Ziyi et al. BMC Medical Education (2024) 24:964
https://doi.org/10.1186/s12909-024-05932-y

BMC Medical Education

RESEARCH Open Access

Development of a basic evaluation model for manual therapy learning in rehabilitation students based on the Delphi method

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Abstract

Objective Manual therapy is a crucial component in rehabilitation education, yet there is a lack of models for evaluating learning in this area. This study aims to develop a foundational evaluation model for manual therapy learning among rehabilitation students, based on the Delphi method, and to analyze the theoretical basis and practical significance of this model.

Methods An initial framework for evaluating the fundamentals of manual therapy learning was constructed through a literature review and theoretical analysis. Using the Delphi method, consultations were conducted with young experts in the field of rehabilitation from January 2024 to March 2024. Fifteen experts completed three rounds of consultation. Each round involved analysis using Dview software, refining and adjusting indicators based on expert opinions, and finally summarizing all retained indicators using Mindmaster.

Results The effective response rates for the three rounds of questionnaires were 88%, 100%, and 100%, respectively. Expert familiarity scores were 0.91, 0.95, and 0.95; coefficient of judgment were 0.92, 0.93, and 0.93; authority coefficients were 0.92, 0.94, and 0.94, respectively. Based on three rounds of consultation, the model established includes 3 primary indicators, 10 secondary indicators, 17 tertiary indicators, and 9 quaternary indicators. A total of 24 statistical indicators were finalized, with 8 under the Cognitive Abilities category, 10 under the Practical Skills category, and 6 under the Emotional Competence category.

Conclusion This study has developed an evaluation model for manual therapy learning among rehabilitation students, based on the Delphi method. The model includes multi-level evaluation indicators covering the key dimensions of Cognitive Abilities, Practical Skills, and Emotional Competence. These indicators provide a preliminary evaluation framework for manual therapy education and a theoretical basis for future research.

Keywords Manual therapy, Delphi method, Rehabilitation education, Educational model

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Introduction

The term "manual therapy" has traditionally been associated with physical therapists who examine and treat patients who have disorders related to the musculoskeletal system [1]. In vocational colleges in China, manual therapy techniques are an essential part of the rehabilitation education curriculum, integrating traditional Chinese medicine and modern medical teaching methods. These techniques include methods such as neurological rehabilitation, and the level of proficiency in these skills directly impacts the professional capabilities of students after graduation. In documents related to rehabilitation competency by the World Health Organization [2–4], it is noted that traditional teaching implicitly links the health needs of the population to the curriculum content. It also introduces competency-based education, which explicitly connects the health needs of the population to the competencies required of learners. The Rehabilitation Competency Framework (RCF) suggests a methodology for developing a rehabilitation education and training program and curriculum that can support competency-based education [5]. Research indicates that manual therapy education needs reform [6]. The existing evaluation models for manual therapy learning among rehabilitation students face several challenges: the use of equipment for objective assessments is cumbersome, the aspects of evaluation are not comprehensive, and there is a gap between the data from expert practices and the guidance provided to students. Some existing research has proposed models in specific manual therapy instruction. For example, the "Sequential Partial Task Practice (SPTP) strategy" was introduced in spinal manipulation (SM) teaching [7], and studies focusing on force-time characteristics [8, 9] to summarize manual techniques for subsequent teaching. Some approaches apply specific techniques to specific diseases [10]. However, in terms of overall talent development, we may still need a more comprehensive and practical model.

Learning rehabilitation therapy techniques involves comprehensive skill development. Although some studies [11, 12] have addressed the mechanisms of manual therapy, manual therapy based on mechanical actions should be considered one of the most important skills for rehabilitation therapists to focus on [13]. Currently, the training of rehabilitation students in vocational colleges primarily relies on course grades, clinical practice, and final-year exams to assess students before they enter society. However, these assessments often fail to meet the evaluation needs of employers, schools, teachers, patients/customers, and the students themselves regarding their rehabilitation capabilities. We lack a model for evaluating students' manual therapy skills, especially for beginners. Developing a foundational evaluation model that integrates existing courses and clinical practice, in line with the World Health Organization's Rehabilitation Competency Framework, holds significant practical and instructional value. This study aims to construct a foundational evaluation model for manual therapy learning among vocational school rehabilitation students through expert consultation. We present the following article following the CREDES reporting checklist (available at https://figshare.com/s/2886b42de467d58bd631) and the survey was performed according to the Delphi studies criteria [14].

Methods

Design

This study employs the Delphi method for the following reasons [5, 15–18]: Different experts have different emphases in manual therapy evaluation, and we need to collect a wide range of opinions and suggestions; unlike a focus group discussion, the anonymity of the Delphi method can reduce some disturbances in achieving consensus; the Delphi method allows for multiple rounds of consultation, facilitating the optimization of the model and flexible adjustment of issues that arise during consultation; the Delphi method is also used in constructing competency models for rehabilitation and has been maturely applied in closely related fields such as nursing. The research is mainly carried out in three stages: (1) Preparatory phase; (2) Delphi phase; (3) Reach consensus (Fig. 1).

Literature review

We utilized databases from PubMed to search for and collect literature focused on the theme of rehabilitation education. With the MeSH terms related to "manual therapy" and "education" were used in PubMed. We also studied the World Health Organization's (WHO) guidelines on rehabilitation competencies, gathered score sheets from national rehabilitation skills competitions, and collected training programs for students of rehabilitation therapy technology in vocational colleges in Jiangsu Province. This helped us to identify and organize the indicators that may be involved in the basic manual therapy learning of students.

Design consulting framework

The selection of experts for the study followed the principle of representativeness, considering factors such as educational qualifications, years of professional experience, and the type of workplace, which included schools, hospitals, and studios. It was ensured that each round included at least 15 experts [15]. Each round of questionnaires sent to experts is reviewed and tested. An initial list of 20 experts was created, and after a preliminary survey, the consultation list for the first round was determined randomly. The second round was organized based on the feedback and the collection of expert questionnaires from the first round, and the third round was set up following the second round's feedback and questionnaire collection, continuing until the criteria for concluding the study were met. Inclusion criteria for experts included: (1) having a bachelor's degree or higher; (2) at least two years of experience in teaching or mentoring;

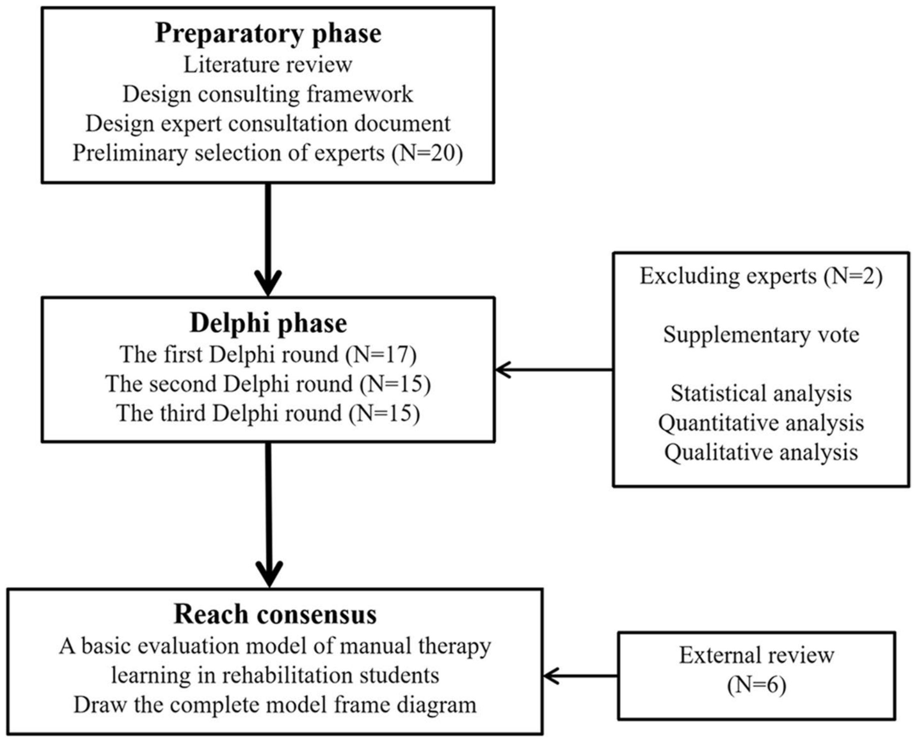

Fig. 1 The flow chart of the research

(3) achievements in provincial or national rehabilitation skills competitions or having guided students to such achievements; (4) high level of enthusiasm; and adherence to the principles of informed consent and voluntariness.

The main contents of expert consultation include the experts' evaluation of the importance of the basic assessment indicators for students' manual therapy learning, suggestions for building the model, basic information about the experts, and self-evaluations of the "basis for expert judgment" and "familiarity level". Importance evaluation follows the Likert five-point rating scale, ranging from "very important" to "not important," with scores assigned from 5 to 1, respectively. Expert Judgment Basis Coefficient (Ca): This includes aspects of work experience, theoretical analysis, understanding of domestic and international peers, and intuitive feelings, scored at three levels: high, medium, and low, with coefficients of 0.4, 0.3, 0.2 (work experience), 0.3, 0.2, 0.1 (theoretical analysis), 0.2, 0.1, 0.1 (understanding of peers), and 0.1, 0.1, 0.1 (intuitive feelings).Expert Familiarity Score (Cs): Rated over five levels: very familiar (1.0), familiar (0.8), moderately familiar (0.5), unfamiliar (0.2), and very unfamiliar (0.0). Expert Authority Coefficient (Cr): Indicates the level of expert authority, represented by the average of the Expert Judgment Basis Coefficient and Expert Familiarity Score. The prediction accuracy increases with the level of expert authority; an Expert Authority Coefficient ≥ 0.70 is considered acceptable, while this study uses an Expert Authority Coefficient > 0.8.

Statistical analysis

In this study, Excel and Dview software were used to analyze and process the data generated in each round. The degree of agreement among experts was analyzed using the coefficient of concordance and the coefficient of variation. The Kendall's W coefficient of concordance, calculated through Dview software, is represented by W, which ranges from 0 to 1. A higher W value indicates better agreement among experts, and vice versa. If the *P*-value corresponding to W is less than 0.05, it can be considered that there is consistency in the experts' ratings of the indicator system. The coefficient of variation (CV) is the ratio of the mean importance score of a certain indicator to its standard deviation; a smaller CV indicates a higher degree of agreement among experts about this indicator. This paper uses the coefficient of variation (CV) and Kendall's W (W) to assess the level of agreement among expert opinions. A $CV < 0.25$ suggests a tendency towards consensus among experts. The concentration of expert opinions is represented by the arithmetic mean and the frequency of maximum scores. The arithmetic mean is the average of the experts' importance scores for a particular indicator; a higher mean indicates greater importance of the indicator in the system. The frequency of maximum scores is the ratio of the number of experts who gave the highest score to an indicator to the total number of experts who rated that indicator; a higher frequency of maximum scores indicates greater importance of the indicator in the system.

A clear and transparent guide for action

During the indicator selection process, this paper adopts the "threshold method" for selecting indicators. The threshold calculation formulas used are as follows: For maximum score frequency and arithmetic mean, the threshold is calculated as "Threshold = Mean - Standard Deviation." We will select indicators that score above this threshold. For the coefficient of variation, the threshold is calculated as "Threshold = Mean + Standard Deviation." We will select indicators that score below this threshold. To ensure that key indicators are not eliminated, we will discard indicators that do not meet all three criteria. For indicators that do not meet one or two criteria, we will modify or discuss selection based on principles of rationality and systematicity. Modifications to the model content are generally confirmed by discussions between two experts. If the two experts cannot reach a consensus, a voting process is introduced for the disputed parts, and consensus is formed through expert voting. The process ends when all consulting experts no longer propose new suggestions for the overall model, and all indicators meet the inclusion criteria.

Basic principles of the model and model presentation

This study establishes two basic principles before constructing the target model. (1) The comprehensiveness of the model, where the dimensions of the assessment indicators built into the model are relatively comprehensive. (2) The flexibility of using the model, allows for flexible application across different scenarios, techniques, and personnel. Additionally, the model can be continuously supplemented and developed through further research. After consensus is reached, use MindMaster software to draw the final model.

Ethical considerations

The assignment for technical design, informed consent form, and data report form were approved by the Research Ethical Committee of Yancheng TCM Hospital Affiliated to Nanjing University of Chinese Medicine according to the World Medical Association Declaration of Helsinki Ethical. Approval number: KY230905-02.

Results

Basic information of experts

In this study, an initial list of 20 experts was drafted. After a preliminary survey of their intentions, one expert who did not respond was excluded, and two with insufficient participation intentions were also excluded. This confirmed a list of 17 experts for the first round of consultation. After the first round, two experts whose authority coefficients were less than 0.8 were excluded, resulting in a final selection of 15 young experts from rehabilitation therapy-related schools, hospitals, and studios in Jiangsu Province (Table 1). The average age was 34.1 ± 6.6 years, and the average teaching tenure was 8.8 ± 7.7 years. Among them, one had an undergraduate degree, and 14 had graduate degrees or higher. All completed all three rounds of the survey. The level of expert engagement was indicated by the response rate of the expert consultation form, reflecting their concern for the study. The effective response rates were 88% for the first round, and 100% for the second and third rounds, all well above the 70% considered excellent. The average familiarity of the experts with the rounds was 0.91, 0.95, and 0.95 respectively, and the judgment basis coefficients were 0.92, 0.93, and 0.93. The authority coefficients were 0.92, 0.94, and 0.94 respectively.

Results of three rounds of the Delphi phase

The experts' scoring data was organized in Excel and imported into DView software to calculate Kendall's

Table 1 Summary of professional information of 17 experts

Expert number	Ca	Cs	Cr	Background	Achievement
1	1.0	1.0	1.00	Medical college	Provincial level
2	0.9	1.0	0.95	Medical college	Provincial level
3	0.9	1.0	0.95	Comprehensive university	Provincial level
4	1.0	1.0	1.00	Comprehensive university	National level
5	1.0	0.8	0.90	Top hospital	Provincial level
6	***0.8***	***0.8***	***0.80***	***First-tier market***	***Provincial level***
7	0.9	1.0	0.95	Medical college	Provincial level
8	1.0	0.8	0.90	Sports college	National level
9	***1.0***	***0.5***	***0.75***	***Top hospital***	***Provincial level***
10	0.7	1.0	0.85	Medical college	National level
11	1.0	1.0	1.00	First-tier market	National level
12	1.0	0.8	0.90	Top hospital	National level
13	1.0	0.8	0.90	First-tier market	National level
14	0.7	1.0	0.85	Special education	Provincial level
15	0.8	1.0	0.90	Comprehensive university	National level
16	1.0	1.0	1.00	Sports college	National level
17	1.0	1.0	1.00	Community hospital	National level

Remarks: Ca: Expert Judgment Basis Coefficient, Cs: Expert Familiarity Score, Cr: Expert Authority Coefficient. The number 6 and 9 are eliminated

Table 2 Three rounds of consultation expert opinion coordination degree

Phase	W	X^2	*P*
The first Delphi round	0.215	28.991	< 0.001
The second Delphi round	0.310	106.971	< 0.001
The third Delphi round	0.243	83.805	< 0.001

Remarks: W: Kendall's W coefficient of concordance, X^2: Chi-square, P: The progressive significance *P* value

Table 3 First round threshold method table

Indicator	Mean	SD	Threshold
Arithmetic Mean	4.3400	0.2905	4.0495
Coefficient of Variation	0.1618	0.0374	0.1992
Full Score Frequency	0.4867	0.1861	0.3006

SD Standard Deviation

coefficient of concordance W, the progressive significance *P* value, chi-square, mean, coefficient of variation, and the frequency of full marks. The degree of opinion coordination and concentration of expert opinions across three rounds was summarized. The threshold method combined with expert views was applied to refine the model after three rounds of indicator screening. The table (Table 2) shows that the experts' scoring on the indicator system was consistent across all three rounds.

The first Delphi round results

This round still included input from experts number 6 and 9 (Table 1). After the first round of consultation, according to the threshold principle (Table 3), the arithmetic mean and full score frequency of the primary indicator "Knowledge" in "On-campus" under "Relevant course scores" and "Off-campus" under "Relevant Skills Knowledge" did not meet the threshold. In the primary indicator "Skill", under "Force" for "Quantitative (Instrument)" the coefficient of variation did not meet the threshold (Table 4). These findings suggest that the indicators set under "Knowledge" and "Skill" require significant modification, combined with the feedback from the consolidated advice of the 17 experts. There were 7 suggestions for optimizing the "Knowledge" indicator, 4 suggestions for "Skill", 6 suggestions for "Emotion," and 7 suggestions for the overall framework. We have redefined the "Knowledge" category as "Cognition" to broaden its conceptual scope [19], incorporating the indicator evaluation dimension of "Clinical Reasoning in Rehabilitation" [20–22]. For the "Skill" category, we included "Proficiency" [23, 24] and "Subject Evaluation/Effectiveness" [25] as indicator evaluation dimensions and divided "Applicability Judgment" [26–29] and "Positioning selection" into four levels of indicators. For the "Emotion" category, we revised the indicators of "Car" and "Respect" to "Conduct and Demeanor" and "Professional Conduct," dividing "Conduct and Demeanor" into four levels and "Professional Conduct" into three levels [30]. These

Table 4 First Round Expert Scoring results

Primary Indicator	Secondary Indicator	Tertiary Indicator	SD	Mean	CV	Full Score Frequency
Knowledge	On-campus	Core Course Scores (School)	0.5164	4.5333	0.1139	0.5333
		Related Course Scores (School)	0.6761	3.8000	0.1779	0.1333
	Off-campus	Clinical Practice (Practice Base)	0.4880	4.6667	0.1046	0.6667
		Relevant Skills Knowledge (Self-assessment)	0.7037	3.9333	0.1789	0.2000
Skill	Selection	Judgment of Applicability (Self-assessment/Peer-assessment)	0.8281	4.4000	0.1882	0.5333
		Positioning (Patient & Therapist)	0.6325	4.6000	0.1375	0.6667
	Force	Qualitative (Evaluator)	0.8165	4.3333	0.1884	0.4667
		Quantitative (Instrument)	0.9411	4.2000	0.2241	0.5333
Emotion	Care	Command of Manners (Evaluator)	0.7237	4.3333	0.167	0.4667
	Respect	Overall Process (Evaluator)	0.6325	4.6000	0.1375	0.6667

SD Standard Deviation, *CV* Coefficient of Variation recommendations were integrated into the design of the second-round consultation form to further explore the scientific nature of the model.

The second Delphi round results

After the second round of consultation, according to the threshold principle (Table 5), the primary indicator "Cognition" under "On-campus" for "Related Course Scores" did not meet the threshold for the arithmetic mean, and the coefficient of variation for "Clinical Practice Site Assessment" under "Off-campus" did not meet the threshold. Additionally, the average and full score frequency for "Related Skills and Knowledge Learning Ability Assessment" under "Off-campus" did not meet the threshold. For the primary indicator "Emotion", under "Conduct and Demeanor", the average and full score frequency for "Appearance and Dress" and the coefficient of variation for "Preparation of Materials" did not meet the threshold (Table 6). We consolidated the feedback from 15 experts and optimized the model. There were 11 optimization suggestions for the "Cognition" indicator, 3 for "Skill", and 3 for "Emotion." Regarding whether the tertiary indicator "Core Courses Scores" should be detailed into "Theoretical scores" and "Practical scores", 13 experts chose "yes," one chose "no," and one was uncertain, thus it was adopted. Concerning whether to divide the tertiary indicators "Communication" and "Conduct and Behavior" into quaternary indicators, 7 experts chose "yes," 7 chose "no," and one was uncertain. Considering the actual application scenario and the simplicity of the model, we retained the quaternary indicators for "Communication" and removed the related quaternary indicators for "Conduct and Behavior". Additionally, in the "Cognition" part of the "Clinical Reasoning in Rehabilitation", we added "Science Popularization and Patient Education Awareness" [31, 32]; in "Skill", we added "Palpation identification" [33–35]; and in "Emotion" under "Professional Conduct," we replaced "Respectful and Compassionate Thinking" with "Benevolent Physician Mindset". After considering the content covered by nouns and the need for translation understanding, we further adjusted some expressions in the whole framework. The primary indicator "Cognitive", "Skill" and "Emotion" were changed into "Cognitive Abilities", "Practical Skills" and "Emotional Competence". The secondary indicators "On-campus" and "Off-campus" are replaced by "Academic Performance" and "External Assessment", and some other details are adjusted. These recommendations were integrated into the design of the third-round consultation form.

Table 5 Second round threshold method table

Indicator	Mean	SD	Threshold
Arithmetic Mean	4.3694	0.3394	4.0300
Coefficient of Variation	0.1370	0.0390	0.1760
Full Score Frequency	0.4778	0.2356	0.2422

SD Standard Deviation

The third Delphi round results

After the third round of consultation, according to the threshold principle (Table 7), the average for "Related Course Grades" under "Academic Performance" in the primary indicator "Cognition Abilities" did not meet the threshold, nor did the average and full score frequency for "Science Popularization and Patient Education Awareness" under "Clinical Reasoning in Rehabilitation". Additionally, the coefficient of variation for "Professional Expression" under "Communication" in "Conduct and Demeanor" within "Emotional Competence" did not meet the threshold (Table 8). After expert discussion, it was considered acceptable that these three indicator thresholds were exceptional. The 15 experts did not suggest further modifications to the model's framework or content of indicators, indicating a stable and ideal concentration of opinions. Consequently, it was decided not to proceed with a fourth round of questionnaire survey.

Model presentation and external review

After the third round of research and investigation, we used Mindmaster software to draw the final model diagram (Fig. 2). Ultimately, three primary indicators, ten secondary indicators, seventeen tertiary indicators, and nine quaternary indicators were identified. Six experts evaluated the final model, and all agreed that it is relatively well-developed. Three experts raised concerns about the weighting of indicators, which may be the focus of our next phase of research. Additionally, one expert expressed great anticipation for feedback from the actual teaching application scenarios of this model.

Discussion

The design of teaching assessments for manual therapy education

A key aspect of manual therapy education in rehabilitation lies in understanding the "practice and case" paradigm [36–38]. Students transition from classroom learning in school to stage-wise assessment of their learning outcomes before entering the professional sphere, where their clinical practice mindset may evolve [20] but remain consistent in principle throughout. In our model, there is a concept of a "simulated patient", which involves simulating assessments using standardized patients or cases representing various types of illnesses. This allows beginners to quickly narrow the gap in operational skills

Table 6 Second round expert scoring results

Primary Indicator	Secondary Indicator	Tertiary Indicator	Quaternary Indicator	SD	Mean	CV	Full Score Frequency
Cognitive	On-campus	Core Course Scores	Theoretical Score	0.6325	4.4000	0.1437	0.4667
			Practical Score	0.3519	4.8667	0.0723	0.8667
		Related Course Scores		0.6172	3.6667	0.1683	0.0667
	Off-campus	Clinical Practice Site Assessment		0.8165	4.3333	0.1884	0.5333
		Related Skills and Knowledge Learning Ability Assessment		0.6399	3.8667	0.1655	0.1333
	Clinical Reasoning in Rehabilitation	Problem Analysis		0.3519	4.8667	0.0723	0.8667
		Problem Solving		0.4140	4.8000	0.0863	0.8000
Skill	Selection	Applicability Judgment	Appropriateness of Technique Selection (Contraindications and Indications Assessment)	0.3519	4.8667	0.0723	0.8667
			Appropriateness of Progression and Regression	0.5164	4.4667	0.1156	0.4667
		Position Selection	Therapist Positioning	0.6172	4.3333	0.1424	0.4000
			Patient Positioning	0.6325	4.4000	0.1437	0.4667
	Force Application	Qualitative Assessment		0.5606	4.2000	0.1335	0.2667
		Quantitative Evaluation		0.7037	4.0667	0.173	0.2667
	Proficiency	Overall Diagnostic and Treatment Process		0.6399	4.5333	0.1412	0.6000
		Overall Operation Status		0.4880	4.3333	0.1126	0.3333
	Subject Evaluation/Effectivenes			0.6399	4.4667	0.1433	0.5333
Emotion	Conduct and Demeanor	Communication	Fluent Expression	0.6325	4.4	0.1437	0.4667
			Professional Expression	0.7037	4.0667	0.173	0.2667
			Clear and Comprehensive Response	0.5071	4.4000	0.1152	0.4000
		Conduct and Behavior	Appearance and Dress	0.7988	3.7333	0.214	0.2000
			Preparation of Materials	0.7432	4.1333	0.1798	0.3333
			Observation of Responses to Patient Feedback	0.4140	4.8000	0.0863	0.8000
	Professional Conduct	Respectful and Compassionate Thinking		0.7037	4.2667	0.1649	0.4000
		Scientific Diagnostic and Therapeutic Reasoning		0.6325	4.6000	0.1375	0.6667

SD Standard Deviation, *CV* Coefficient of Variation

Table 7 Third round threshold method table

Indicator	Mean	SD	Threshold
Arithmetic Mean	4.3944	0.2800	4.1144
Coefficient of Variation	0.1352	0.0336	0.1688
Full Score Frequency	0.4806	0.2162	0.2644

SD Standard Deviation

compared to experts [25]. The advancement of teaching philosophies has posed challenges in integrating the biopsychosocial model into manual therapy practices [30]. Students' expectations regarding manual skills in physical therapy, along with reflections on the experiences of touch, both receiving and administering, can foster an understanding of the philosophical aspects of science, ethics, and communication [19]. The COVID-19 pandemic has altered the clinical practice and education of manual therapy globally [39]. Past classical teaching methods, such as Peyton's four-step approach to teaching complex spinal manipulation techniques, have been found superior to standard teaching methods, effectively imparting intricate spinal manipulation skills regardless of gender [40]. Additionally, other methods

Table 8 Third round expert scoring results

Primary Indicator	Secondary Indicator	Tertiary Indicator	Quaternary Indicator	SD	Mean	CV	Full Score Frequency
Cognitive Abilities	Academic Performance	Core Course Grades	Theoretical Grades	0.6761	4.2000	0.161	0.3333
			Practical Grades	0.3519	4.8667	0.0723	0.8667
		Related Course Grades (Overall Performance)		0.5936	3.7333	0.159	0.0667
	External Assessment	Clinical Practice Site Assessment (Overall Competency)		0.7432	4.5333	0.1639	0.6667
		Related Skills and Knowledge Learning Ability Assessment (Overall Competency)		0.7432	4.1333	0.1798	0.3333
	Clinical Reasoning in Rehabilitation	Problem Analysis (Personalized Plan Development)		0.3519	4.8667	0.0723	0.8667
		Problem Solving (Plan Implementation and Problem Fit)		0.4140	4.8000	0.0863	0.8000
		Science Popularization and Patient Education Awareness		0.5936	4.0667	0.146	0.2000
Practical Skills	Selection	Applicability Judgment	Appropriateness of Technique Selection (Contraindications and Indications Assessment)	0.3519	4.8667	0.0723	0.8667
			Appropriateness of Progression and Regression	0.5164	4.5333	0.1139	0.5333
		Position Selection	Therapist Positioning	0.5936	4.2667	0.1391	0.3333
			Patient Positioning	0.6325	4.4	0.1437	0.4667
	Palpation Identification			0.5164	4.5333	0.1139	0.5333
	Force Application	Qualitative Assessment		0.5606	4.2000	0.1335	0.2667
		Quantitative Evaluation		0.7037	4.2667	0.1649	0.4000
	Proficiency	Overall Diagnostic and Treatment Process		0.6399	4.5333	0.1412	0.6000
		Overall Operation Status		0.488	4.3333	0.1126	0.3333
	Subject Evaluation/Effectiveness			0.6399	4.4667	0.1433	0.5333
Emotional Competence	Conduct and Demeanor	Communication	Fluent Expression	0.7037	4.2667	0.1649	0.4000
			Professional Expression	0.7746	4.2	0.1844	0.4000
			Clear and Comprehensive Response	0.5164	4.4667	0.1156	0.4667
		Conduct and Behavior (Attention to Appearance, Preparation of Materials, and Response to Patient Feedback)		0.6399	4.1333	0.1548	0.2667
	Professional Conduct	Benevolent Physician Mindset		0.7037	4.2667	0.1649	0.4000
		Scientific Diagnostic and Therapeutic Reasoning		0.6399	4.5333	0.1412	0.6000

SD Standard Deviation, *CV* Coefficient of Variation

involving the integration of teaching with clinical practice [38], interdisciplinary group learning approaches [41], and utilization of instructional videos instead of live demonstrations [42] have also been explored. From the initial use of closed-circuit television in massage education [43], we have progressed to leveraging the internet

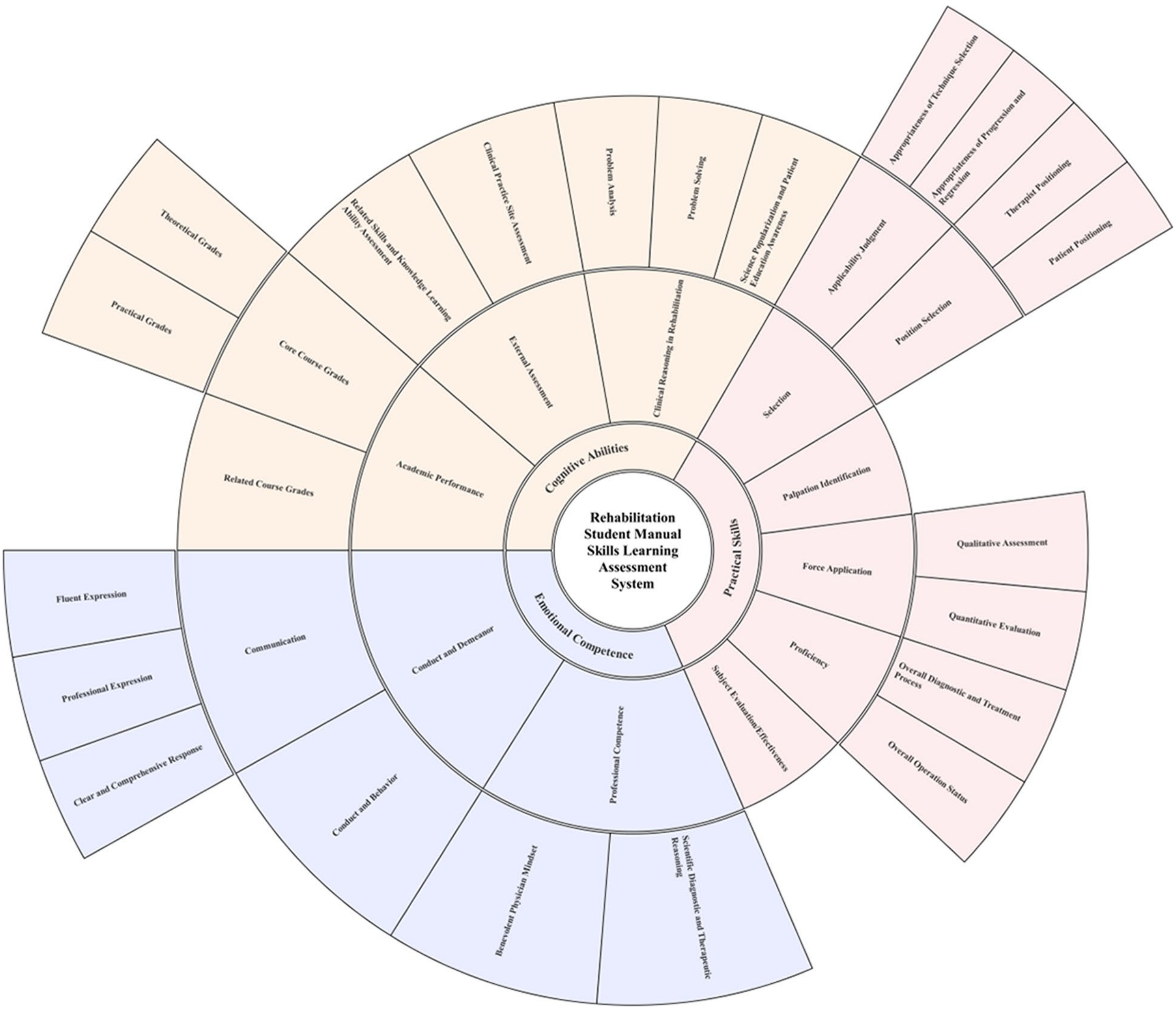

Fig. 2 The final model diagram

to learn the operational strategies and steps of exemplary therapists worldwide. This includes practices such as utilizing Computer-Assisted Clinical Case (CACC) SOAP note exercises to assess students' application of principles and practices in osteopathic therapy [44] or employing interactive interdisciplinary online teaching tools for biomechanics and physiology instruction [45]. Establishing an online practice community to support evidence-based physical therapy practices in manual therapy is also pivotal [46]. Moreover, the integration of real-time feedback tools and teaching aids has significantly enhanced the depth and engagement of learning [9].

Designing teaching assessments is considered an "art", and with the enrichment of teaching methods and tools, feedback strategies [47] in teaching are continuously optimized. The development of rehabilitation professional courses remains a focal point and challenge for educators. Reubenson A and Elkins MR summarize the models of clinical education for Australian physiotherapy students and analyze the current status of entry-level physiotherapy assessments, along with suggesting future directions for physiotherapy education [48]. Their study underscores the inclusivity of indicator construction in model development, enabling students from different internship sites to evaluate their manual therapy learning progress using the model. Moreover, the model can be utilized for assessment even in non-face-to-face scenarios. Tai J, Ajjawi R, et al.'s study [49] summarized the historical development of teaching assessment, highlighting the transition of assessment models from simple knowledge or skill evaluation to more complex "complex appraisal." This reflects the increased dimensions of educational assessment, the evolution of methods, and the emphasis on quality. From the Delphi outcomes, Sizer et al. identified eight key skill sets essential for proficiency in orthopedic manual therapy (OMT), as distilled through principal component factor analysis: manual joint assessment, fine sensorimotor proficiency, manual patient management, bilateral hand-eye coordination, gross manual characteristics of the upper extremity, gross manual characteristics of the lower extremity, control of self and patient movement, and discriminate touch [50]. Additionally, Rutledge CM et al.'s study [51] focuses on developing remote health capabilities for nursing education and practice. Caliskan SA et al. [52]. established a consensus on artificial intelligence (AI)-related competencies in medical education curricula. These breakthroughs in teaching assessment concepts and formats that transcend spatial limitations are worth noting for the future. While existing research has established quantitative models for some challenging manual therapy operations, such as teaching and assessment of high-speed, low-amplitude techniques for the spine [53], a more comprehensive model is needed to assist beginners in manual therapy education.

The key elements in the manual therapy evaluation model

In 1973, McClelland DC first introduced the concept of competence, emphasizing "Testing for competence rather than for intelligence," highlighting the importance of distinguishing individual performance levels within specific job contexts [54]. In 2021, the World Health Organization introduced a competence model for rehabilitation practitioners, defining competence in five dimensions: Practice, Professionalism, Learning and Development, Management and Leadership, and Research. Each dimension outlines specific objectives from the perspectives of Competencies and Activities, with requirements for rehabilitation practitioners varying from basic to advanced levels, encompassing simple to more comprehensive skills, under general principles of talent development [2]. Our model draws inspiration and insights from the framework and concepts proposed by the World Health Organization, as well as the scoring criteria of the Rehabilitation Skills Competition. When constructing primary indicators, we initially identified three dimensions: knowledge, skills, and emotions. Subsequently, adjustments were made during three rounds of the Delphi method. The content within the three modules can be independently referenced or utilized for novice practitioners to conduct self-assessment or peer evaluation before entering the workplace.

In the Cognitive Abilities module, the model incorporates Academic Performance, External Assessment, and Clinical Reasoning in Rehabilitation. Apart from the conventional Core Course Grades and Related Course Grades from the school curriculum, it also integrates evaluations from students' internship processes, including Clinical Practice Site Assessment and Related Skills and Knowledge Learning Ability Assessment. To emphasize the significance of professional course learning in school, we further divide Core Course Grades into Theoretical Grades and Practical Grades, aligning with the current pre-clinical internship assessments at our institution. Regarding health education, this model focuses on areas consistent with some related research directions [32, 55, 56]. The model highlights the importance of Clinical Reasoning in Rehabilitation by emphasizing Problem Analysis and Problem Solving in clinical practice, while also addressing the importance of Science Popularization and Patient Education Awareness.

In the Practical Skills module, this model allows for demonstration assessment based on simulated clinical scenarios, where students perform maneuvers on standardized patients, with evaluation conducted by instructors or other experts. During the operation process, we may involve assessment criteria such as Selection of techniques, Palpation Identification, Force Application, Proficiency, and ultimately, Subject Evaluation/Effectiveness. The selection of techniques involves assessing the condition of the subject, determining specific maneuvers, and appropriateness of progression and regression during maneuvers. Additionally, the selection also considers the positioning of both the operator and the subject. In assessing Force Application, besides traditional subjective evaluations, objective assessments can also be facilitated with the aid of instrumentation. Finally, for assessing Proficiency in operation, evaluations can be provided for the Overall Diagnostic and Treatment Process and Overall Operation Status. This serves as a complement to further standardizing the manual therapy process [16, 53], as the model can be applied in evaluating the procedures of certain specialized manual techniques.

In the Emotional Competence module, the model is divided into Conduct and Demeanor, and Professional Conduct. We believe that the therapeutic process between therapists and patients inherently involves interpersonal communication, hence focusing on Conduct and Behavior. Therefore, in conjunction with score sheets from national rehabilitation skills competitions, we may introduce more detailed requirements for Fluent Expression, Professional Expression, and Clear and Comprehensive Response. Furthermore, from the perspective of rehabilitation therapists' professional roles and in alignment with the competence model, we emphasize the importance of Professional Conduct. We consider aspects such as Benevolent Physician Mindset and Scientific Diagnostic and Therapeutic Reasoning to be particularly noteworthy.

The scope and prospects of application of manual therapy evaluation model

The assessment model we designed holds relevance for skills or disciplines involving manual manipulation. Reviewing the literature on Manual Therapy [1, 57, 58] reveals that several terms are used interchangeably, such as Manipulative Therapy [59], Hands-on Therapy [31], Massage Therapy [24, 60], Manipulative Physiotherapy [36], the Chiropractic Profession [61], and Osteopathy [62]. Threlkeld AJ once stated that manual therapy encompasses a broad range of techniques used to treat neuromusculoskeletal dysfunctions, primarily aiming to relieve pain and enhance joint mobility [58]. From a professional perspective, practitioners are often referred to as Physical Therapists [30, 59], Manual Therapists [63], Manipulative Physiotherapists [33], and Massage Therapists [24, 37, 64]. Differences between Chiropractors and Massage Therapists have also been discussed in the literature [65]. The evolution of specific manual techniques such as Joint Mobilization [66], Osteopathic Manipulative Treatment (OMT) [67, 68], Spinal Manipulation Therapy (SMT) [69–71], Posterior-to-Anterior (PA) High-Velocity-Low-Amplitude (HVLA) Manipulations [72], and Cervical Spine Manipulation [73] has provided more precise guidance for addressing common diseases and disorders. Furthermore, researchers have highlighted that the development of motor skills is an essential component of clinical training across various health disciplines including surgery, dentistry, obstetrics, chiropractic, osteopathy, and physical therapy [47]. In current rehabilitation education, manual therapy is a crucial component of physical therapy. We categorize physical therapy into physiotherapy and physical therapy exercises. Physiotherapy typically requires the use of special devices to perform interventions involving sound, light, electricity, heat, and magnetism. On the other hand, physical therapy exercises are generally performed manually, with some techniques occasionally requiring the use of simple assistive tools. As researchers have suggested with the concept of motor skills [47], our physical therapy exercises in teaching may not only be beneficial for a single discipline but could also enhance all disciplines that require "hands-on" [31] or "human touch" [13] operations.

In the prospects of manual therapy education, the comprehensive neurophysiological model has revealed that manual therapy produces effects through multiple mechanisms [11, 12]. Studies have indicated [12, 74] that the correlation between manual assessments and clinical outcomes, mechanical measurements, and magnetic resonance imaging is poor. As measurement methodologies enrich, our teaching assessment methods will also continuously evolve. Moreover, the close connection of manual therapy with related disciplines such as anatomy and physiology [75–77] provides physical therapists with a comprehensive biomedical background, enhancing their clinical capabilities and multidisciplinary collaboration skills [13]. Secondly, the development of educational resources should emphasize the integration of practice and theory. Drawing on the educational content packaging model of dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) [78], combining e-learning with practical training, and computer-related teaching models will enrich offline teaching [74], providing students with a comprehensive learning experience. This model not only increases flexibility and accessibility but also optimizes learning outcomes through continuous performance assessment. Finally, with the development of artificial intelligence and advanced simulation technologies [79], future manual therapy education could simulate complex human biomechanics and neurocentral processes, providing deeper and more intuitive learning tools. This will further enhance educational quality and lay a solid foundation for the lifelong learning and career development of physical therapy professionals.

Limitations

The panel of experts consulted in this study is relatively concentrated among middle-aged and young professionals and exhibits noticeable regional characteristics. Consequently, the conclusions drawn may exhibit certain regional specificities. Moreover, during the translation process of professional terminology, some terms in the Chinese consultation form were uniform; however, modifications were made to ensure comprehension in the English context.

Conclusions

This study comprehensively utilized theoretical research, literature analysis, and the Delphi expert consultation method. The selected experts are highly authoritative, and there was a good level of activity across three rounds of consultations, with well-coordinated expert opinions. The model includes multi-level evaluation indicators covering the key dimensions of Cognitive Abilities, Practical Skills, and Emotional Competence. This research systematically and preliminarily constructed an evaluation system for foundational manual therapy learning in rehabilitation students.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-024-05932-y.

Supplementary Material 1.

Acknowledgements

Thanks to Dong Xinchun, Gu Zhongke, Lu Honggang, Li Le, Sun Wudong, Wang Yudi, Wu Wenlong, Zhao Xinyu and other experts for their assistance and patient analysis during the Delphi consultation process, and some experts chose to remain anonymous, we would like to express our gratitude once again.

Authors' contributions

Both authors contributed to the creation of the manuscript. WZ designed and conceptualized the review and wrote the draft manuscript. ZS assisted with the Delphi consultation process and article writing. MB was involved in designing and implementing the project as a supervisor.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Availability of data and materials

The datasets generated and/or analysed during the current study are available in the "figshare" repository, available at https://figshare.com/s/2886b42de467d58bd631.

Declarations

Ethics approval and consent to participate

This research was approved by the Research Ethical Committee of Yancheng TCM Hospital Affiliated to Nanjing University of Chinese Medicine according to the World Medical Association Declaration of Helsinki Ethical. Approval number: KY230905-02. Written Informed consent was obtained from all the study participants.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data in any form (including individual details, images, or videos).

Competing interests

The authors declare no competing interests.

Received: 14 May 2024 Accepted: 20 August 2024
Published online: 04 September 2024

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