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Research Article

The development of an analysis of quantitative measurements competence disparity scale for graduate students

Jian-Hong Ye [1,2], Yuting Cui [3], Weiguaju Nong [4,*], Yi-Sang Lee [5], Xiantong Yang [6,*], Li Wang [7], Jhen-Ni Ye [8]

[1] *Faculty of Education, Beijing Normal University, Beijing 100875, China; kimpo30107@hotmail.com*
[2] *National Institute of Vocational Education, Beijing Normal University, Beijing 100875, China*
[3] *College of Education Cadre, Beijing Institute of Education, Beijing 100120, China; cuiyuting.cyt@163.com*
[4] *School of Education, Guangxi University of Foreign Languages, Nanning 530222, China; weiguaju.nong@hotmail.com*
[5] *Department of Industrial Education, National Taiwan Normal University, Taipei City 106, Taiwan; 80770005h@ntnu.edu.tw*
[6] *Faculty of Psychology, Beijing Normal University, Beijing 100875, China; xtyang93@foxmail.com*
[7] *College of Education and Music, Hainan Vocational University of Science and Technology, Hainan, China; 1400818342@qq.com*
[8] *Graduate Institute of Technological & Vocational Education, National Taipei University of Technology, Taipei City 106344, Taiwan; t109499005@ntut.edu.tw*

*** Correspondence:** Weiguaju Nong, weiguaju.nong@hotmail.com (W.N.);
Xiantong Yang, xtyang93@foxmail.com (X.Y.)

ABSTRACT

Academic research competencies play the most essential role in graduation for graduate students, but there is still a lack of in-depth research on this matter. Since talent development suggestions are provided based on the survey results of capability gaps, this study aimed to develop a scale to examine the research competency disparity between graduation requirements and graduate students' current levels of competency in the context of quantitative research in the education, arts and humanities, and business domains. It is named the "Quantitative Academic Competence Scale". To explore the needs of graduate students regarding their academic research competence, we constructed a draft questionnaire with nine categories of competence; academic experts validated the scale. It was then administered to graduate students to explore their perceived disparities. A total of 457 participants assisted in filling out the questionnaire, from which 86 invalid samples were deleted, leaving 371 valid participants, giving an effective recovery rate of 81.2%. After collection and analysis, the analysis results found that the three graduate students' academic research competences with the greatest disparity were English writing competence, research design and implementation competence, and data processing and analyzing competence. According to the results, graduate students should take more courses on English writing competence, research design and implementation competence, and data processing and analyzing competence to enhance their competencies. generative artificial intelligence (GenAI) suggests that research ability factors can be comprehensively considered. Based on the graduate students' ability gaps, curriculum settings and training plans can be adjusted and more targeted (personalized) at teaching and guidance to help graduate students improve their academic performance and reduce weaknesses in their research capabilities.

Keywords: Academic literacy, higher education, quantitative research, Academic research competence, AI-assisted research discussion, generative artificial intelligence (GenAI)

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1. Introduction

The educational goal of graduate schools is to cultivate academic talents who can independently complete academic research or perform teaching tasks. Therefore, the students of the graduate schools should develop solid academic knowledge, independent thinking, and an innovative spirit, learn academic thinking and innovative competency, research practice competency, literature review ability, and academic paper writing competency to engage in scientific research [1,2]. The graduate learning process intertwines the steps of course taking, scientific research thinking, topic research, and thesis writing [3]. To improve the level of academic writing, learners should be equipped with the competencies to innovate, discover and solve problems, collect and analyze data, and express themselves in writing. However, Hao pointed out more clearly that when writing academic articles, graduates in master's and doctoral programs often have the following deficiencies: 1. The setting of research topics is often too broad; 2. The literature review lacks analysis; 3. Research methods and the implementation and analysis process are not fully explained; 4. The research results are not well interpreted; and 5. Mistakes are made in the use of vocabulary in the thesis and typographical errors in the article format [4]. In addition, Aitchison and Lee stated that in current graduate programs, students' writing is still poor [5]. Nowadays, many graduate students are still confused and at a loss about research before writing their dissertations [6]. However, there is currently no good assessment tool to systematically help graduate students understand their own competency gaps, which may make them more at a loss as to how to effectively improve their academic research competencies. In this study, the competency gap refers to the gap between the current level of competency and the essential level [7,8]. The self-perception of the competency gap helps individuals solve the problems which lead to the gap [9]. Currently there are few studies on the self-perception research competency of graduate students; therefore, we constructed a self-assessment system for graduate students to assess the competency gap of their own existing academic research competency, and then identified the countermeasures to improve the competency so as to reduce the sense of confusion in their research careers.

Before discussing research capabilities, it is necessary to understand the characteristics of different research methods. The characteristics of quantitative research are to measure objective facts and explain the causal relationship of variables by verifying hypotheses; the characteristics of qualitative research are to construct social meaning, pay attention to the interactive process, and describe and understand experiences by generating theories. The mixed research method integrates the two methods and so studies problems from different perspectives. Each method has its advantages and disadvantages. In recent years, quantitative research has been gradually adopted in Taiwan as the mainstream research trend [10], and currently, graduating master's and doctoral theses in Taiwan predominantly adopt the quantitative research approach [11]. Therefore, this study aimed to focus on the competency gap in quantitative research between graduates' perceptions and their actual competency.

Performance indicators must be clearly defined prior to assessment as the basis for student self-assessment [12]. To date, only a few domestic and international studies have discussed the constructs and definitions of academic research competency that graduate students should possess, as well as the gap between the existing competency and the essential competency. Therefore, this study constructed a "Quantitative Academic Research Competency Scale" applicable to the fields of social science and management, and verified its reliability and validity. Since different types of academic research require different levels of competency [13], this study first focused on the fields of education, arts and humanities, and business, and analyzed the competency gap of graduate students engaged in quantitative research using various indicators. Through the competency gap indicators constructed in this study, students who are interested in quantitative research are able to perceive their own gaps, and then eliminate them so that the quality of their academic writing could be improved, and the setbacks in their research careers could be diminished. Hence, the purpose of this study was

to develop a quantitative research competency scale, to use this scale to explore the gaps between graduate students' self-perceived competencies and essential competencies, and to arrange the sequence of graduate students' required abilities and existing abilities.

2. Literature review

Ability is the comprehensive quality reflected in completing a goal or task. In addition, competency refers to comprehensive knowledge, skills, talents, and other factors which can be observed, measured, and compared, and which are vital for both personal and professional success [14,15]. According to Hong et al., competency is a result of combining individual cognitive resources and intelligence [12]. Vidal-Gomel and Samurçay indicated that to confirm the construct of executive competency [16], the required competency outline must be formulated in order to determine the scope of competence that is really applied when dealing with situations according to their characteristics. From the perspective of competence analysis, the role in the situation should be analyzed first to examine the required standards and execution standards. For example, Stagg and Kimmins divided the academic research competency required by graduate students into information literacy (research skills) and academic learning competency (academic reading and writing) [17].

In addition, Wu pointed out that in order to obtain academically innovative research results, graduate students should first have the prior knowledge of the academic field, research methods, interdisciplinary fields, and academic paper writing [18]. From the perspective of performing academic research, a complete academic paper needs to be scientific, innovative, logical, and formally published, so researchers must master the skills of writing and revising articles in order to successfully execute the academic research process [19]. Based on the above, the talent cultivation goal of higher education is to enable graduate students to produce rigorous and innovative academic achievements.

In quantitative research, there is already a fixed and linear pattern of research steps and procedures. It is necessary to raise research questions or form research hypotheses through literature collection [20]. According to the analysis of academic reference books of scholars such as Bi Guo, Grimm and Harvey, Holliday, Redman and Maples, Nayak et al., Wu, and Yan , the implementation of a complete research process is roughly divided into the following: topic formulation, literature review, research design and implementation, research analysis, paper writing, briefing design, report publication and other research processes [21-28], as shown in **Table 1**.

Table 1. Dissertation writing format and process specification.

Scholar	Dissertation writing format and process specification
Holliday	Research problem description and definition, literature review, research methods, data processing and analysis, thesis writing
Guo	Introduction (research concept, purpose, ethics), research planning, data collection methods and sampling, research design, data analysis and reporting
Wu	Content and typesetting, text (preface, literature review, theoretical framework, research methods, research results and analysis, research conclusions, references), and attention should be paid to academic ethics (rewriting, literature citation and plagiarism), and the preparation of thesis report materials
Redman and Maples	Definition of research questions, literature review, essay writing, writing format, research keywords
Yan	Formation of thesis theme, text writing, literature retrieval and reading, research structure and methods, research results, writing format and typesetting, publishing briefings

Scholar	Dissertation writing format and process specification
Grimm and Harvey	Successful writing strategies and common writing styles include an overview of templates for producing abstracts, introductions, methods, results, and discussions, as well as techniques for gathering references and producing high-quality figures and tables.
Nayak et al.	Papers usually comprise six main sections, namely an introduction, literature review, materials and methods, results, discussion, and summary and conclusion.

Research on the teaching of academic research competency can be divided into research introduction, defining research questions, proposing research hypotheses (literature review), research design, data collection and analysis, briefing content presentation, research management (including research restrictions), and other procedures [29]. Based on this, this study summarized the required competencies, research process, paper writing norms, and layout format requirements mentioned by the above scholars, and concluded that in the implementation of a complete research process, at least nine criteria of academic research competencies should be met, as described in the following sections.

2.1. Academic innovation competency

Innovation is considered an intangible resource that cannot be imitated and is the source of competitive advantage [30]. Therefore, innovation competency is an important indicator of progress and the first goal of contemporary education [31]. All activities of higher education institutions, such as in research and innovation, strive to achieve high quality and high standards [32]. Knowledge innovation is a kind of knowledge processing, linking knowledge and knowledge meaning [33]. The ultimate goal of academic innovation is to shape new theories. Theories here refer to a set of concepts, definitions or issues with a structure that can be used to explain and predict phenomena in real life [18]. Understanding the needs of graduates and their perceived degree of existing academic innovation competency is helpful for understanding the possibility of graduates in research innovation.

2.2. Academic ethics competency

The convenience of technology, the popularization of the Internet, and the ease of downloading digital articles have led to more frequent instances of improper citation and plagiarism [34]. In the process of academic cultivation, academic ethics education needs to be integrated into all academic research development processes to strengthen the cultivation of graduates' scientific research spirit, pursuit of truth, and innovation competency [35]. Abiding by ethics is the core spirit of academic practice and also the key to protecting the interviewees (interlocutors) and respondents (informants) [36] which contributed to an understanding of the extent to which responsible research conduct is possible.

2.3. English writing competency

Scholars around the world are under increasing pressure to publish internationally. As associate members of the academic community, graduate students also find themselves under pressure to publish internationally [37], while graduate students commit to publishing in international journals. Facing the language challenges is often a burden, and is even more severe for students whose first language is not English [38]. Studies have shown that graduate students generally have poor academic English skills, so they hope to attend academic English training courses to improve their competency to write and publish international academic papers and participate in international seminars [39]. Academic literacy in higher education is critical for students who want to be successful in their studies. For example, grammatical structure, content development, composition, and so on all play important roles in writing [40], providing researchers with a context of how to organize

information and form articles [41]. As a result, analyzing the required and existing English writing competency of graduate students will help to analyze their level of English writing competency.

2.4. Chinese writing competency

Thesis writing reflects the author's cognition of the event itself, the social cognition related to the event, and the metacognition of the writing itself, with the attitude of constant revision and the mentality of drawing conclusions based on evidence [42]. Educators around the world should agree that "effective writing" is a basic academic competency and is usually cultivated in secondary/ high school and higher education [43], so that graduate students can develop advanced academic writing competency which enables them to not only produce high-quality published papers, but also to write different types of papers [44]. Therefore, the competency to understand Chinese writing is also the basis for the development of academic research for graduate students in Chinese-speaking countries. Chinese writing usually needs to quote foreign literature; as a result, the competency of the writer to overcome the cognitive load of translation and integrate it into the text to make it harmonious is relevant to the quality of their papers [42]. Therefore, it is necessary to explore the degree of perception of graduates' necessary and existing Chinese writing competency, and then to understand the level of existing written expression competency.

2.5. Literature review competency

A literature review is a useful, critical, and integrative process that helps researchers identify what is known and what is unknown in a subject area, enables understanding of controversial or debated parts of a field, and helps researchers to further formulate research questions [45]. Reading literature is an important way to formulate research topics, to construct a theoretical basis, and to help researchers choose appropriate research methods and measurement tools [6]. Since the competency to apply scientific and technological information has been found useful for data collection, students' information competency to retrieve relevant or authoritative information from multiple sources is quite critical [46]. The competency of students to retrieve literature in their academic field and meaningfully apply relevant literature to guide and facilitate the execution of their research tasks is one of the most complex research competencies in graduate school education [47]. Therefore, discussing the needs of graduate students and the perceptions of existing literature review competency will help to explore and understand the competency level of graduate students in literature retrieval and application.

2.6. Research design and implementation competency

The key points of research design are to describe and explain the research structure and procedures properly [48], which involves a series of research planning and activity execution processes promoting the finding of implementation plans to solve research problems or verify hypotheses [49]. The correct application of research methods is an element to ensure good reliability and validity of scientific research [50]. The traditional quantitative research process includes four basic links: data design, data collection, collation and analysis, and statistical data application [51]. However, the current poor research practice competency of graduate students has become one of the bottlenecks that hinder the improvement of the quality of academic research [52]. Hence, investigating the gap between the required perceived level and existing research design and implementation competencies will help to understand the degree to which graduate students are able to effectively design and execute a complete research process.

2.7. Data processing and analysis competency

Data analysis is an important evidence-based approach in social sciences, where different types of statistical analysis techniques can be applied, for example, to provide descriptive, explanatory, or causal

verification, and to respond to any type of research question and design [53,54]. Data analysis research can reflect academic results including theory, hypotheses, models, samples, data, or parameter estimation [55]. The competency to properly evaluate and interpret data results is therefore an important academic competency that all students should learn as part of their educational programs [56]. Based on this, exploring the required and existing perceptions of data processing and analysis competencies will help to grasp graduate students' competency to correctly analyze data.

2.8. Presentation preparation competency

When publishing a thesis, graduate students should make prepared speeches and effectively use multimedia or briefings to display and introduce their research results [57]. However, studies have shown that many graduate students often have problems with poor quality slides (briefings) when presenting their dissertations [58]. Although audiences can process the visual information provided by the presentation content, their visual search competency and working memory load will still be affected by limited visual short-term memory [59]. Therefore, how to make presentations with focused and clear content should be an indispensable competency for graduate students. Investigating the perceived degree of graduate students' required and existing data processing and analysis competencies will help to understand their competency level in presentation production.

2.9. Oral presentation competency

Oral presentation competency is very important in the academic field [60], so it is one of the basic goals of higher education for learners to develop oral presentation competency [61]. Good oral presentation competency will help them to share their own academic research results with others, and will enable them to better understand the content of their own results [62]. However, there are also studies showing that graduate students are prone to problems such as improper control of reporting time and unclear expression of research content when they present their theses [58]. Therefore, it is important to explore the degree of perception of graduate students' necessary and existing oral presentation competencies, so as to understand the level of their oral presentation competency.

2.10. Research purposes and research questions

Although graduate education is the stage of developing academic competency, graduate students who have experienced a period of academic development have at least basic academic competency, and the academic research competency of graduate students is related to the quality and smoothness of their dissertations. Besides, most studies on competency assessment only surveyed participants' current abilities or needs. Assessing the gap between existing abilities and required abilities can not only help to understand the current ability level of learners, but can also confirm the effectiveness of training programs. In addition, education planners and teachers can help learners improve their abilities in specific dimensions in a more targeted way. In sum, developing a quantitative academic competency scale for use by graduate students for self-reporting, and to evaluate the gap between their academic research competencies needed to conduct research and their own existing academic research competencies is the research topic of this study. The research questions are as follows:

(1) How can the degree of graduate students' perceptions of the nine quantitative academic research competency constructs proposed in this study be analyzed?

(2) What is the gap between graduate students' perceptions of the required level of the nine quantitative academic research competency constructs and their current competency levels?

3. Research design

3.1. Participants

(1) The pilot study

In the pilot test phase, a total of 250 Taiwanese graduate students participated in the study. After deleting 29 invalid questionnaires, there were 221 valid data, including data from 95 males (43%) and 126 females (57%), of whom 75 studied in universities of science and technology (33.5%), while 147 (66.5%) studied in general universities. The average age of the pilot test participants was 26.19 years old (standard deviation was 3.47 years old).

(2) The formal phase

In the formal phase, a total of 457 Taiwanese participants assisted in filling out the formal questionnaire, of which 86 invalid samples were deleted. The number of valid participants was therefore 371, giving an effective recovery rate of 81.2%, including 157 males (42.3%) and 214 females (57.7%); 286 (77.1%) were in public schools and 85 (22.9%) were in private schools; 249 (67.1%) were in general (normal) universities and 122 (32.9%) were in universities of science and technology; 308 (83%) were in master's programs and 63 (17%) were in doctoral programs; 165 (44.5%) were in the field of education, 119 (32.1%) were in arts and humanities, and 87 were in business (23.5%).

3.2. Procedures

In the pilot test trial phase of the scale, we recruited fresh graduates from a Facebook graduate exchange community who were studying in the fields of education, arts and humanities, and business, and specifically those who had adopted quantitative research methods for their doctoral or master's dissertations, to fill in the online questionnaire. The collection time of the pilot test questionnaire was from May 1 to 15, 2020. A total of 250 participants were recruited to fill out the pilot test questionnaire.

In the formal testing phase, the online questionnaires were also distributed to graduates of doctoral programs and master's programs in the fields of education, arts and humanities, and business, and those whose dissertations were conducted with quantitative research methods in the graduate exchange clubs of the same nature, using the questionnaire online platform. The official questionnaire collection time was from June 1 to 30, 2020. A total of 433 questionnaires were collected.

3.3. Measurements

Competency identification means that it must be assessed in advance, and performance indicators must be clearly defined [63]. Therefore, the content of this study scale was developed from past research and related theories, and was reviewed by three quantitative research scholars engaged in social science research. There were three rounds in the expert review: the first round of review focused on the design suitability and completeness of the construct and its items, and proposed amendments and suggestions for revision; the second round was to review the legibility of the text of the revised topic, and to make suggestions for revision; the third round was for the fluency of the text of the revised topic. Lastly, two fresh doctoral students studying in the field of social science and management, and two master's degree graduates were recruited to try out the scale. The content of the scale was evaluated on a Likert 5-point scale (where 1 to 5 means *strongly disagree* to *strongly agree*) as the evaluation standard. After the questionnaires were collected, first-order confirmatory analysis was performed using AMOS, and the decision value was used as the standard for deleting questions. The reliability and validity analyses were carried out with SPSS 23. Relevant construct descriptions and items are stated below.

3.3.1. Questionnaire

3.3.1.1. Academic innovation competency

Academic innovation competency refers to researchers being able to independently find, select, and formulate novel research topics, put forward unique viewpoints from different perspectives, or combine different theories. The items are shown in **Table 2**.

Table 2. Construct content of academic innovation competency.

Coding	Questionnaire Content
AI1	I know how to find new research topics from a certain phenomenon.
AI2	I know how to come up with new research topics from current research topics.
AI3	I know how to find the missing parts of research in the academic field.
AI4	I know how to conduct research theoretically and expand the theoretical framework.
AI5	I know how to combine multiple theories to develop a new framework.
AI6	I understand how to apply theories from different fields to create a new research topic.
AI7	I know how to see the world from different viewpoints and create new ideas from previous research topics.
AI8	I know how to formulate novel research topics.

3.3.1.2. Academic ethics competency

Academic ethics competency means that researchers can maintain a neutral, objective and benevolent research standpoint, and conduct academic research under the principle of protecting the interests of research participants. The items are shown in **Table 3**.

Table 3. Construct content of academic ethics competency.

Coding	Questionnaire Content
AE1	I know how to conduct research under the principle of doing well (avoiding harm).
AE2	I know how to conduct research based on the principles of respect for people (protection of participants).
AE3	I know how to conduct research with the lowest risk and the highest benefit contribution.
AE4	I know how to identify vulnerable and disadvantaged groups and protect their rights in research.
AE5	I know how to write an informed consent statement for research.
AE6	I know how to ensure that the questionnaire information does not reveal the personal information of the respondent.
AE7	I understand that when conducting a literature review, one should avoid taking things out of context.
AE8	I know how to avoid deliberate selection or omission of actual data when conducting statistical analysis.
AE9	I know how to discuss from a neutral point of view when writing a paper.
AE10	I understand that there should be no mentality of getting something for nothing, and that research needs to be down-to-earth and there should be continuous improvement.

3.3.1.3. English writing competency

English writing competency refers to the researcher's competency to correctly use English grammar, writing skills, application of punctuation marks, typesetting format, and academic proper nouns to write English academic articles. The items are listed in **Table 4**.

Table 4. Construct content of English writing competency.

Coding	Questionnaire Content
EW1	I have a good sense of English grammar and sentence patterns.
EW2	I am familiar with many English academic terms.
EW3	I know the synonym substitution technique in English writing.
EW4	I know how to use conjunctions in English writing.
EW5	I understand the application rules of punctuation marks in English writing.
EW6	I know the writing skills of English writing.
EW7	I know how to write chapters in English writing.
EW8	I know how to clearly describe my research plan in an English article.
EW9	I understand the typesetting skills of English writing (such as in accordance with APA format, Harvard format, etc.).

3.3.1.4. Chinese writing competency

Chinese writing competency refers to the researcher's competency to correctly use Chinese grammar, writing skills of inheritance and transformation, application of punctuation marks, typesetting format, academic proper nouns, and so on, to complete Chinese academic articles. The items are listed in **Table 5**.

Table 5. Construct content of Chinese writing competency.

Coding	Questionnaire Content
CW1	I have a good concept of Chinese grammar and sentence patterns.
CW2	I am familiar with many Chinese academic terms.
CW3	I know the synonym substitution technique in Chinese writing.
CW4	I know how to use conjunctions in Chinese writing.
CW5	I understand the application rules of punctuation marks in Chinese writing.
CW6	I understand the writing skills of Chinese writing.
CW7	I know how to write chapters in Chinese writing.
CW8	I know how to articulate my research plan clearly in a Chinese article.
CW9	I understand the typesetting skills of Chinese writing (such as in accordance with APA format, Harvard format, etc.).

3.3.1.5. Literature review competency

Literature exploration competency refers to the researcher's competency to make good use of physical or electronic databases for literature retrieval in Chinese and foreign languages, and the competency to effectively collect, correctly use, and present literature. The items shown in **Table 6**.

Table 6. Construct content of literature review competency.

Coding	Questionnaire Content
LR1	I know how to use Chinese databases to search for relevant literature.
LR2	I know how to use foreign language databases to search for relevant literature.
LR3	I know how to create my own reference folder to help myself improve the efficiency of document collection.
LR4	I know how to use keywords to search for relevant literature.
LR5	I know how to extract the required information from the literature.
LR6	I know how to speak through evidence, citing literature to support relevant arguments.
LR7	I know how to compile multiple documents into graphs.
LR8	I know how to correctly present literature citation formats (such as APA format, Harvard, etc.) in the text.
LR9	I know how to correctly present bibliographic formats (such as APA format specifications) in references.

3.3.1.6. Research design and implementation competency

Research design and implementation competency refers to the researcher's competency to formulate a reasonable research scope, define research limitations, find research implementation errors, improve research deficiencies, compile tools, and practice research methods. The items are listed in **Table 7**.

Table 7. Construct content of research design and implementation competency.

Coding	Questionnaire Content
RDR1	I know how to set an appropriate research scope.
RDR2	I was able to spot mistakes in other people's research implementations and prevent them from happening again when I implemented them myself.
RDR3	I understand the importance of continuous improvement of research, and I am willing to accept suggestions from others and correct my own research deficiencies.
RDR4	I know how to research frameworks (patterns) through theoretical design.
RDR5	I know how to design and compile measurement tools.
RDR6	I know how to edit measurement tools.
RDR7	I know how to design research implementation steps.
RDR8	I understand how to set appropriate sampling methods (e.g., cluster sampling, stratified sampling).
RDR9	I know how to do research implementation properly.
RDR10	I know how to use websites to create electronic questionnaires.

3.3.1.7. Data processing and analysis competency

Data processing and analysis competency means that researchers can effectively check the reliability and validity of measurement tools (questionnaires), select correct and appropriate statistical tools or methods for analysis, and correctly present and explain the analysis results. The items are listed in **Table 8**.

Table 8. Construct content of data processing and analysis competency.

Coding	Questionnaire Content
DPA1	I know how to conduct expert validity testing of measurement (survey) instruments.
DPA2	I know how to delete invalid profiles.
DPA3	I know how to encode data.
DPA4	I understand the operation of statistical software.
DPA5	I know how to conduct data reliability and validity analysis.
DPA6	I know how to choose the appropriate statistical analysis method (such as SEM, one-way analysis of variance).
DPA7	I know how to read statistical analysis results.
DPA8	I know how to present research data (tables and descriptions) in a paper.

3.3.1.8. Presentation preparation competency

Presentation preparation competency refers to the competency of researchers to make good use of presentation tools and techniques to make slides, present their own research results in a good, clear, and visual way, and achieve effective research information transmission. The items are listed in **Table 9**.

Table 9. Construct content of presentation preparation competency.

Coding	Questionnaire Content
AP1	I know how to choose the materials to present in a presentation.
AP2	I know how to design to highlight the key points of a presentation.
AP3	I know how to replace the design method with too much text in a graphical way.

Coding	Questionnaire Content
AP4	I know how to use proper font weight and size to differentiate presentation content.
AP5	I know how to design presentation content in a concise manner.
AP6	I know many techniques of presentation design and production.

3.3.1.9. Oral presentation competency

Oral presentation competency means that researchers can maintain their composure when reporting papers, be able to properly allocate publication time, and report their questions and answers in an orderly manner, so that the research content can be conveyed to the audience more quickly through oral expression. The items are listed in **Table 10**.

Table 10. Construct content of oral presentation competency.

Coding	Questionnaire Content
OP1	I know how to master the allocation of time when presenting.
OP2	I know how to explain the key points of research in an orderly manner when presenting.
OP3	I know how to present my research fluently.
OP4	I know how to avoid repetition of redundant words when presenting.
OP5	I know how to respond to questions and answers when presenting.
OP6	I know how to avoid stage fright when presenting.

3.4. Presentation method of measurement

Measurement for this study was filled in through a digital menu, and was divided into two sub-groups: the competencies required for academic research and the participants' self-assessment of their existing competencies. The participants could choose their perceived competency level by dragging the arrow, as shown in **Figure 1**.

Question 1. I know how to find new research topics from a certain phenomenon.

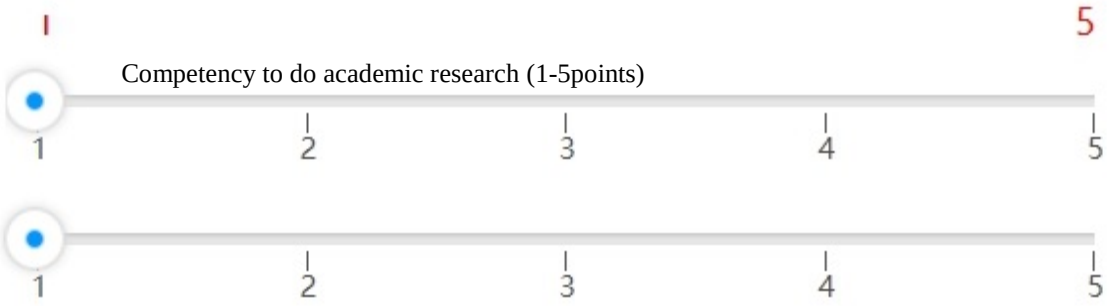

Figure 1. Schematic representation of measurement tools.

3.5. Reliability and validity analysis of the pilot study

Hair et al. suggested that when the factor loading (FL) value of an item is less than 0.5, the item must be deleted. When the Cronbach's α is greater than or equal to .7, the reliability of the internal consistency of the questionnaire is acceptable [63]. Based on these two indicators as the pilot test standard, if any value of any item was not met, it was deleted. Accordingly, one item, AE10, was deleted from the academic ethics competency construct; two items, EW8 and EW9, were deleted from the English writing competency construct; one item, CE9, was deleted from the Chinese writing competency construct; one item, LR3, was deleted from the literature research competency construct; four items, RDR1, RDR2, RDR3, and RDR9, were deleted from the

research design and implementation competency construct; two items, DPA1 and DPA8, were deleted from the data processing and analysis competency construct; and one item, AP6, was deleted from the presentation production competency construct. After deleting the unacceptable questions in the pilot test phase, the Cronbach's α values of the required competency of the nine constructs were between .78 and .89, and the Cronbach's α values of the existing competency were between .70 and .87. The FL values of the required competencies were between .51 to .78, and FL values for the existing competencies ranged from .50 to .78, as shown in **Table 11**.

Table 11. Internal consistency analysis and factor loading analysis of the questionnaire.

Construct	Items	The required competency		The existing competencies	
		Cronbach's α	FL	Cronbach's α	FL
Academic innovation competency	8	.85	.58~.72	.81	.50~.65
Academic ethics competency	9	.88	.64~.72	.79	.50~.62
English writing competency	7	.86	.62~.70	.79	.51~.66
Chinese writing competency	8	.89	.63~.78	.87	.63~.70
Literature review competency	8	.87	.60~.73	.86	.57~.71
Research design and implementation competency	6	.78	.51~.66	.87	.58~.78
Data processing and analysis competency	5	.83	.68~.72	.70	.53~.63
Presentation preparation competency	5	.78	.58~.74	.80	.61~.71
Oral presentation competency	6	.82	.60~.78	.85	.64~.76

4. Results and discussion

4.1. Analysis of normal distribution

When testing the normality of data, a value between -2.0 and +3.5 is generally selected. When the skewness is 0 and the kurtosis is 0, normality is obtained; when the skewness is between 0.3 and 0.4, and the kurtosis is between 0.3 and 0.4, a value of around 1.0 is considered slightly abnormal. When the skewness is greater than 0.7 and kurtosis is greater than 3.5, the value is severely abnormal [64]. The skewness and kurtosis of all constructs in this study were relatively low compared to the values mentioned in Lei and Lomax, which meant that the data in this study had the characteristics of normal distribution, as shown in **Table 12**.

Table 12. Analysis of normal distribution.

Construct	The required competencies		The existing competencies	
The critical value	Skewness	Kurtosis	Skewness	Kurtosis
Academic innovation competency	-.14	-.65	.16	-.07
Academic ethics competency	-.18	-.62	-.02	.91
English writing competency	-.22	-.44	.59	-.49
Chinese writing competency	-.22	-.49	-.18	.41
Literature review competency	-.18	-.52	.11	-.38
Research design and implementation competency	.15	-.71	-.14	-1.43
Data processing and analysis competency	-.03	-.88	-.67	.35
Presentation preparation competency	-.42	-.09	-.02	-.15
Oral presentation competency	-.41	.23	.18	-.54

4.2. Analysis of measurement model

One of the main advantages of confirmatory analysis is that it provides evidence of the validity of scale constructs [65]. In this study, we therefore utilized first-order confirmatory factor analysis (first-order CFA) for the analysis and testing of the internal validity of the items. Hair et al. and Kenny et al. have specified the following thresholds to ensure validity): the chi-square degree of freedom ratio (χ^2/df) should be less than 5, the root mean square error (RMSEA) should be less than 0.1; the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI) and the non-normative fit index (TLI) should not be lower than .80, and the expected cross-validation index (ECVI) value should be as small as possible [63,66]. Referring to Table 2, among the nine constructs of the formal measurement scale in this study, the competency required for academic research (hereinafter referred to as the required competency) and the existing competency all passed the item analysis test, as shown in **Table 13**.

Table 13. Analysis of the measurement model.

Construct		χ^2	*df*.	χ^2/df.	RMSEA	GFI	AGFI	CFI	TLI	ECVI
The critical value		---	---	< 5	<.1	>.8	>.8	>8	>.8	---
Academic innovation competency	The required competencies	33.8	20	1.69	.043	.98	.96	.98	.98	.18
	The existing competencies	39.9	20	2.00	.052	.97	.95	.97.	96	.19
Academic ethics competency	The required competencies	64.3	27	2.38	.061	.96	.94	.97	.96	.27
	The existing competencies	40.3	27	1.49	.037	.98	.96	.98	.97	.21
English writing competency	The required competencies	9.5	14	.68	.000	.99	.99	.99	.99	.10
	The existing competencies	27.5	14	1.96	.051	.98	.96	.97	.96	.15
Chinese writing competency	The required competencies	28.8	20	1.44	.035	.98	.97	.99	.99	.16
	The existing competencies	34.8	20	1.74	.044	.98	.96	.99	.98	.18
Literature review competency	The required competencies	44.4	20	2.22	.057	.97	.94	.98	.97	.21
	The existing competencies	22.9	20	1.14	.020	.98	.97	.99	.99	.15
Research design and implementation competency	The required competencies	13	9	1.44	.035	.99	.97	.99	.99	.10
	The existing competencies	41.7	9	4.63	.099	.96	.91	.96	.94	.18
Data processing and analysis competency	The required competencies	9	5	1.80	.047	.99	.97	.99	.99	.08
	The existing competencies	9.7	5	1.94	.050	.99	.97	.98	.97	.08
Presentation preparation competency	The required competencies	8.9	5	1.78	.046	.99	.97	.99	.98	.08
	The existing competencies	14.9	5	2.98	.073	.99	.95	.98	.95	.09

Construct		χ^2	*df*.	χ^2/*df*.	RMSEA	GFI	AGFI	CFI	TLI	ECVI
Oral presentation competency	The required competencies	26.1	9	2.90	.072	98	.95	.98	.96	.14
	The existing competencies	18.4	9	2.04	.053	.98	.96	.99	.98	.12

Besides, the research pointed out that the external validity of the construct items should be evaluated to determine the interpretable range of the study [67]. When the *t*-value of the item is greater than 3 (***$p < .001$), it means that the item has external validity after the independent sample *t* test of the high-low grouping of the construct and each item. However, Appendix 1 showed that the *t*-values of the nine constructs of required academic research competencies in this study were higher than 13.61 (***$p < .001$), and the *t*-values of the nine constructs of the existing academic research competencies were higher than 10.46 ($p < 0.001$), indicating that the retained items in the nine academic research competency constructs all had external validity [68].

4.3. Reliability and validity of each variable

4.3.1. Reliability analysis

This study confirmed the reliability of the scale tool through Cronbach's α. Hair et al. pointed out that an α value greater than or equal to .9 represents excellent reliability, greater than or equal to .8 represents good reliability, greater than or equal to .7 represents acceptable reliability, greater than or equal to .6 represents almost acceptable reliability, greater than or equal to .5 represents weak reliability, and less than .5 represents unacceptable reliability [63]. Besides, Taber also believed that when Cronbach's α is higher than the value of .7, it is considered an acceptable standard. Accordingly, this study used .7 as the test standard of reliability [69]. The Cronbach's α value of the nine constructs of required academic research competencies in this study ranged from .78 to .88, and the overall Cronbach's α value was .97, while the Cronbach's α value of the nine constructs of the existing competencies ranged from .78 to .86, and the overall Cronbach's α value was .92. It represented that the nine constructs of the participants' perceptions of the required and existing competencies were consistent with Hair et al. and Taber, as shown in **Table 14**.

Table 14. Analysis of the internal consistency of the questionnaire (Cronbach's α).

Construct	The required competencies	The existing competencies
Entire scale	.97	.92
Academic innovation competency	.84	.81
Academic ethics competency	.88	.79
English writing competency	.86	.78
Chinese writing competency	.88	.86
Literature review competency	.87	.84
Research design and implementation competency	.78	.85
Data processing and analysis competency	.81	.70
Presentation preparation competency	.80	.77
Oral presentation competency	.83	.86

4.3.2. Validity analysis

The convergent validity of this study was tested by factor loading (FL). In previous studies, the lowest acceptable standard value of FL was .30 [70], but Hair et al. later pointed out the FL value of each construct item should not be less than .50 to have convergent validity [63]. As a result, this study used .50 as the test standard. The FL values of the nine constructs of the required competencies in this study ranged from .55 to .77, and the

FL values of the nine constructs of the existing competencies ranged from .51 to .78, which met the criteria of convergent validity proposed by Hair et al. The convergent validity analysis results of each item are shown in **Appendix 1**.

Discriminant validity is the degree to which a latent variable is individualized from other latent variables [71]. Discriminant validity analysis is mainly used as a prerequisite for evaluating the relationship between latent variables [72]. Awang pointed out that when the AVE root value of the construct exceeds the Pearson correlation coefficient value of other constructs, the construct can be considered as having discriminant validity [73]. However, according to Ahmad et al., discriminant validity can also be ascertained by assessing the correlation between constructs [74]. When the correlation coefficient value is less than .85, it means that it has a discriminative calibration. When the correlation coefficient value is lower than .85, it means that there is a difference calibration. In addition, Rönkkö and Cho stated that the most commonly used analytical technique in testing discriminant validity is usually to evaluate the fit of the model [75]. Although there is a problem that the correlation coefficient value is greater than the root value of AVE among the various variables in this study, it is still acceptable if the FL value passes and the fitting degree of the item analysis passes the test. Discriminant validity analysis results are shown in **Tables 15** and **16**.

Table 15. Discriminant validity analysis of required abilities.

Construct	1	2	3	4	5	6	7	8	9
1. Academic innovation competency	.64								
2. Academic ethics competency	.80	.67							
3. English writing competency	.79	.82	.68						
4. Chinese writing competency	.75	.81	.80	.69					
5. Literature review competency	.74	.76	.75	.85	.69				
6. Research design and implementation competency	.59	.67	.65	.66	.63	.61			
7. Data processing and analysis competency	.70	.76	.74	.78	.79	.67	.68		
8. Presentation preparation competency	.69	.72	.76	.75	.76	.60	.77	.67	
9. Oral presentation competency	.47	.46	.51	.50	.53	.36	.52	.48	.67

Table 16. Discriminant validity analysis of present competency.

Construct	1	2	3	4	5	6	7	8	9
1. Academic innovation competency	.58								
2. Academic ethics competency	.53	.54							
3. English writing competency	-.23	-.13	.58						
4. Chinese writing competency	.68	.56	-.24	.67					
5. Literature review competency	.63	.59	-.21	.78	.64				
6. Research design and implementation competency	-.03	-.13	-.09	-.06	-.04	.70			
7. Data processing and analysis competency	.010	-.15	.04	.08	.01	.07	.57		
8. Presentation preparation competency	.61	.51	-.18	.67	.71	-.09	.07	.64	
9. Oral presentation competency	.52	.39	-.18	.50	.54	-.002	.06	.55	.71

4.4. Feelings of gaps in various academic research competencies

First of all, this study conducted descriptive numerical analysis on nine academic research competency dimensions. The results indicated that the average value of the nine dimensions reached 4±0.1, which shows that the graduate students agreed with the nine quantitative academic research competency dimensions proposed in this study. At the same time, a paired sample *t* test was conducted on the average of the required competencies of the graduate students for the nine major items and the perceptions of the current academic research competencies, and according to the degree of the gap between the two academic research abilities, they were sorted in sequence.

In the difference analysis, there were significant differences between the nine existing academic research competency dimensions and the required level perceived by graduate students, all of which were significantly lower than the required competency, as shown in Table 15. The top three items with the largest gap are English writing competency (a 1.57 point gap), research design and implementation competency (a 1.27 point gap), and data processing and analysis competency (a 1.27 point gap). The three with the smallest gaps in academic research competency were academic ethics (a .251 point gap), oral presentation (a .38 point gap) and presentation production (a .47 point gap). There was still a significant gap in the comparison of the differences with the existing competencies, as shown in **Table 17**.

Table 17. Analysis of the gaps in academic research competencies in all dimensions.

Construct	Required competencies		Existing competencies		*t*-value	Cohen's *d*	Drop degree	Drop to sort
	M	*SD*	*M*	*SD*				
Academic innovation competency	3.98	.60	3.49	.59	12.41***	.82	.49	4
Academiethics competency	4.02	.61	3.78	.48	7.15***	.46	.25	9
English writing competency	3.92	.66	2.35	.55	35.29***	2.59	1.57	1
Chinese writing competency	3.96	.65	3.49	.67	11.16***	.72	.47	5
Literature review competency	3.98	.62	3.54	.63	11.25***	.69	.44	6
Research design and implementation competency	4.12	.50	2.85	.55	30.95***	2.40	1.27	2
Data processing and analysis competency	4.01	.61	2.74	.43	31.97***	2.40	1.27	2
Presentation preparation competency	3.98	.65	3.52	.66	11.28***	.71	.47	7
Oral presentation competency	3.98	.63	3.60	.71	9.18***	.56	.38	8

****p* < .001

5. Research discussion

Morin pointed out that people's self-perceptions can help them pay attention to themselves and form a method of self-improvement through the competency to analyze their current state [76,77]. In other words, when people are aware of their own existing knowledge, skills and insufficient abilities, they will choose corresponding learning behaviors [13]. Therefore, this study used self-awareness to explore participants' perceptions of the required degree of academic research competencies and their existing competencies.

In the academic field, regardless of the type of information or questions, the research in the general academic field needs to be executed and cross-verified during the research process. Demetriou et al. pointed

out that in order to achieve the research goals, one should have the competency of diversity in order to continuously integrate and improve in the process of academic research [9]. In this study, the required and existing competencies of graduate self-reported academic research were analyzed to confirm the degree of the competency gaps. The results of the difference analysis found that the nine academic research competencies perceived by graduate students all had significant gaps, and the three constructs with the largest gaps with the average gap in competency requirements greater than 1 point were: English writing competency, research design and implementation competency, and data processing and analysis competency, while the smallest gap was for academic ethics competency.

English writing competency was the construct in which the participants of this study felt the biggest gap. This result was consistent with Ceng et al., who found that for non-English native speakers, writing English papers was a challenging task [39]. Meanwhile, some studies have pointed out that current graduate students ignore the competency of using the second language when learning English, resulting in the need to greatly improve their English writing competency [78]. Therefore, some studies have pointed out that in the first semester of graduate school, the focus on learning language should be placed on improving graduates' comprehension of writing, rhetoric, language and literacy [79], and should also emphasize the teaching of grammatical structure, content development, composition, and so on[40], so as to gradually plan the development and the improvement of graduate English writing competency.

Second, participants felt that their research design and implementation competencies were insufficient compared to what is required to conduct research. This was consistent with the viewpoint of Zhong et al. that the research practice competency of graduate students was still relatively insufficient [52]. However, academic research involves a series of research planning and activity implementation processes, which promote the finding of implementation plans to solve research problems or verify hypotheses [49]. Correct application of research methods is necessary to ensure good reliability and validity of research results [50]. Based on this, a number of academic research practice courses should be planned in the graduate school curriculum to improve the research design and execution competency of graduate students.

Being able to properly evaluate and interpret data results is an important academic competency [56]. Participants also felt a lack of ability in data processing and analysis competency, and this academic research competency was listed as the construct with the third greatest gap. Ben-Zvi and Garfield 's research found that despite the growing demand for learning statistics, many students still think that it is a difficult and unpleasant task [56]. Therefore, how to eliminate the negative emotional performance of graduate students is very important. Some research has also suggested that graduate students should be allowed to take core professional courses such as educational survey and measurement, educational statistical analysis, and so on in advance to help them improve their statistical operation competency [50]. This study also supported that it takes time to become proficient in using the tools. In graduate courses, the earlier students can study statistics, the more likely it is that they can improve their proficiency.

Independent study of graduate students is an important condition for completing their studies. The gap in research competency will affect the competency of independent study, and then affect the duration of study. The scale compiled in this study is not only helpful for graduate students to self-assess their level of competency as a reference for independent or further study, but also for teaching or mentoring professors as a reference when arranging academic courses. Besides, the Academic Research Competency Scale is a powerful tool that can be adapted to individual graduate students to minimize the competency gap and establish academic confidence, thereby greatly reducing the possibility of what Stagg and Kimmins said, namely that when students think they are not capable enough, they will lose self-esteem or self-confidence [17].

This study also discussed the analysis results of the capability gap with ChatGPT and Ernie Bot (文心一言), respectively. ChatGPT stated: "The reason for the large gap in English writing ability, research design and implementation ability, and data processing and analysis ability may be affected by factors such as insufficient training, disciplinary background, and insufficient practical opportunities. For academic ethics, oral presentation, and briefing production, although the gap is relatively small, there are still significant differences, which may be affected by awareness, education, and comprehensive ability. Therefore, when formulating improvement plans, comprehensive consideration of these factors may help to be more targeted comprehensively improve the academic research capabilities of graduate students." Ernie Bot stated: "The three abilities with the biggest gap may be caused by the lack of long-term accumulation and professional training required, and they play a vital role in the academic research process. For example, English writing ability is significant to the basis of international academic communication; Research design and implementation capabilities are directly related to the quality and effect of research, while data processing and analysis capabilities are the key to drawing scientific conclusions. In contrast, the gaps in these abilities academic ethics, oral publishing and presentation production are relatively small, because these abilities are relatively basic and graduate students have more opportunities to exercise and improve in their daily study and life.

Furthermore, the analysis results indicated that the current academic development courses provided by research institutes in the field of social science and management cannot meet the needs of graduate students in their research practice. In addition to research competencies, academic lectures, theoretical, practical, and tool-based academic workshops can also be provided; academic research consulting services at the college or school level, establishment of peer academic discussion communities, and design of academic research tools and teaching materials, planning an autonomous learning mechanism, and so on, should be put in place to help graduate students refine their quantitative academic research competencies through different channels.

6. Conclusions and recommendations

6.1. Conclusion

Self-assessment methods or indicators for academic research competencies have rarely been discussed. Therefore, the purpose of this study was to develop a scale tool suitable for self-assessment of academic research competencies of graduate students engaged in quantitative research in the fields of social science and management to explore the academic research competency needs and the degree of existing competencies perceived by graduate students. This study also conducted competency difference analysis based on the two perception levels.

The study results showed that the scale developed in this study has good reliability and validity. Meanwhile, analysis of the ability gaps showed a significant difference between the nine existing academic research ability criteria perceived by graduate students and the required levels; that is, the existing capabilities perceived by graduate students were significantly lower than the required capabilities. The top three criteria with the biggest gaps were English writing ability, research design and implementation ability, and data processing and analysis ability. The top three criteria with the smallest gaps in academic research ability were academic ethics, oral presentation and presentation production.

6.2. Recommendations

The scale developed by this institute can help graduate students to systematically analyze the strengths and weaknesses of their academic research competencies, so that they can seek assistance and continuously improve on their deficiencies according to their own needs. Supervisors and teachers of research methods

courses can also analyze the academic research competencies of students' perceptions to understand the level of their current perceptions. They can also observe and examine the students according to the items in the scale. It is possible to adjust the curriculum and implement counseling measures according to the actual performance of the students. In addition, for students with low self-perceived academic research competency, advisors or teachers can provide more counseling sections and provide other channels for self-improvement (such as MOOCs). Schools can also start from the needs of students and offer them the expected academic lecture series, to gradually establish their research confidence. ChatGPT suggested that research ability factors can be comprehensively considered, curriculum settings and training plans can be adjusted according to the ability gaps of graduate students, and more targeted (personalized) teaching. Guidance can be provided to help graduate students improve their academic research capabilities.

Besides, as artificial intelligence technology becomes more mature, it can be used as an academic assistant to assist researchers in analyzing literature, suggesting suitable theoretical models, designing preliminary research frameworks, repeating data verification (statistical analysis), providing argument support, chart production, citation sorting, language polishing, and so on. The effectiveness of AI can save researchers a great deal of time and energy. In this study, AI was also confirmed to be used as an academic aid. Therefore, teachers can further strengthen the boundaries and application ethics of AI use for graduate students. Researchers use AI to assist academic writing within the scope of reasonable use, thereby helping to improve students' research capabilities. However, this premise requires students to have good AI application performance, as well as sufficient technological literacy and media literacy, in order to effectively distinguish the accuracy of the information provided by AI.

6.3. Research limitations and future study

This study was limited to data collection through online methods, and the research purpose focused on the development of the scale; however, analysis of the validity of the calibration was not carried out. In the follow-up research, the academic achievements of graduate students in the research methods class or the grades of dissertations can be collected as indicators for further testing to confirm whether the scale tool in this study has good prediction of the academic achievement performance of graduate students' competencies. Young researchers can also understand the factors that influence their poor academic abilities or the help they need at the same time.

Comparative education research can push us to gain more information from data analysis, especially from a regional/international perspective, to improve our understanding of competency gaps. Follow-up research can translate the scale tool developed by this research institute into English, and conduct investigations on cross-strait regions, Asian regions, or European and American countries, so as to explore the competency perceptions and differentiation of graduate students in different regions. This scale tool can also be used to conduct surveys on graduate students in mainland China to analyze the similarities and differences in the development of graduate academic competencies in higher education across the Taiwan Strait. The scale developed in this study explored whether there are differences between the existing academic research competencies and the required competencies perceived by Taiwanese graduate students of different genders studying in the social science and management fields in different types of universities, at different research stages.

Writing a dissertation is one of the main academic activities of graduate students, and the quality of the dissertation and acquired academic experience are highly dependent on guidance. The supervisory professor should therefore have a decisive influence on the cultivation of the academic competency of graduate students. Discussing the differences or effects of different supervisory professors' guidance styles and guidance

frequency on the level of academic research competencies of graduate students will help to understand how to help graduate students develop their research professional knowledge in a more effective way. Based on the theoretical framework, this study can be combined with other academic research-related variables to construct a research model to develop a process model of academic research competencies. Follow-up research can also be focused on the collinearity and correlation between different dimensions in quantitative research capabilities.

In addition to research capabilities being an important research topic, AI-assisted academic research (writing) is also an important current research topic. Since most of the current articles are opinion or critical studies, more empirical research or experimental research is needed to let more researchers understand how to apply this emerging technology more efficiently and reasonably. Through survey data, variables such as self-efficacy, usage attitude, expected value, trust, usage effect, acceptance, willingness to use, satisfaction, and so on can be explored from the perspective of user experience based on AI usage scenarios to verify more theoretical models of AI-assisted academic research (writing) and confirm their theoretical relationships. In addition, research on academic ethics also needs widespread attention.

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Ethics statement

Ethical review and approval was not required for the study on Human Participants in accordance with the Local Legislation and Institutional Requirements. However, participants provided an electronic version of their informed consent statement.

Competing interests

The authors declare that they have no conflict of interest.

Artificial intelligence usage scope statement

One of the authors had a dialogue with generative artificial intelligence (ChatGPT 3.5 and Ernie Bot V2.5.4) based on the research analysis results, and wrote with reference to its opinions to support the research results in one paragraph each of the Discussion and Suggestions section.

Conflict of interest

The authors declare no conflict of interest.

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Appendix. Validity analysis

Item	The required competency		The existing competencies		Item	The required competency		The existing competencies	
	FL	***t***	**FL**	***t***		**FL**	***t***	**FL**	***t***
AI1	.589	14.649	.581	14.080	CW8	.656	16.367	.605	13.223
AI2	.580	16.405	.554	12.836	LR1	.653	16.985	.628	15.292
AI3	.739	17.829	.601	15.548	LR2	.680	15.877	.658	15.797
AI4	.601	14.787	.560	14.403	LR4	.672	15.960	.589	15.340
AI5	.684	17.798	.625	15.954	LR5	.661	17.741	.673	17.862
AI6	.627	15.970	.600	13.861	LR6	.662	16.277	.611	13.741
AI7	.655	16.459	.541	11.953	LR7	.638	15.453	.623	15.475
AI8	.614	16.497	.602	14.122	LR8	.722	18.845	.648	15.660
AE1	.655	18.016	.578	13.076	LR9	.666	15.538	.656	15.838
AE2	.703	18.347	.568	12.398	RDR4	.557	13.798	.683	24.559
AE3	.690	17.948	.518	10.848	RDR5	.621	15.738	.780	25.624
AE4	.689	16.882	.513	10.217	RDR6	.623	13.697	.770	30.531
AE5	.642	17.953	.569	12.260	RDR7	.655	14.204	.779	28.692
AE6	.698	18.081	.550	10.833	RDR8	.554	13.612	.661	36.853
AE7	.702	16.847	.529	11.745	RDR10	.616	15.903	.514	15.017
AE8	.668	15.593	.515	12.579	DPA2	.666	17.332	.537	13.244
AE9	.595	15.751	.551	11.871	DPA4	.673	18.911	.515	10.582
EW1	.680	18.283	.539	13.242	DPA5	.694	21.477	.573	15.779
EW2	.700	19.723	.618	13.546	DPA6	.728	20.561	.623	14.438
EW3	.654	17.879	.615	12.679	DPA7	.653	19.141	.576	13.855
EW4	.687	19.233	.560	10.925	AP1	.693	17.202	.559	15.886
EW5	.636	17.532	.597	13.575	AP2	.630	15.499	.671	17.757
EW6	.720	19.854	.588	13.810	AP3	.672	17.281	.653	17.983
EW7	.683	19.332	.511	10.455	AP4	.680	16.763	.639	17.313
CW1	.672	19.975	.692	18.035	AP5	.671	17.641	.669	18.447
CW2	.705	17.139	.716	17.104	OP1	.623	15.307	.658	17.049
CW3	.710	18.694	.670	16.963	OP2	.694	15.899	.709	18.822
CW4	.733	19.009	.633	14.396	OP3	.618	15.471	.743	20.504
CW5	.710	17.732	.676	16.311	OP4	.673	17.118	.717	20.395
CW6	.691	18.183	.672	16.291	OP5	.627	15.136	.701	16.815
CW7	.631	16.397	.653	16.428	OP6	.767	15.319	.727	18.503