality models are needed. Ginns and Ellis (2009) promoted the idea of e-learning in the blended learning experience of university students, creating a reliable questionnaire called "The Student Course Experience." This study used a large sample size method, which affects precision and replicability (Asonitou et al., 2018; Kassab et al., 2015; Kyriazos, 2018; Vo et al., 2020). In the context of Thailand, the medical education curriculum stands out as particularly challenging, complex, and practice-focused. Previous studies have found that students in different departments or contexts had different perceptions of their learning context (Andrew, 2010; Barattucci & Zuffo, 2012; Fryer et al., 2012; Ramsden, 1991). Confirmatory Factor Analysis (CFA), a popular and reliable method, confirms the performance of an assessment within a specific context.

This study focuses on validating core issues and examining the consistency between the students' course experience in blended learning within Thailand's medical curriculum and empirical data. The goal is to ensure quality and address challenges with a blended learning approach. This could involve pilot testing with students, conducting a CFA to ensure items measure intended constructs, and assessing internal consistency and reliability. The outcome of this study would contribute to social science by preparing educators to gain valuable insights into the effectiveness of their program design and student behavior in blended learning, identify areas for improvement, and prepare for quality assurance that will lead future medical professionals to success.

## Literature Review

### *Theoretical Background*

Blended learning, or hybrid learning, is a pedagogical approach that combines traditional face-to-face instruction with online activities (Makhdoom et al., 2013; Mubayrik, 2018). It incorporates various learning theories, including social learning theory, adult learning theory, and constructivism theory. Social learning theory suggests that learning occurs through observation, interaction, and mutual learning. Online forums and collaborative activities foster peer-to-peer learning and knowledge exchange, while face-to-face sessions provide opportunities for interaction with instructors and peers (Bandura & Walters, 1977; Devi et al., 2017; Makhdoom et al., 2013). Adult learning theory emphasizes self-directed learning, active participation, and the real-world application of knowledge (Makhdoom et al., 2013; McKenna et al., 2020). Blended learning allows students to learn at their own pace and explore topics independently (Jethro et al., 2012; May et al., 2009), while face-to-face sessions facilitate discussion, collaboration, and the application of knowledge in practice scenarios (Knowles et al., 2014; Makhdoom et al., 2013).

Based on constructivism theory, blended learning (Cheung & Hew, 2011; Cronje, 2020; Makhdoom et al., 2013; Westerlaken et al., 2019) encourages students to actively construct and apply their knowledge by engaging with various learning materials and interacting with teachers and peers. Online resources present foundational concepts, facilitate communication, and support inquiry and discovery learning, while face-to-face sessions encourage students to challenge assumptions through collaboration and discussion, building upon their existing knowledge base for problem-solving (Cheung & Hew, 2011; Vygotsky, 1987).

### *The Blended Learning Environments in Medical Education*

Blended learning is a pedagogical approach that combines online learning modules with traditional face-to-face instruction, revolutionizing medical education (Crawford & Jenkins, 2018; Medina, 2018). It offers numerous benefits, including increased access to learning materials, catering to diverse learning styles, and fostering crucial skills for lifelong learning. Online modules, often asynchronous and accessible anytime and anywhere, provide greater flexibility and control over the learning pace, allowing students with demanding clinical rotations or varied learning styles to explore topics at their convenience and revisit challenging concepts as needed (Chhetri, 2017; Shahabadi & Uplane, 2015; Westerlaken et al., 2019).

Blended learning goes beyond content delivery; actively engages students in the learning process through interactive online activities, simulations, and digital case studies. These activities stimulate critical thinking and problem-solving abilities, which are vital for navigating complex medical scenarios. Online forums and collaborative learning tools foster dialogue and knowledge exchange among students, replicating the collaborative nature of future practice (Hou, 2011; Nortvig et al., 2018).

The online component of blended learning often requires independent exploration of resources and completion of activities, fostering the development of essential self-directed learning skills (Akgunduz & Akinoglu, 2016; Geng et al., 2019). These skills are vital for future healthcare professionals to remain lifelong learners in a rapidly evolving field (Ilic et al., 2015; Rowe et al., 2012). Designing a successful blended learning program requires meticulous planning, selecting appropriate online resources, ensuring seamless integration between online and offline components, and training instructors to facilitate interactive and engaging sessions (Dangwal, 2017; Nortvig et al., 2018).

In conclusion, blended learning offers a transformative approach to medical education, empowering future healthcare professionals to navigate the complexities of the medical field and adapt to continuous advancements throughout their careers. By addressing potential challenges and continuously refining best practices, blended learning holds the potential to shape the future of medical education.

### *Assessing the Quality of Blended Learning through Students' Course Experiences*

The Student Course Experience (SCE) is a widely used instrument for assessing student experiences and feedback on teaching quality in higher education (Westerlaken et al., 2019; Yin & Ke, 2017). It has evolved from the course perceptions questionnaire developed at a British university by Ramsden (1979) and has been applied across 3,372 institutions from 13 Australian higher education institutions, making it multidisciplinary. The instrument has been revised to accommodate current students and address concerns about its psychometric functioning (Wilson et al., 1997).

Specifically, the SCE is designed for blended learning, measuring student satisfaction with online resources, face-to-face session facilitation, teaching performance, and the learning environment (Ginns & Ellis, 2009). It is a reliable instrument for assessing the blended learning environment. Validation through confirmatory factor analysis involving 3,602 students from 16 higher education faculties showed Cronbach's alpha values indicating internal consistency between 0.71 and 0.83. The instrument consists of 28 indicators with a six-factor structure, including good teaching, clear goals and standards, assessment, workload, e-learning or online components, and general skills. Previous studies have used the SCEQ as their basis, including those by (Ali & Mohd Dodeen, 2021; Andrew, 2010; Asonitou et al., 2018; Chakrabarty et al., 2016).

## Methodology

This study employed a quantitative survey method to validate students' blended learning course experiences in Thai medical education. It involved medical undergraduate students in their 2nd–6th year of

the Doctor of Medicine curriculum who utilized e-learning or online sessions to supplement their face-to-face curriculum at a large medical school in Thailand.

### *Participants*

The study analyzed data from medical undergraduate students (2nd–6th year) enrolled in a Doctor of Medicine program, a bachelor's degree program that used e-learning and online sessions to support the face-to-face curriculum at a large Thai medical school. The population consisted of 1,398 medical students, with a minimum sample size of 280 participants. The study followed Kyriazos' (2018) recommendations for CFA, ensuring a sample size at least 10:1 greater than the number of observed variables ($n$ = 28). The sample selection method involved random sampling, first selecting participants via quota sampling techniques according to year levels (2nd–6th year), representing 30 percent of the students per year level. Subsequently, convenience sampling techniques were used. Freshmen were excluded due to their lack of course experience.

### *Data Collection*

The study aimed to improve and develop scale items for data collection by converting the SCE based on Ginns & Ellis (2009), into a Thai version. For verification, three translators forward-translated the items to Thai, and then two translators back-translated them into English.

We implemented the following measures to evaluate the content's validity and reliability in the Thai version: (1) The content validity and reliability of the scale was verified by five university professors specializing in Medical Education, Foreign Language, Education Technology, Educational Assessment, and Psychological Measurement. The IOC values ranged from 0.60 to 1.00, with a cut-off value of .50 (Turner & Carlson, 2003); and (2) A trial run was conducted to assess the Cronbach's alpha coefficient of the scale, yielding a value of .95.

The scale consisted of two parts. The first part included three questions regarding demographic characteristics, such as gender, year level, and cumulative Grade Point Average (GPAx). The second part included six components covering 28 indicators, using five-point Likert scales to measure medical students' perception of their course experience in the blended learning program. An example question was, "The e-Learning systems and online sessions of medical teachers helped in learning in my Doctor of Medicine program." The measure was publicized, and medical student volunteers were invited to participate through posters.

Before conducting the survey, the research ethics committee of the author's institution formally examined and approved the scale and research procedures. Medical students were invited to participate voluntarily, and data collection was conducted over one month in September 2020. All survey results were collected electronically and encrypted for analysis.

### *Data Analysis*

This study analyzed data from 560 respondents (42.26%) who completed the research scale using licensed SPSS version 26 for descriptive analysis, corrected-item-total correlation, ANOVA, and correlation coefficient analysis. The internal consistency of the scale was assessed for reliability, yielding a Cronbach's alpha coefficient of .817 for the entire scale. The six components had Cronbach's alpha coefficients of .866, .755, .750, .760, .888, and .881, respectively.

Construct validity was investigated using ANOVA to analyze mean differences between known student groups, and the correlation coefficient was obtained to ascertain criterion validity. Confirmatory factor analyses were used to extract components and validate consistency between indicators and components using licensed AMOS. The study followed fit indices and criteria for evaluating CFA model, including $\chi^2/df \leq 3.00$, $p > .05$, RMSEA ≤ .08, RMR ≤ .05, SRMR ≤ .05, GFI ≥ .90, AGFI ≥ .90, NFI > .95, and CFI ≥ .95 (Hair et al., 2019).

## Results

### *Participants*

The study involved 560 medical students enrolled in a blended learning program within the medical curriculum. The majority were male ($n$ = 324, 57.7%). The distribution by education level was as follows: 4th year ($n$ = 146, 26.6%), 2nd year ($n$ = 135, 24.1%), 5th year ($n$ = 132, 23.6%), 3rd year ($n$ = 80, 14.3%) and 6th year ($n$ = 64, 11.4%). In terms of GPAx, most participants had a GPAx between 3.50–4.00 ($n$ = 300, 54.1%), 3.00–3.49 ($n$ = 225, 40.2%), 2.50–2.99 ($n$ = 29, 5.2%), and 2.00–2.49 ($n$ = 3, 5.0%).

*Descriptive Results*

According to Table 1, most participants performed at a median level in terms of good teaching, clear goals and standards, appropriate assessment, appropriate workload, online sessions, and general skills. The mean for each variable was greater than 3.40 out of a maximum of 5. The results of the correlation analysis between variables showed no significant differences across various demographic variables (gender, year level, and GPAx). These demographic variables did not meet the preliminary agreement for the ANOVA analysis. We also obtained the correlation coefficient to confirm the validity of the criteria.

In addition, we obtained the correlation coefficient to confirm the validity of the criteria. Bartlett's test of sphericity revealed that the six components (latent variables) were statistically significant at the .05 level, indicating relationships between the variables studied. Additionally, when testing the appropriateness of the variables used in CFA, the Kaiser-Meyer-Olkin (KMO) was .818, with the measure of sampling adequacy (MSA) ranging from .787 to .838, all exceeding the .50 threshold (Hair et al., 2019).

According to Table 2, each of the six components underwent validation using a measurement model. All components passed the criteria, indicating that all measurement models could be entered into the first order of CFA.

Considering factor loading (β) as shown in Table 3 and Figure 1, it was found that the standardized coefficients of the 28 indicators were positive, ranging from .219 to .823, and statistically significant at the .05 level. It can be concluded that the first order of CFA confirmed that the students' blended learning course experience model in the Thai medical education had a reasonable fit with $\chi^2/df = 1.145$, $p = .059$, RMSEA = .016, RMR = .005, SRMR = .053, GFI = .995, AGFI = .995, NFI = .962, and CFI = .995.

**Table 1** Descriptive, construct reliability and correlation of model

*n* = 560

| Factor | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Gender | 1 | 0.08 | 0 | -0.06 | -0.09* | -0.06 | 0.03 | 0.01 | -0.05 |
| Year | | 1 | 0.02 | -0.04 | -0.03 | 0.03 | 0.08 | 0.06 | 0.01 |
| GPAx | | | 1 | 0.07 | -0.14** | 0.07 | 0.14** | 0.02 | 0.13** |
| GT | | | | 1 | 0.52** | 0.33** | 0.17** | 0.46** | 0.48** |
| CG | | | | | 1 | 0.41** | 0.28** | 0.47** | 0.46** |
| AA | | | | | | 1 | .41** | 0.37** | 0.36** |
| AW | | | | | | | 1 | 0.32** | 0.31** |
| OS | | | | | | | | 1 | 0.60** |
| GS | | | | | | | | | 1 |
| M | 1.42 | 1.52 | 2.84 | 3.94 | 3.82 | 3.80 | 3.44 | 3.88 | 3.90 |
| SD | 0.49 | 0.62 | 1.33 | 0.60 | 0.61 | 0.65 | 0.67 | 0.72 | 0.58 |
| Bartlett's test = 954.022, $p < .01$, KMO = .818, MSA between .787–.838 | | | | | | | | | |

*Note: M* = mean, *SD* = standard deviation, Gender (male = 1, female = 2), Year level (a 2nd year = 1, a 3rd year = 2, a 4th year = 3, a 5th year, a 6th year = 6), GPAx (3.50–4.00 = 1, 3.00–3.49 = 2, 2.50–2.99 = 3, 2.00–2.49 = 4).
*$p < .05$, ** $p < .01$.

**Table 2** Measure model of the students' blended learning course experience in Thai medical education

| Components and number of indicators | β Ranges | *SE* Ranges | $R^2$ | Qualified criteria |
|---|---|---|---|---|
| Good teaching (GT: 6 indicators) | 0.620–0.808 | 0.047–0.056 | 0.384–0.654 | $\chi^2/df = 1.535$, $p = .175$, RMSEA = .031, RMR = .008, SRMR = .013, GFI = .995, AGFI = .981, NFI = .995, CFI = 998. |
| Clear goals and standards (CG: 4 indicators) | 0.208–0.863 | 0.057–0.061 | 0.043–0.745 | $\chi^2/df = .317$, $p = .728$, RMSEA = .001, RMR = .001, SRMR = .007, GFI = 1.000, AGFI = .981, NFI = .998, CFI = 1.000. |
| Appropriate assessment (AA: 3 indicators) | 0.315–1.00 | 0.035–0.037 | 0.099–1.00 | $\chi^2/df = .004$, $p = .951$, RMSEA = .036, RMR = .001, SRMR = .006, GFI = 1.000, AGFI = .98, NFI = 1.000, CFI = 1.000. |
| Appropriate workload (AW: 4 indicators) | 0.150–0.855 | .050 –.058 | 0.022–0.732 | $\chi^2/df = .885$, $p = .413$, RMSEA = .000, RMR = .008, SRMR = .009, GFI = .998, AGFI = .992, NFI = .996, CFI = 1.000. |
| Online sessions (OS 5 indicators) | 0.691–0.822 | 0.044–0.051 | 0.477–0.676 | $\chi^2/df = 1.375$, $p = .248$, RMSEA = .026, RMR = .007, SRMR = .01, GFI = .997, AGFI = .986, NFI = .997, CFI = .999. |
| General skills (GS: 6 indicators) | 0.695–0.815 | 0.483–0.664 | 0.483–0.664 | $\chi^2/df = 1.496$, $p = .163$, RMSEA = .030, RMR = .007, SRMR = .014, GFI = .994, AGFI = .981, NFI = .993, CFI = .998. |

**Table 3** Second-order of CFA of the students' blended learning course experience in Thai medical education

| Components | Manifest | β | *b* | *SE* | CR | $R^2$ | Order |
|---|---|---|---|---|---|---|---|
| 1. Good teaching | Q1 | .712 | .781 | .049 | 15.981*** | .509 | 4 |
| | Q2 | .798 | .893 | .051 | 17.612*** | .474 | 1 |
| | Q3 | .776 | 1.000 | <-> | <-> | .679 | 2 |
| | Q4 | .657 | .702 | .048 | 14.658*** | .464 | 5 |
| | Q5 | .737 | .861 | .053 | 16.110*** | .509 | 3 |
| | Q6 | .647 | .765 | .049 | 15.584*** | .568 | 6 |
| 2. Clear goals and standards | Q7 | .699 | .896 | .072 | 12.520*** | .575 | 3 |
| | Q8 | .698 | .949 | .074 | 12.800*** | .656 | 2 |
| | Q9 | .783 | 1.000 | <-> | <-> | .696 | 1 |
| | Q10 | .219 | .334 | .071 | 4.733*** | .569 | 4 |
| 3. Appropriate assessment | Q11 | .683 | 1.000 | <-> | <-> | .462 | 1 |
| | Q12 | .681 | .921 | .083 | 11.064*** | .278 | 2 |
| | Q13 | .438 | .595 | .072 | 8.261*** | .033 | 3 |
| 4. Appropriate workload | Q14 | .766 | .972 | .071 | 13.606*** | .677 | 2 |
| | Q15 | .823 | 1.000 | <-> | <-> | .586 | 1 |
| | Q16 | .183 | .235 | .059 | 4.010*** | .192 | 4 |
| | Q17 | .527 | .681 | .061 | 11.103*** | .464 | 3 |
| 5. Online sessions | Q18 | .680 | .750 | .044 | 17.062*** | .466 | 5 |
| | Q19 | .754 | .927 | .048 | 19.146*** | .048 | 4 |
| | Q20 | .834 | 1.000 | <-> | <-> | .613 | 1 |
| | Q21 | .810 | .936 | .045 | 20.938*** | .487 | 2 |
| | Q22 | .758 | .903 | .047 | 19.347*** | .489 | 3 |
| 6. General skills | Q23 | .754 | .918 | .051 | 17.930*** | .419 | 2 |
| | Q24 | .713 | .893 | .052 | 17.303*** | .543 | 3 |
| | Q25 | .681 | .891 | .048 | 18.542*** | .432 | 5 |
| | Q26 | .824 | 1.000 | <-> | <-> | .603 | 1 |
| | Q27 | .688 | .834 | .051 | 16.470*** | .636 | 4 |
| | Q28 | .714 | .881 | .051 | 17.317*** | .507 | 3 |
| Second order confirmatory factor analysis | | | | | | | |
| General skills | | .865 | .825 | .062 | <-> | .748 | 1 |
| Online sessions | | .829 | 1.000 | <-> | <-> | .687 | 2 |
| Clear goals and standards | | .664 | .691 | .064 | <-> | .441 | 3 |
| Good teaching | | .628 | .687 | .063 | <-> | .395 | 4 |
| Appropriate assessment | | .572 | .569 | .065 | <-> | .327 | 5 |
| Appropriate workload | | .273 | .333 | .064 | <-> | .074 | 6 |
| $\chi^2/df$ = 1.148, $p$ = .056, RMSEA = .016, RMR = .005, SRMR = .05, GFI = .995, AGFI = .995, NFI = .961, and CFI = .995. | | | | | | | |

*Note:* *** $p < .001$, two-tailed.

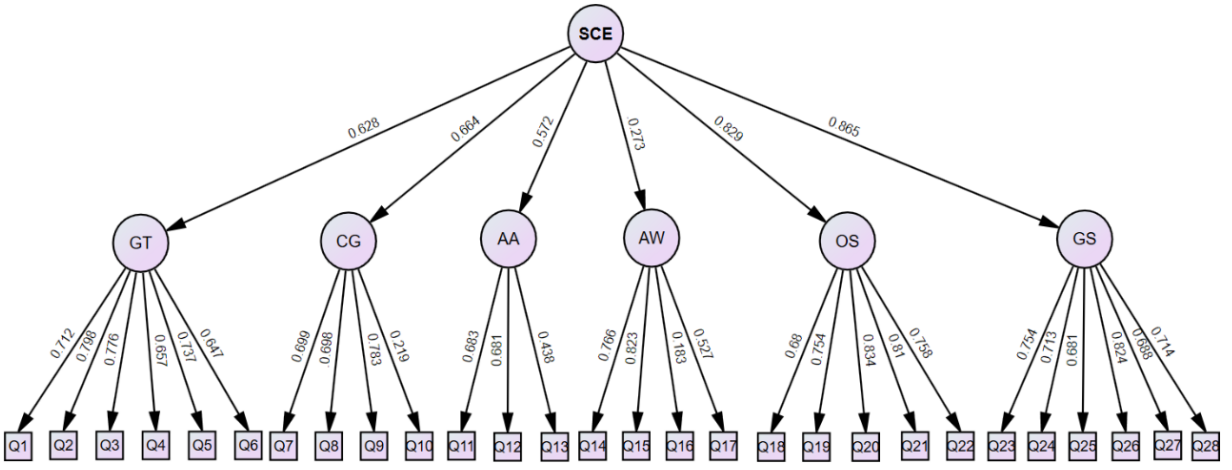


**Figure 1** CFA of the students' blended learning course experience in Thai medical education

The students' blended learning course experience in Thai medical education consists of six components, and the second order of CFA confirmed that this model had a reasonable fit between the model and the empirical data. The result revealed that the model showed $\chi^2/df$ = 1.148, $p$ = .055, RMSEA = .016, RMR = .005, SRMR = .053, GFI = .995, AGFI = .995, NFI = .961, and CFI = .995. For the first component of the students' blended learning course experience, "General Skills (GS)," the indicator "Q2" had the highest factor loading (β = .798). In the second component, "Online Sessions (OS)," the indicator "Q20" had the highest factor loading (β = .834). In the third component, "Clear Goals and Standards (CG)," the indicator "Q9" had the highest factor loading (β = .783). In the fourth component, "Good Teaching (GT)," the indicator "Q2" had the highest factor loading (β = .798). In the fifth component, "Appropriate Assessment (AS)," the indicator "Q11" had a higher factor loading (β = .683) than indicators Q12 and Q13, respectively. In the sixth component for "Appropriate Workload (AW)," the indicator "Q15" had the highest factor loading (β = .823).

Furthermore, these six components can explain the variability of the indicators in the student's blended learning experience model in Thai medical education. General skills were found to be the most important, explaining 74.8 percent of the variance. Online sessions explained 68.7 percent of the variance, Clear goals and standards explained 44.1 percent of the variance, and Good teaching explained 39.5 percent of the variance. Appropriate assessment accounted for 32.7 percent of the variance, while appropriate workload explained 0.74 percent of the variance in the SCE model.

## Discussion

This study validates and examines the relationship between students' blended learning course experiences and empirical data in Thai medical education. Medical students moderately rated their overall perception at 3.40, possibly due to the COVID-19 outbreak, which has not yet allowed blended learning to reach its full potential. Gender factors did not play a statistically significant role in predicting these perceptions, consistent with studies by Savara and Parahoo (2018) and Yin and Ke (2017), but differing from Yin et al. (2016). Additionally, year level and GPAx did not play a statistically significant role. However, students gave relatively high ratings to their perceptions of good teaching, general skills, online sessions, clear goals and standards, appropriate assessment, and appropriate workload. These results reflect a student-centered academic system.

The study validated the six-factor structure of the students' blended learning course experience in Thai medical education using Confirmatory Factor Analysis (CFA), discussing each component in descending order of squared multiple correlation ($R^2$ value).

Firstly, General Skills, such as critical thinking, problem-solving, communication and teamwork, had the highest impact on the students' perception of blended learning. These skills are vital because the medical profession demands quick, effective decision-making collaboration and solving in real-world clinical settings. Blended learning environments enhance these skills by offering diverse learning activities like online activities, case studies, and problem-solving simulations. The online components allow students to engage with materials independently, fostering self-directed learning, while face-to-face interactions help them apply their knowledge in practice scenarios. For example, online forums and group assignments enhance communication and teamwork (He & Huang, 2017), while case scenarios and simulations improve critical thinking and problem-solving abilities (Hou, 2011). This is crucial for medical professionals working in multidisciplinary teams, shown as the studies of Asonitou et al. (2018) and Stergiou and Airey (2012), who found that the general skills component had the highest predictive value in the course experience structure of Greek students.

Secondly, Online Sessions are a significant factor in the success of blended learning. For medical students, flexibility and accessibility are critical, as they often juggle demanding clinical rotations. Online modules allow them to access course materials at their convenience, revisit challenging concepts, and learn at their own pace (Ally & Samaka, 2013). The asynchronous nature of many online activities allows students to review material multiple times, enhancing comprehension and retention. This adaptability supports the self-regulation required in the medical field, where continuous learning is essential for staying updated with medical advancements. Furthermore, online sessions offer interactive simulations and virtual case studies (Dailey-Hebert, 2018), which are vital in developing clinical decision-making skills. This is consistent with Kintu et al. (2017), who indicated that the quality of the learning management system can predict good performance in blended learning.

Thirdly, Clear Goals and Standards are crucial for guiding medical students through the complexity of their education. Medical education requires precise learning outcomes, and students must understand what

is expected or learning objectives of them in terms of both knowledge and practical skills. Blended learning environments with well-defined objectives ensure that all components both online and offline are aligned and contribute to the overall educational goals (Graham et al., 2013; Krajcik et al., 2008). This alignment is particularly important for medical students, who need to balance theoretical knowledge with practical skills, ultimately supporting student success.

Fourth, Good Teaching is essential in blended learning environments (Anthony et al., 2019), especially in medical education, where instructors play a pivotal role in guiding students through complex clinical and theoretical content. Instructors must be adept at using both online and face-to-face teaching methods to provide constructive feedback, clarify difficult concepts, and support students' learning journeys. Medical students benefit from teachers who can bridge the gap between theoretical knowledge and practical application, helping them to develop clinical reasoning skills. Although ranked fourth, good teaching remains an important component of blended learning (Asonitou et al., 2018; Ginns & Ellis, 2007; Ginns & Ellis, 2009; Ginns et al., 2007; Saputra et al., 2021; Stergiou & Airey, 2012). This lower ranking may be due to some medical teachers' lack of experience with blended learning methods.

Fifth, Appropriate Assessment in blended learning environments for medical students has less predictive value because in this context traditional assessments struggle to evaluate hands-on skills critical to medical practice, reducing their effectiveness in blended learning. Students often view online assessments as less rigorous, further diminishing their predictive value. Additionally, a heavy reliance on final exams can overlook continued clinical skills development. Therefore, medical teachers and instructional designer should combine formative and summative assessments to provide a comprehensive picture of student progress (Broadbent et al., 2021).

Lastly, Appropriate Workload, while workload is important, often receives lower predictive value in blended learning environments. Medical students, in particular, face significant demands on their time due to clinical rotations and intensive study schedules, consistent with previous studies (Ginns & Ellis, 2007; Stergiou & Airey 2012). Furthermore, the study by Asonitou et al. (2018) and Saputra et al. (2021) indicated that students may struggle to identify the "appropriate workload" factor due to negative wording in three of the four items in this component.

## Conclusion and Recommendation

In conclusion, the second-order CFA confirmed that the indicator model accurately reflected students' blended learning course experience in Thai medical education. An effective blended learning quality assessment instrument can guide the design of the Doctor of Medicine program and other online and face-to-face courses, serving as a key part of educational quality assurance. The success of blended learning in Thai medical education depends on key factors such as developing general skills, online sessions, clear goals and standards, good teaching, appropriate assessment, and appropriate workload. These components are interrelated and significantly impact the effectiveness of blended learning, particularly for medical students. By focusing on these components, medical educators can create a more effective, engaging, and flexible learning environment that prepares students for the complexities of medical practice.

The findings of this study provide valuable insights into the effectiveness of blended learning in medical education, and the recommendations can be extended to broader social science. It is essential to apply similar research methods to explore how blended learning influences other professional fields that require practical skills. Future research in social science should focus on longitudinal studies to assess the sustained impact of blended learning on key outcomes such as professional competence, knowledge retention, and practical skills. This will help in understanding how blended learning shapes professional development over time. Additionally, research should explore the role of technological proficiency by examining the influence of digital literacy and access to resources in enhancing the effectiveness of blended learning. Future studies should focus on identifying gaps in access to technology and proposing solutions to bridge this divide, ensuring equitable opportunities for all students.

Lastly, research should investigate the impact of blended learning on key behavioral factors, including self-regulation, time management, and stress levels among medical students. Focusing on these areas can offer crucial insights into how students manage the demands of blended learning. Such findings would contribute to optimizing learning strategies and enhancing the overall effectiveness of medical education in Thailand. By understanding these behavioral outcomes, educators can tailor blended learning approaches to better support students' academic and emotional well-being.

## Conflict of Interest

The authors declare that there is no conflict of interest.

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## Ethical Approval Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Human Research Protection unit of Faculty of Medicine Siriraj Hospital, Mahidol University (protocol code 691/2562(EC1) and date of approval 3 March 2020.

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