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Article

Assessment Scale for Enhancing Professional Competencies in Virtual Reality

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Abstract: This study aims to explore the construction and application of a scale for assessing the professional competence for VR workers, which provides a scientific assessment tool for the field of VR design as a way to promote the cultivation and development of talents in this field.The Delphi method and analytical hierarchical process were used in this study. A questionnaire survey was conducted through the opinions of 16 experts, and the results of the questionnaire were statistically analyzed. In addition, exploratory factor analysis was conducted to extract the information , finally, the weights and importance of the indicators were calculated by analytical hierarchical process.The results showed that the assessment scale of professional competence in VR contains 2 2-indicators, 6 3-indicators of professional knowledge, 2 2- indicators, 6 3- indicators of professional competence, and 2 2- indicator and 10 3- indicators of professional attitudes. The results of this research provide a better assessment system for the professional competencies needed by VR . Meanwhile, this paper suggests that VR should focus on improving its technical application and the ability of interaction design, which can promote the innovativeness of the work and the diversification and enrichment of the way it is presented. This study provides a reference standard for the professional development of VR workers along with guidance for education and training and recruitment and selection in this field.

Keywords: Professional competence, VR, Delphi method, Factor analysis, professional, Analytical hierarchical process

1. Introduction

With the rapid development of VR technology, the roles and responsibilities of VR practitioners are increasingly emphasised. As an innovative field that integrates reality with the VR world, VR design not only requires deep technical skills, but also requires practitioners to possess comprehensive interdisciplinary abilities. However, there is still a lack of unified standards and assessment tools on how to scientifically assess and define the core professional competencies of VR practitioners. By combining the Delphi method and analytical hierarchical process, this study integrates the opinions and experiences of several experts in the field, and systematically analyzes the professional knowledge, skills, and attributes required by VR workers. With this scale, we aim to provide guidance for VR workers and the education field to help recruiters assess more accurately the abilities of candidates, as well as to provide workers with directions for self-assessment and career development. In this paper, we will introduce in detail the construction process of the scale, the assessment methodology and its potential application in the field of VR design. Ultimately, we hope that the results of this research will contribute to the systematic enhancement of VR practitioners' competence and promote their innovation and career development to cope with the increasingly complex and diversified demands of VR applications.

2. A Literature Review

As a cutting-edge interactive technology, VR has demonstrated great potential and application prospects in a wide range of fields.VR has not only changed the way people interact with information and environments, but has also played an important role in education, healthcare, entertainment, and other fields. As the technology continues to advance and gain popularity, the role of VR practitioners has become increasingly critical, requiring not only an in-depth understanding of the operation and development of the technology, but also comprehensive interdisciplinary skills to cope with changing and complex design needs.

Although there are a large number of papers in China that mention the core literacy competence that designers, art students, and art practitioners should have, for example, Mingxing Gao (2021) mentions that the cultivation of designers' professional quality is embodied in the cultivation of ethical, technical, and artistic professional qualities. It is divided into three categories: moral, technical, and artistic expertise. YunJie Ke (2024) indicated that the core skills of art talents should cover three parts: art theory, application skills, and professional comprehensive quality.According to Xia Fan (2017), core literacy mainly includes values, knowledge structure, academic competence, and information literacy.Similarly, Qi Zhang (2015) put forward the view that designers should have the ability to create design, implement the ability to realise it and the ability to learn from theories. As well, Qian Ji (2013) also published the view that professionalism and professional core competencies are the cornerstone of achieving professional designers. However, relevant studies at home and abroad on the assessment of core professional competencies of VR practitioners are still in the preliminary stage and lack unified assessment standards and scales.Among them, Zhongwen Xiao (2023) mentioned that all students majoring in VR should have the ability of art modelling to improve their aesthetic quality, design ability and innovative thinking ability, so as to lay a solid foundation for their career development as VR practitioners in the future. Similarly, Danrong Ni (2024) stated that the three dimensions of practical ability, professional knowledge and innovative thinking should be used as indicators for the assessment of VR courses. At present, many schools cultivate VR students who do not have the knowledge and skills of art majors. Therefore, the professional competence table of VR practitioners can not only provide a scientific basis for social enterprises, but also provide an educational basis for schools to cultivate students of related majors.

In terms of methodology, the Delphi method, factor analysis and hierarchical analysis have been widely used to determine and weigh the importance and hierarchy of professional competencies. These methods not only integrate expert opinions, but also quantify the relative importance of different elements of competence, so as to construct a scientifically rigorous assessment system. This thesis combines the division of the competency assessment scale into primary, secondary, and tertiary indicators and the use of hierarchical analysis to determine the weights of each indicator, as applied by Yunxi Liu (2024); as well as reference to the Delphi method of expert enquiry adopted by Hui Jiao (2022); and the factor analysis method of the studies by Jianjun Hou (2021) and Yuan Wang (2022). In summary, the purpose of this paper is to construct and validate the Core Professional Competency Assessment Scale for VR Practitioners, which provides a scientific assessment tool for the field, in order to promote the enhancement of VR practitioners' competency and the development of the industry. Through the literature review, we will delve into the progress and challenges of the related research, and provide theoretical and practical guidance for the design and implementation of subsequent studies.

However, it is important to note that there are still some challenges and limitations in assessing the professional competence of VR practitioners in current research. For example, the rapid development of VR technology leads to frequent updating of new technologies and tools, making the updating and adaptation of assessment tools particularly important. In addition, the needs of practitioners' competence may vary across application scenarios and industries, thus further research and customisation of assessment tools are needed to meet the specific needs of different fields.

3. Research Design and Method

3.1 Research Framework

The aim of this study was to develop an assessment tool for the professional competence of VR practitioners.The research includes faculty from art and design schools, VR industry practitioners, and graduate students in digital media arts, with a focus on the VR design industry. The research method is based on relevant theories and literature, qualitative and quantitative research in parallel, using the Delphi method and literature survey. The Delphi method was used in this study, which is an anonymous method that allows for the selection of suitable experts to form an expert panel. The structure of this study, as shown in Table I, divides the content of VR practitioners' professional competence into three dimensions of Level 1 indicators: professional knowledge, professional skills, and professional attitudes, as well as nine Level 2 indicators, totalling 140 Level 3 indicators. These three dimensions are (i) professional knowledge: basic knowledge, application knowledge, and feasibility knowledge; (ii) professional skills: research and development skills, practical skills, and application skills; and (iii) professional attitudes: self-growth, personality traits, and interpersonal communication;The construction of the indicator system is from Yunxi Liu (2024) and Hongyan Kong (2024); the reference content of the primary indicators is from Mingxing Gao (2021), Yunjie Ke (2024), Fan Xia (2017), and Ji Qian (2013); the reference content of the secondary indicators is from Hou Jianjun (2021), and Shenzen Hao (2024); and the reference content of the tertiary indicators is from Zhongwen Xiao (2023), Qi Zhang (2015), and Nan Wang (2020). The questionnaire of this study was based on a five-point Likert scale, i.e., "1" means "very unimportant", "2" means "unimportant", "3" means "average", "4" means "important", and "5" means "unimportant". "1" means "very unimportant", "2" means "unimportant", "3" means "average", "4" means "important", "5" means "unimportant", and "6" means "unimportant". "5" means "very important". The suggestions of experts and scholars on the evaluation of the professional competence of VR practitioners were explored through the Delphi technique, and the reliability test of exploratory factor analysis was conducted. Meanwhile, each three-level index was established. As a result, the scale for evaluating the professional competence of VR practitioners was constructed.

Table 1. VR Practitioner Occupational Competence Evaluation Scale Architecture Scale

<table>
<tr><td rowspan="9">Evaluation indicators of the connotation of professional competence of VR practitioners</td><td rowspan="3">Domain of professional knowledge（30%）</td><td>Design theory: 23 indicators</td></tr>
<tr><td>Applied knowledge: 19 indicators</td></tr>
<tr><td>Knowledge of feasibility: 14 indicators</td></tr>
<tr><td rowspan="3">Domain of professional skills（50%）</td><td>R&D skills: 17 indicators</td></tr>
<tr><td>Practical skills: 16 indicators</td></tr>
<tr><td>Applied skills: 17 indicators</td></tr>
<tr><td rowspan="3">Domain of professional attitude（20%）</td><td>Self-growth: 12 indicators</td></tr>
<tr><td>Personality traits: 12 indicators</td></tr>
<tr><td>Interpersonal communication: 10 indicators</td></tr>
</table>

3.2 Implementation Procedures

The content of the Delphi questionnaire was compiled through literature analysis and expert consultation. In addition, the questionnaire was modified based on the comments of the supervising professors.First, a scale with 140 indicators in three dimensions was developed, including 56 indicators of professional knowledge, 50 indicators of professional skills and 34 indicators of professionalism. The study authors invited 16 experts to participate in the Delphi questionnaire. The questionnaires were sent out on 14 March with a return date of 21 March. The results of the questionnaire were analysed in terms of questionnaire analysis and reliability, and items whose decision values did not meet the criteria for establishing the reliability of the indicator were removed. Subsequently, exploratory factor analysis and principal component analysis were conducted based on the results obtained from the questionnaire analysis. After repeated screening and indicator weighting analysis based on the important items selected in the factor analysis, the VR Practitioner Professional Competence Evaluation Scale was finally constructed.

3.3 Analysis of Data from the Delphi Questionnaire

The key elements were identified through factor analysis, which led to the development of a scale for evaluating the professional skills of VR practitioners. The three criteria are: mean greater than or equal to 3, standard deviation less than or equal to 1.5, and interquartile deviation less than or equal to 0.5. All items that did not meet the criteria for the indicator were deleted.

3.4 Questionnaire Results

According to the statistical analysis of the questionnaire and the results of the expert opinion revision based on the above criteria, and according to the opinions provided by the members of the group to make moderate amendments, a total of 82 indicators were amended and deleted, and 58 indicators were retained. And the reliability analysis of each item of the questionnaire, the Cronbach's α coefficient of the three subscales are above 0.90, and the whole scale is as high as 0.967, which shows that the consistency of the content of each item is quite strong, and the credibility is very high.As shown in table 2.

Table 2. Reliability analysis of the questionnaire

<table>
<tr><th>Items</th><th>Number of items</th><th>Cronbach’s α</th><th>Cronbach’s α of Subscale</th><th>Full scale Cronbach’s α</th></tr>
<tr><td>Design theory</td><td>23 indicators</td><td>0.893</td><td rowspan="3">0.953</td><td rowspan="9">0.967</td></tr>
<tr><td>Applied knowledge</td><td>19 indicators</td><td>0.853</td></tr>
<tr><td>Knowledge of feasibility</td><td>14 indicators</td><td>0.928</td></tr>
<tr><td>R&D skills</td><td>17 indicators</td><td>0.865</td><td rowspan="3">0.939</td></tr>
<tr><td>Practical skills</td><td>16 indicators</td><td>0.825</td></tr>
<tr><td>Applied skills</td><td>17 indicators</td><td>0.808</td></tr>
<tr><td>Self-growth</td><td>12 indicators</td><td>0.890</td><td rowspan="3">0.962</td></tr>
<tr><td>Personality traits</td><td>12 indicators</td><td>0.924</td></tr>
<tr><td>Interpersonal communication</td><td>10 indicators</td><td>0.888</td></tr>
</table>

3.5 Amendments to the First Questionnaire

Based on the results of the statistical analysis of the first Delphi questionnaire, and then based on the criteria for reservations and expert opinions, the questionnaire's indicators were deleted and revised as shown in Table 3, with a total of 82 indicators amended and deleted and 58 indicators retained.

Table 3. Delphi questionnaire modified retention indicator scenarios

Domain of professional knowledge	
1.1 Design theory	
1.Knowledge of core VR fundamentals	14.With VR environment design theory
2.Have a basic research methodology in VR technology	15.With 3D modelling and animation theory
3.Have basic concepts of VR technology	18.Possesses VR modelling theory
5.Knowledge of interaction design	19.Have a theory of interaction design
13.Possesses the theory of human-computer interaction	21.Has a theory of information visualisation
1.2 Applied knowledge	
24.Application knowledge of VR development tools	30.Applied knowledge of interaction design
25.Knowledge of 3D modelling software applications	
1.3 Knowledge of feasibility	
44.Technical feasibility	52.Content planning
49.Risk Assessment	53.Technical Support
50.Brand position	56.Market Promotion
51.User Experience Design	
Domain of professional skills	
2.1 R&D skills	
57.Knowledge of VR development platforms and tools such as Unity, Unreal Engine, etc.	68.Understanding the principles of human-computer interaction.
58.Ability to model and animate in 3D.	70.Possesses big data processing skills
62.Experience in user interface design	71.Multi-Platform Adaptation
67.Optimise VR application performance to ensure it works well on a wide range of devices.	
2.2 Practical skills	
74.Skilled in operating various VR equipment	78.nteraction Design & Implementation
75.3D modelling and animation using professional software	80.VR Navigation and Control
77.User Interface Design & Optimisation	84.Multimedia content production and integration
2.3 Applied skills	
90.VR Development Skill	96.Sound design and sound production skills
91.3D Modelling & Animation Skills	98.Multimedia content production skills
92.VR Design Skill	99.VR Interaction Design Skills
93.UX Design Skills	100.VR Guide System Design Skills
94.Programming & Coding Skills	102.Ability to analyse design results
Domain of professional attitude	
3.1 Self-growth	
107.Continuous learning of VR technology	112.Creative thinking development
110.UX Design Enhancement	113.The Pursuit of Technological Innovation
111.Communication & Collaboration Skills	114.Focus on user needs
3.2 Personality traits	
119.Innovativeness	122.Self-discipline
120.Patience	125.Curiosities
121.Sense of responsibility	129.Attention to detail
3.3 Interpersonal communication	
131.Ability to work effectively with team members	133.Ability to listen carefully to the opinions and suggestions of others
132.Ability to express your ideas, needs and opinions clearly	

4. Statistical Analysis and Results

4.1 Factor Analysis

A total of 58 indicators were retained as a result of the first questionnaire revision, as shown in Table 3, and the results of the revision were subjected to factor analysis.In this study, with reference to the studies of Hui Jiao (2022), Jianjun Hou (2021), and Yuan Wang (2022), there are four principles for deleting indicators:(1)Questions with factor loadings lower than 0.5;(2)Common factors with eigenvalues less than 1.(3)Questions simultaneously covering two common factors;(4) Questions with no more than two items. Based on the results of the factor analysis, a total of 14 topics were finally extracted from the two factors of expertise facets: Name the factor 1 facet as late applied knowledge; Factor 2 facets named as VR technology theory; Factor 3 facets are named software knowledge; Factor 4 facets named as VR design theory. Its eigenvalues were 4.248, 2.892, 2.502 and 1.870; in the validity test section, the total cumulative explanatory variance of the scale was 82.227%; A total of 14 topics were extracted from the three factors of the professional skills construct: factor one contained four items, 2-3-96, 2-2-75, 2-3-94, and 2-3-99, and this construct was named software production skills; Factor 2 contains 3 question items, 2-3-92, 2-1-58, and 2-3-100, naming this construct as VR

Application Skills;Factor 3 contains 3 question items, 2-2-80, 2-2-84, and 2-2-78, naming this construct as Interaction Skills; Factor 4 contains 4 question items, 2-1-67, 2-2-74, 2-1-68, and 2-1-62, naming this construct the Late Refinement Skill. Its eigenvalues were 4.285, 2.666, 2.027 and 1.621 respectively; in the validity test section, the total cumulative explanatory variance of the scale was 75.706%. A total of 10 topics were extracted from the two elements of the professional literacy framework: Factor 1 contains 7 question items 3-2-119, 3-3-133, 3-3-131, 3-2-129, 3-1-107, 3-2-121, and 3-2-122, naming this construct Personality and Interpersonal; Factor 2 contains three question items, 3-1-114, 3-1-110, and 3-1-112, naming this construct Refinement and Enhancement, with eigenvalues of 5.763 and 1.072, respectively; In the validity test section, the total cumulative explanatory variance of the scale was 68.352%. The scales were shown to have good construct validity. In addition, with regard to the factor loadings of the 58 observational variables of the outcome scale of the suitability assessment of the questionnaire's dimensions, the values of 20 observational variables did not meet the four aforementioned principles or were lower than 0.5, while the remaining 38 factor loadings fulfilled the four principles. This suggests that in terms of theoretical conceptualisation, the VR practitioners' professional competence assessment system can indeed be judged from these three dimensions.

4.2 Reliability Analysis

The reliability was then tested with the Cronbach α. Based on the correlation between each item in the Expertise Construct First Factor Late Applied Knowledge and the subscale, the alpha coefficient for this subscale can be increased to 0.896 if items 1-3-52 and 1-1-2 are deleted. The other three question items 1-3-50, 1-3-56, and 1-1-1 had satisfactory values, so 1-3-50, 1-3-56, and 1-1-1 were retained, and the alpha coefficient value for this factor was 0.896; According to the correlation between each item and subscale in the second factor VR technology theory of expertise constructs, the interphase values between items 1-1-18, 1-1-13, and 1-1-3 and the subscales were all ideal, so 1-1-18, 1-1-13, and 1-1-3 were retained, and the alpha coefficient value for this factor was 0.916; According to the correlation between each question item and the subscale in the third factor of the software knowledge of the expertise construct, the correlation value between question items 1-2-30 and the subscale is slightly lower, and if question items 1-2-30 are deleted, there are only two question items left in the third factor of the expertise construct, so the third factor of the expertise construct will be deleted in its entirety; According to the correlation between each item and subscale in the VR design theory of the fourth factor of the expertise construct, the correlation values between items 1-1-14 and 1-2-24 and the subscales were slightly lower, and if they were deleted, there would be only one item left in the fourth factor of the expertise construct, so the fourth factor of the expertise construct was deleted in its entirety; the alpha coefficient of the expertise construct was 0.734, which is highly reliable. Based on the correlation between each item and subscale in the Professional Skills Construct 1 factor Software Production Skills, the correlation values between items 2-3-94 and 2-3-99 and the subscales were slightly lower, and if they were deleted, there would be only two items left in the Professional Skills Construct 1 factor, so the Professional Skills Construct 1 factor would be deleted in its entirety; Based on the correlations between each item and subscale in the second factor of the professional skills construct, VR Application Skills, the interphase values between items 2-3-92, 2-1-58, and 2-3-100 and the subscales were all satisfactory, so the three items were retained, and the alpha coefficient value for this factor was 0.909; Based on the correlations between each item and subscale in the third factor of the professional skills construct, Interaction Skills, the interphase values between items 2-2-80, 2-2-84, and 2-2-78 and the subscales were all satisfactory, so the three items were retained, and the alpha coefficient value for this factor was 0.907; Based on the correlations between each item and subscale in the Late Refinement Skills for the fourth factor of the Professional Skills Construct, the correlation values between items 2-1-67, 2-2-74, 2-1-68, and 2-1-62 and the subscales were all slightly lower, so the fourth factor of the Professional Skills Construct was deleted in its entirety; Based on the correlations between each item and subscale in the first factor of the professional attitude construct, personality and interpersonal, items 3-2-119, 3-3-133, 3-3-131, 3-2-129, 3-1-107, 3-2-121, and 3-2-122 all had desirable values of intervals with the subscales, and therefore seven items were retained, and the alpha coefficient value for this factor was 0.929; Based on the correlation between each item and subscale in the second factor enhancement and refinement of the professional attitude construct, the interphase values between items 3-1-114, 3-1-110, and 3-1-112 and the subscales were all satisfactory, so all three items were retained, and the α factor value for this factor was 0.603; The α factor for the professional attitude construct was 0.906, which is highly reliable. The α factor for the full scale was 0.741, which is a high level of reliability. Based on Yuan Wang (2022) principle that Cronbach α factor of 0.6 or higher is acceptable, the reliability of each dimension passed the criteria of reliability test. Therefore, the test results show that the scales obtained after exploratory factor analysis have strong internal consistency, which can ensure the credibility of the results of data analysis.

4.3 Principal Component Analysis

The analysis of principal component factor was performed. A total of six questions were extracted from the two factors of the expertise construct, as shown in Table 4, with the first factor of three items named as late application knowledge;The second factor of three items was named VR technology theory; the cumulative explained variance was 84.875%; the value of the late application knowledge eigenvalue was 2.464 with 41.831% of explained variance, and the value of the VR technology theory eigenvalue was 2.628 with 43.044% of explained variance, which represents a stronger explained variance for the VR technology theory factor than for the late application knowledge factor.The two factors of the professional skills construct were extracted with a total of 6 questions, the first factor of 3 items was named VR application skills; the second factor of 3 items was named interaction skills; the cumulative explanatory variance was 85.859%; the eigenvalue of VR application skills was 2.658, with an explanatory variance of 43.543%; and the eigenvalue of interaction skills was 2.494, with an explanatory variance of 42.316%; the VR application skills were shown to have higher explanatory variance than interaction skills. skills have higher explained variability than interaction skills;A total of 10 questions were extracted from the two factors of the professional attitude construct, the first factor with 7 items named Character and Interpersonal; the second factor with 3 items named Enhancement and Refinement; the cumulative amount of explained variance was 68.352%; the eigenvalue of Character and Interpersonal was 5.763, with an amount of explained variance of 45.995%; and the eigenvalue of Enhancement and Refinement was 1.072, with an amount of explained variance of 22.357%; representing a stronger explained variance for the Character and Interpersonal factor than that for the Enhancement and Refinement factor. interpersonal factor explains more variation than the enhancement and refinement factor.Yuan Wang (2022) stated that factor analysis results are considered desirable when the factor loadings are greater than 0.5 and the cumulative explained variance is greater than 40%. The results obtained in this study are above this recommended value, so the factor loadings of the principal component factors and the indicator items are satisfactory and show a considerable degree of correlation.

Table 4. The results of factor analysis

Domain	Naming of factors	No. of item	Total number of indicators	Factor loadings	Common	Eigenvalue	Rotation Sums of Squared	percentage of Variance	Cumulative percentage of Variance
Professional knowledge	**Post-application knowledge**	1-3-50	3	0.967	0.936	2.464	2.510	41.831%	84.875%
		1-3-56		0.892	0.797				
		1-1-1		0.877	0.773				
	VR Technology Theor	1-1-18	3	0.947	0.897	2.628	2.583	43.044%	
		1-1-13		0.959	0.925				
		1-1-3		0.873	0.765				
Professional skills	**VR Application Skills**	2-3-92	3	0.972	0.950	2.658	2.613	43.543%	85.859%
		2-1-58		0.899	0.809				
		2-3-100		0.893	0.799				
	interaction skill	2-2-80	3	0.943	0.902	2.494	2.539	42.316%	
		2-2-84		0.906	0.832				
		2-2-78		0.906	0.859				
professional attitude	**Personality & Interpersonal**	3-2-119	7	0.931	0.869	5.763	4.600	45.995%	68.352%
		3-3-133		0.900	0.897				
		3-3-131		0.774	0.654				
		3-2-129		0.744	0.669				
		3-1-107		0.741	0.623				
		3-2-121		0.741	0.762				
		3-2-122		0.690	0.660				
	Enhancement and Improvement	3-1-114	3	0.852	0.734	1.072	2.236	22.357%	
		3-1-110		0.711	0.579				
		3-1-112		0.524	0.389				

4.4 The Importance of Indicators

This section presents the results of the analysis of the importance of the core professional competence indicators for VR practitioners, as shown in Table 5. According to the content of the indicators of the expertise dimension and their corresponding average ratings and rankings, Item 1-1-13 has HCI theory at the top of the list of the expertise dimension, which shows that HCI theory has a central position and is extremely important for VR practitioners, and it is the first step to become the expertise of VR practitioners. Item 1-1-18 VR modelling theory indicates that VR practitioners need to be skilled in accurate modelling concepts and a focus on visual representation. Item 1-1-1 VR Core Fundamentals and 1-3-56 Marketing indicate that VR practitioners need to learn the core fundamental theories of VR as well as the theories related to marketing the designed VR products so that they can achieve a balance and interaction between theories and practical applications. Item 1-3-50 Brand Positioning is the fourth of the expertise constructs according to the weighting, showing that VR designers need to be familiar with the key roles of VR design applications in different markets. Finally, Item 1-1-3 possesses the basic concepts of VR technology reflecting the fact that VR technology is the foundation of being a VR practitioner. In summary, these metrics provide an important reference for the assessment and development of the core dimensions of expertise that should be present in order to become a VR practitioner, highlighting that human-computer interaction theory, modelling theory, the core fundamentals of VR, market perception, and brand positioning play a key role in becoming a professional VR practitioner. Based on the content of the Professional Skills Component indicators and their corresponding mean ratings and rankings, Item 2-3-92 VR Design Skills tops the list of the Professional Skills Component, highlighting its dominance in the list of core competencies required of VR practitioners; Item 2-3-100 VR Guide System Design Skills, shows that practitioners need to acquire skills that are useful for creating immersive guide experiences; Item 2-1-58 Ability to produce 3D modelling and animation, 2-2-80 VR navigation and control, and 2-2-84 Multimedia content production and integration reflect the need for practitioners to collectively focus on the visual and functional aspects of building VR environments; Item 2-2-78 Interaction Design and Implementation ranked fourth in the professional skills construct, emphasising the importance of user experience and interaction design in VR applications. These skill constructs provide key guidance and direction for professionals seeking success within the VR field, emphasising the importance of a combination of multifaceted skills in design, navigation, production and interaction. Based on the content of the professional attitude construct indicators and their corresponding average ratings and rankings, Item 3-2-119 Innovativeness topped the professional attitude construct, highlighting the importance and high recognition of the need for VR practitioners to continue to innovate in the field of VR technology. Item 3-3-133 Ability to listen carefully to others' opinions and suggestions, 3-1-107 Continuous learning of VR technology, 3-1-114 Attention to user needs, and 3-1-110 Enhancement of user experience design show that VR professionals place equal importance on interacting with users, learning about technology, and optimising the user experience. Item 3-2-129 Attention to detail and 3-2-121 Responsibility emphasise the importance of precision and professional responsibility in VR projects. Item 3-3-131 Ability to work effectively with team members, 3-2-122 Self-discipline, and 3-1-112 Creative thinking development show key literacy skills in teamwork, personal self-management, and creative development. These professional attitude constructs provide a comprehensive assessment and direction for professionals pursuing excellence within the VR field, emphasising the indispensability of multiple literacies such as innovation, user relations, teamwork and personal development in the successful implementation of VR projects. Taken together, becoming a good VR practitioner requires not only solid professional knowledge and skills, but also a high degree of creativity and good professionalism. Within the professional knowledge facets, human-computer interaction theory, modelling theory, and fundamentals are considered central, providing VR designers with a balance of theoretical foundations and application implementations. VR design skills, guided tour system design, 3D modelling and animation, and interaction design and implementation are seen as key in the professional skills profile, with an emphasis on the ability to apply them in real projects and creative problem solving. And within the professional attitude construct, the literacies of innovation, teamwork, user focus, and self-management highlight the integral role in teamwork and project success. Together, these constructs form a comprehensive framework of competencies needed to be a successful VR professional, leading to growth and innovation within the industry.

Table 5. Analysis of results in terms of significance

Domain	Content of the indicators	Mean(M)	Rank of averages
Professional knowledge	1-1-13 Possesses the theory of human-computer interaction	4.5	1
	1-1-18 Possesses VR modelling theory	4.375	2
	1-1-1 Knowledge of core VR fundamentals	4.25	3
	1-3-56 Market Promotion	4.25	3
	1-3-50 Brand position	4.188	4
	1-1-3 Have basic concepts of VR technology	4.125	5
Professional skills	2-3-92 VR Design Skill	4.375	1
	2-3-100 VR Guide System Design Skills	4.313	2
	2-1-58 Ability to model and animate in 3D	4.188	3
	2-2-80 VR Navigation and Control	4.188	3
	2-2-84 Multimedia content production and integration	4.188	3
	2-2-78 Interaction Design & Implementation	4.125	4
professional attitude	3-2-119 Innovativeness	4.188	1
	3-3-133 Ability to listen carefully to the opinions and suggestions of others	4.125	2
	3-1-107 Continuous learning of VR technology	4.125	2
	3-1-114 Focus on user needs	4.125	2
	3-1-110 UX Design Enhancement	4.125	2
	3-2-129 Attention to detail	4.063	3
	3-2-121 Sense of responsibility	4.063	3
	3-3-131 Ability to work effectively with team members	3.938	4
	3-2-122 Self-discipline	3.938	4
	3-1-112 Creative thinking development	3.938	4

In this study, a specialized scale for assessing the professional competence of VR workers was developed through exploratory factor analysis based on the Delphi method. This study provides a reliable assessment tool for the VR industry, which can help professionals to improve their professionalism. It also provides a standardized evaluation basis for companies to select talents and for universities to design courses.The basis of judgment Ca for the experts in this study was 0.963, the expert familiarity Cs was 0.975, while the expert authority coefficient Cr was 0.969, which indicated that the experts possessed a high level of professionalism. Meanwhile, the Kendall's coordination coefficient value W of the questionnaire is 0.094, while the coefficient of variation CV is all less than 0.36. The consistency of the opinions of the experts is high, which indicates that they have reached an agreement on the assessment criteria of professional competence.Exploratory factor analysis showed that the scale was divided into three main dimensions, including professional knowledge (6 indicators), professional skills (6 indicators) and professional attitudes (10 indicators). The cumulative explained variances of these three dimensions were 84.875%, 85.859%, and 68.532%, respectively, showing that the scale's dimensional structure was reasonable and explanatory. In addition, the Cronbach's α values of the three dimensions were greater than 0.73, indicating that the scale has good internal consistency and reliability. Therefore, the assessment results of the questionnaire were satisfactory. Through the Delphi questionnaire and exploratory factor analyses, the study successfully developed a set of core professional competency evaluation scales for VR practitioners containing 22 indicators, which provides the industry with an effective tool to facilitate the professional development of practitioners and the talent management of enterprises.

5. Conclusion

With the rapid development of VR technology, it is particularly important to conduct a comprehensive assessment of the professional competence of VR practitioners. This study explores and establishes a set of scientific and effective assessment tools to measure the competency level of practitioners in the areas of professional knowledge, professional skills and professional attitudes with the Professional Competency Assessment Scale for VR Practitioners. Through in-depth analyses of the weighted rankings of various indicators, this study provides a specific assessment of the different dimensions of professional competence for VR practitioners, which provides a reliable standard for corporate recruitment, employee training and university curriculum development. This not only helps practitioners to stay competitive in the highly competitive market, but also injects new impetus for the industry's continuous innovation and development. In future research and practice, the assessment tool can be further optimised, and the indicator system of the scale can be continuously updated and improved in conjunction with the industry development trend and technological updates, in order to better serve the talent training and management needs of the VR industry. This study not only theoretically constructs a framework for assessing the core professional competencies of VR practitioners, but also provides operability and implementation for practical application, providing strong support and guidance for the progress and development of the industry.

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