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The Fuzzy Delphi Method: Validation of the Professional Competencies Elements in Career Readiness Instrument for Students with Disabilities

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Abstract

This study seeks to achieve expert consensus on the items created for professional competencies elements in the career readiness assessment tool for students with disabilities. The study utilized the Fuzzy Delphi Method (FDM) using a seven-point Likert scale to collect reviews from 13 experts in diverse disciplines such as special education, batik making, textiles, food & beverage, laundry, and cleaning services. The research instrument comprises 12 item into for professional competencies elements. The data was analyzed utilizing Triangular Fuzzy Numbers and the Defuzzification Process. The results suggest that expert comments and consensus on the instrument's constructions are satisfactory. The study found that the expert consensus was above 75%, with a Threshold (d) value below 0.2 and an α–cut value above 0.5. All 12 items in the personal quality and ability elements for students with disabilities satisfied the Triangular Fuzzy Numbers criteria and were approved. Thus, this indicates that all items have obtained expert consensus and are essential for evaluating the professional preparation of students with exceptional needs. FDM can amalgamate expert perspectives to reach a consensus on item validation, ensuring the reliability and relevance of the built items.

Keywords: Fuzzy Delphi Method, Instrument Validity, Career Readiness, Students with Disabilities

Introduction

Attaining career readiness is an essential milestone for every student, as it acts as a connection between academic life and professional success (Borg et al., 2020). Career readiness is an essential component that requires attention and assistance to guarantee successful transitions to the workforce for students with disabilities (Mazzotti et al., 2024; National Association of Colleges and Employers, 2023). Students with impairments face distinct obstacles and can utilize specialized skills to enhance their chances of achieving success in the professional realm. Career preparedness comprises a variety of abilities, such as the capacity to advocate for oneself, employ effective job-seeking techniques, and adjust to the demands of the workplace (Majid et al., 2012; Sek-yum Ngai et al., 2023). These skills

are crucial for students with disabilities as they move from education to employment, allowing them to compete on an equal level with their peers and succeed in different professional settings. Research suggests that students with disabilities frequently face obstacles, including increased course failure rates, limited access to academically rigorous curricula, and fewer opportunities to develop critical thinking skills. These challenges have a significant impact on their preparedness for postsecondary education and employment (Choiseul-Praslin & McConnell, 2020; Mazzotti et al., 2024).

Efforts to improve career preparation for individuals with disabilities involve prioritising transition programmes that equip them for immediate work and enrollment in higher education (Alias, 2013; Lombardi et al., 2018). Research has shown that vocational training, work-based learning experiences, and internships are excellent strategies for improving the employability and career preparation of students with disabilities (Riesen et al., 2022; Sek-yum Ngai et al., 2023). Moreover, the implementation of customised assistance programmes and personalised learning plans is essential in aiding students with disabilities to acquire the requisite skills for smooth transitions to higher education and the workforce.

Furthermore, it is crucial to cater to the unique requirements of students with disabilities in terms of career planning. This can be achieved by offering resources such as disability management programmes, employing professionals who specialise in this area, and providing training for work-integrated learning practitioners. These measures are vital for fostering career readiness among students with disabilities (Gatto et al., 2021; Lu et al., 2022). Recognising the valuable skills, aspirations, and achievements of students with disabilities is crucial. It is also important to offer continuous support and opportunities for skill enhancement to improve their readiness for future careers (J.francois et al., 2010; Karhina et al., 2022).

Career Readiness Instruments for Students with Disabilities

Career Readiness Instruments for students with disabilities are specialized tools designed to evaluate and enhance the skills and preparedness of these students for entering the workforce. These instruments consider the unique challenges and needs of students with disabilities, providing tailored assessments that focus on their strengths, areas for improvement, and specific accommodations they may require. By doing so, they help ensure that students with disabilities receive the appropriate support and resources to develop the necessary skills for successful career transitions. In this study, the instrument are developed based on “Work Readiness Skills for the Commonwealth” and “College and Career Readiness for Transition”.

A 25-year study conducted by the University of Virginia shows a high demand for career readiness skills in Commonwealth countries and one of the important elements is this study is “professional competencies” (Crespin et al., 2017). Professional competencies are essential for successful performance in the workplace. These competencies encompass a variety of behavioral abilities, social and emotional skills, knowledge, attitudes, and experiences (Rashed & Snoubar, 2020). This includes traits such (i) big picture thinking, (ii) career & life management, (iii) continuous learning & adaptability, (iv) efficiency & productivity, (v) information literacy, (vi) information security, (vii) information technology, (viii) job-specific tools & technologies, (ix) mathematics, (x) professionalism, (xi) reading & writing and (xii)

workplace safety. These qualities enable a person to perform effectively in various situations, work well with others, and contribute positively to their environment. Collectively, these skills and abilities establish the basis for being prepared for a career, enabling individuals to flourish in their positions and advance in their professional paths. Table 1 show basic characteristics of each traits in professional competencies element.

Table 1
Basic Characteristics of Each Traits

Traits	Characteristics
Big Picture Thinking	Understands one's role in fulfilling the mission of the workplace and considers the social, economic, and environmental impacts of one's actions
Career And Life Management	Plans, implements, and manages personal and professional development goalsrelated to education, career, finances, and health
Continuous Learning And Adaptability	Accepts constructive feedback well and is open to new ideas and ways of doing things; continuously develops professional skills and knowledge to adjust to changing job requirements
Efficiency And Productivity	Plans, prioritizes, and adapts work goals to manage time and resources effectively
Information Literacy	Locates information efficiently, evaluates the credibility and relevance of sources and facts, and uses information effectively to accomplish work-related tasks
Information Security	Understands basic Internet and email safety and follows workplace protocols to maintain the security of information, computers, networks, and facilities
Information Technology	Maintains a working knowledge of devices, resources, hardware, software, systems, services, applications, and IT conventions
Job-Specific Tools And Technologies	Knows how to select and safely use industry-specific technologies, tools, and machines to complete job tasks effectively
Mathematics	Applies mathematical skills to complete tasks as necessary
Professionalism	Meets organizational expectations regarding work schedule, behavior, appearance, and communication
Reading And Writing	Reads and interprets workplace documents and writes effectively
Workplace Safety	Maintains a safe work environment by adhering to safety guidelines and identifying risks to self and others

(Source: 21st Century Workplace Readiness Skills for the Commonwealth by the Virginia Department of Education's Office of Career, Technical, and Adult Education)

Method

Research Design

This study is quantitative in nature and applies the Fuzzy Delphi Method (FDM) to achieve expert consensus on the constructs for the professional competencies required by employers for MBPK based on expert consensus. This method involves the use of fuzzy set theory integrated into the classical Delphi method, where the Likert scale selected by experts is converted to a fuzzy scale using fuzzy numbering, which consists of binary terms (0, 1). The integration of fuzzy numbering will yield three values: the minimum value, the most reasonable value, and the maximum value, which will be selected by the experts.

Instrument

This study uses a questionnaire as an instrument to obtain quantitative data regarding the constructs for the professional competencies elements required by employers for students with disabilities. The questionnaire has undergone expert review and refinement and has received language validation and content validation from subject matter experts and curriculum experts. The use of the questionnaire is to meet the criteria and requirements for the use of the Fuzzy Delphi Method (FDM), which involves the use of mathematical formulas to achieve expert consensus. The instrument used by the researcher is based on the needs of this study.

Data Analysis Procedure

The data collection and analysis process for this study is based on the implementation steps of the Fuzzy Delphi Method (FDM) as follows:

Step 1: Selection of experts

To implement the Fuzzy Delphi Method (FDM) in this study, the researcher identified a group of experts who agreed to contribute their expertise by providing ideas, critiquing, and improving the content of the items determined by the researcher. The experts in this study consist of employers and teachers from Vocational Special Education School. The method for selecting the sample of experts was non-probability sampling, specifically purposive sampling, chosen based on the purpose of evaluating their knowledge and experience. The researcher suggests that the criteria for selecting experts should also include the willingness of individuals to be appointed as experts. Willingness is important to ensure that the experts are genuinely willing to assist the researcher and have sufficient time to participate in the study. Initially, 20 experts were identified to validate this survey instrument. However, only 13 agreed to cooperate, take the time, and willingly assist the researcher. According to Clayton (1997), a number of 10 to 15 experts is considered a homogeneous group of experts, which is the small sample size required as experts. Table 2 below shows experts profile involved in this study.

Table 2
Experts Profile

Experts	Field	Sex	Age	Experience (Year)
E1	Food & Beverage	Male	42	20
E2	Cleaning Service	Female	40	15
E3	Dress Making	Male	44	10
E4	Laundry	Male	38	12
E5	Bakery	Female	45	12
E6	Hand Craft	Female	46	23
E7	Landscape	Male	38	16
E8	Human Resource	Female	39	10
E9	Education	Female	42	19
E10	Education	Male	40	14
E11	Education	Male	37	11
E12	Education	Female	48	22
E13	Education	Female	42	17

Step 2: Create a questionnaire for experts
In this process, the construction of the questionnaire can be done through several methods, namely interviews and literature reviews. Powell (2003) stated that the Delphi method is a very flexible method for achieving expert consensus. This is because the first round of Delphi is conducted to identify an issue through expert interviews. However, identifying and obtaining an issue can also be done through open-ended questions. There are also other methods for obtaining related issues by using questionnaires from literature reviews (Duffield, 1993). In the phase of designing and developing the MBPK career readiness skills instrument, the foundation for the study is based on a combination of literature review mapping analysis and expert interviews in needs analysis. A total of 12 items for professional competencies elements have been developed for the questionnaire in the design and development of the MBPK career readiness skills instrument.

Step 3: Distribute the questionnaire form
The researcher met all 13 experts individually face-to-face while distributing the questionnaire to collect data. During these meetings, the researcher and experts discussed each developed item.

Step 4: Linguistic variable transformation
This process involves converting all linguistic variable scales into Triangular Fuzzy Numbers. Triangular Fuzzy Numbers are represented by values $m1$, $m2$, and $m3$. $m1$ represents the minimum value, $m2$ represents the most reasonable value, and $m3$ refers to the maximum value. Next, Triangular Fuzzy Numbers are used to generate a Fuzzy scale that utilizes a Likert scale for translating linguistic variables into Fuzzy numbers. The number of levels for the Fuzzy scale is odd. A higher Fuzzy scale provides more precise data obtained. Figure 1 illustrates the minimum triangle graph against the Triangular value, which includes all three values in the Triangular Fuzzy Number.

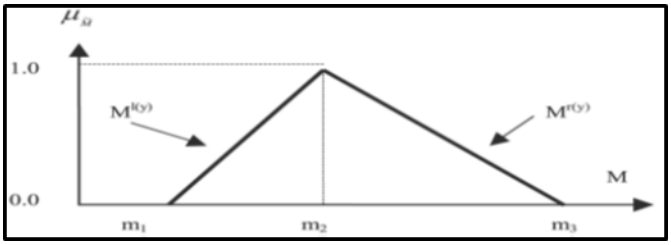

Figure 1: Minimum triangle graph against triangular. Adapted from Jamil & Noh (2021)

Figure 1 shows the minimum triangle graph against Triangular with $m1$=$nilai\ minimum$, $m2$=$nilai\ sederhana$, and $m3$=$nilai\ maksimum$. Likert scale data obtained were analyzed using Microsoft Excel software. All data were converted into Triangular Fuzzy Number format. Seven-point Fuzzy scale was used in this study. Table 3 shows the fuzzy scale comprising linguistic variables indicating a 7-point scale in the fuzzy Delphi method.

Table 3
Fuzzy Scale

Preferential Scale	7-point Fuzzy Scale	Likert Scale
Strongly disagree	(0.0, 0.0, 0.1)	1
Somewhat disagree	(0.0, 0.1, 0.3)	2
Disagree	(0.1, 0.3, 0.5)	3
Neutral	(0.3, 0.5, 0.7)	4
Agree	(0.5, 0.7, 0.9)	5
Somewhat disagree	(0.7, 0.9, 1.0)	6
Strongly disagree	(0.9, 1.0, 1.0)	7

Step 5: Data analysis
Data analysis is based on the scoring of Triangular Fuzzy Numbers aimed at obtaining Threshold (d) values. According (Thomaidis et al., 2006), identifying the Threshold (d) value is crucial for achieving expert consensus. To achieve expert consensus for each item, the first condition that must be meet is that the Threshold (d) value should not exceed or equal 0.2, indicating expert consensus has been reached (Cheng & Lin, 2002). The vertex method is used to calculate the distance between the average rij. The distance for each Fuzzy number m = ($m1$, $m2$, $m3$) and n = ($m1$, $m2$, $m3$) is calculated using the following formula;

$$(\tilde{m},\tilde{n})=\sqrt{13}[(m1-n1)2+(m2-n2)2+(m3-n3)2]$$

Step 6: Determination of expert consensus percentage
The second condition to determine the percentage value of expert consensus is that the overall group consensus must exceed 75% for each item. If not, a second round needs to be conducted (Chu & Hwang, 2008; Murray et al., 1985).

Step 7: Data analysis using the average of Fuzzy numbers or average response (Defuzzification process)
This analysis process aims to obtain a Fuzzy score (A). The third condition to be meet, to obtain the Fuzzy score (A), is that it must exceed or equal the median value (α-cut value), which is 0.5 (Bodjanova, 2006; Tang & Wu, 2010). This indicates that the element is accepted by expert

consensus. Among other functions, the Fuzzy score (A) can be used to determine the position and priority of an element according to expert consensus. The formula involved in obtaining the Fuzzy score (A) is as follows;

i. Amax = 1/3 * (a1 + am + a2)
ii. Amax = 1/4 * (a1 + 2am + a2)
iii. Amax = 1/6 * (a1 + 4am + a2)

Alpha-cut value = median value for '0' and '1', that is, α-cut = (0+1)/2 = 0.5. If the value of A produced is less than the α-cut value = 0.5, the item will be rejected because it does not show expert consensus. According to Bodjanova (2006) and Tang & Wu (2010), the α-cut value needs to exceed 0.5.

Results

In this professional competencies element design construct, the items given to the experts are stated in Table 4.

Table 4
Items for the Element of Professional Competencies Design Construct

Traits		Items
C1	Big Picture Thinking	The ability to understand one's role in fulfilling the mission of the workplace and to consider the social, economic, and environmental impacts of one's actions.
C2	Career And Life Management	The ability to plan, implement, and manage personal and professional development goals related to education, career, finance, and health.
C3	Continuous Learning And Adaptability	The ability to receive constructive feedback well and be open to new ideas and new ways of doing things; continuously developing professional skills and knowledge to adapt to changing job requirements.
C4	Efficiency And Productivity	The ability to plan, prioritize, and adjust work goals to manage time and resources effectively.
C5	Information Literacy	The ability to efficiently find information, evaluate the credibility and relevance of sources and facts, and use information effectively to complete work-related tasks.
C6	Information Security	The ability to understand the basics of Internet and email security, and follow workplace protocols to maintain the security of information, computers, networks, and facilities.
C7	Information Technology	The ability to maintain functional knowledge of devices, resources, hardware, software, systems, services, applications, and IT conventions.
C8	Job-Specific Tools And Technologies	The ability to safely select and use technology, tools, and machines specific to the industry to effectively complete work tasks.
C9	Mathematics	The ability to apply mathematical skills to complete necessary tasks.
C10	Professionalism	The ability to meet the work schedule, behavior,

		appearance, and communication expectations of the organization.
C11	Reading And Writing	The ability to read and interpret workplace documents and write effectively.
C12	Workplace Safety	The ability to maintain a safe work environment by following safety guidelines and identifying risks to oneself and others.

The threshold value (d), expert consensus percentage, defuzzification and item position for the above items are shown in Table 5.

Table 5
Findings of Expert Consensus on Professional Competencies Element

Item	Condition of Triangular Fuzzy Numbers		Condition of Fuzzy Evaluation Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
C1	0.155	90.91%	0.773	12	Accepted
C2	0.076	100.00%	0.879	5	Accepted
C3	0.096	90.91%	0.842	9	Accepted
C4	0.119	90.91%	0.870	8	Accepted
C5	0.181	90.91%	0.815	11	Accepted
C6	0.108	100.00%	0.830	10	Accepted
C7	0.098	100.00%	0.864	6	Accepted
C8	0.076	100.00%	0.912	4	Accepted
C9	0.110	100.00%	0.873	7	Accepted
C10	0.071	100.00%	0.930	2	Accepted
C11	0.071	100.00%	0.930	2	Accepted
C12	0.025	100.00%	0.958	1	Accepted

Condition:
Triangular Fuzzy Numbers Defuzzification Process
1) Threshold Value (d) ≤ 0.2 3) Fuzzy Score (A) ≥ α – cut value = 0.5
2) Percentage of Experts Consensus > 75%

Based on the findings in Table 5 above, all items recorded a value of Threshold (d) ≤ 0.2. This result indicates that all of these items have gained an expert consensus (Cheng & Lin, 2002). The expert agreement percentage shows that all items are above 75% and all defuzzification values for items also exceed the value of α - cut = 0.5. The result shows that the items in professional competencies element have gained consensus from the experts.

Discussion

The results of the FDM analysis in this study have produced a list of constructs for professional competencies in career readiness instruments. The initial findings using FDM show high validity and reliability. The analysis results on expert consensus indicate a good level of agreement, demonstrating that FDM can be used to obtain expert consensus as respondents

based on quantitative methods. The findings from the analysis using the fuzzy Delphi technique revealed items that were agreed upon and prioritized by the experts for each construct. The results indicate that all these items should be incorporated into the design and development of the career readiness assessment tool for students with disabilities.

Through this FDM analysis, the prioritization of item arrangement begins with the construct (i) workplace safety, (ii) reading & writing, (iii) professionalism, (iv) job-specific tools & technologies, (v) career & life management, (vi) information technology, (vii) mathematics, (viii) efficiency & productivity, (ix) continuous learning & adaptability, (x) information security, (xi) information literacy and (xii) big picture thinking. All experts agreed that these attributes help students with disabilities build confidence, foster independence, and effectively engage in both educational and social environments. Students with disabilities who focus on their professional competencies are well-positioned to thrive in the workplace. Students are able to develop their full potential even further when they are given the opportunity to embrace diversity, receive training, and receive support from employers.

Professional competencies have a significant impact on employees, influencing various aspects of their performance and development. Research by Rika & Nurhayati (2017), highlighted that individual competencies positively affect employee performance. It emphasized that work-based programs enhance competence, reduce stress, and provide immediate benefits to employees (Lester & Costley, 2010). Moreover, Anderson et al. (2021) demonstrated that targeted training interventions can significantly enhance staff confidence in diversity-related professional competencies. Sinambela et. al. (2020), found that work competency and supervision positively influence employee professionalism. Competencies play a crucial role in influencing employee abilities, as indicated by research conducted by Bukit et al. (2024).

The study findings indicate that the construct of workplace safety is the most important element in professional competencies. Employers prioritize workplace safety for several crucial reasons. Firstly, ensuring workplace safety is a legal obligation for employers to protect the health and well-being of their employees, as highlighted by DEMİRKAYA (2023). Compliance with occupational health and safety regulations not only safeguards employees but also mitigates legal risks for the organization. By prioritizing workplace safety, employers demonstrate their commitment to fulfilling their duty of care towards their workforce. Secondly, workplace safety is closely linked to human rights and diversity in the workplace, as discussed by Adams (2016). Employers who prioritize safety contribute to creating an inclusive environment that respects the rights of all employees. This approach fosters a culture of respect, equality, and dignity within the organization, enhancing employee morale and well-being.

Conclusion

In conclusion, the validation of professional competencies elements in the Career Readiness Instrument for students with disabilities through the FDM represents a significant step towards enhancing career readiness and inclusivity in the workforce. By incorporating validated competencies tailored to the needs of students with disabilities, educational institutions and employers can better prepare and support these individuals in their transition to the professional world. The integration of such validated competencies not only ensures

that students with disabilities are equipped with the necessary skills and knowledge for successful career outcomes but also promotes a more diverse and inclusive work environment. By validating professional competencies elements for students with disabilities, tailored support can be provided to ensure their successful integration into the workforce. In essence, the validation of professional competencies elements in the Career Readiness Instrument for students with disabilities is a crucial step towards promoting inclusivity, enhancing work knowledge and fostering a supportive environment that values the diverse talents and contributions of all individuals in the professional realm.

Recommendations

Based on the research and literature available, several recommendations can be proposed to enhance the validation of professional competencies elements in the Career Readiness Instrument for students with disabilities. Firstly, it is crucial to design tailored training programs that incorporate the validated competencies and address the specific needs and challenges faced by students with disabilities (Rachmawati et al., 2024). Additionally, practitioners should focus on reducing barriers for students with disabilities by designing pre-placement plans, facilitating communication with placement hosts, and ensuring appropriate disability-related accommodations (Gatto et al., 2021). Moreover, educators and practitioners can refer to the Transition Specialist Competencies to guide the development of competencies related to philosophical foundations, learner characteristics, instructional practices, and professionalism (Morgan et al., 2014). Furthermore, it is essential to promote a culture of self-determination and ownership of learning among students with disabilities to enhance their career readiness and decision-making skills (Rowe et al., 2015). By implementing these recommendations, educational institutions and employers can better support the career readiness and success of students with disabilities, fostering inclusivity and empowerment in the professional realm.

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