Fundamental Skills for Learning Strategies Based on Multiple Intelligences

Based on 192 Cases of Problematic Behavior in Vocational Training

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Abstract— The growing number of trainees with developmental disabilities and other special needs in vocational training programs necessitates innovative approaches to support their learning and development. Despite individualized measures, many trainees with special needs struggle to achieve independent task performance. This study proposes a novel framework of fundamental skills for Learning Strategies, based on Multiple Intelligences (MI) theory, to address this challenge. By identifying and nurturing trainees' unique strengths from a set of skills that facilitate Learning Strategies, this framework aims to help them develop effective self-regulated learning strategies. The ultimate goal is to equip trainees with special needs to become independent learners, capable of completing tasks without relying on the support of instructors.

Keywords - *Multiple Intelligences(MI) Theory; Learning Strategies; Polytechnic science; Steps for Coding and Theorization (SCAT); Developmental disabilities.*

I. INTRODUCTION

Effectively educating individuals with developmental disabilities and other special needs in Japanese vocational training schools is a pressing challenge. Traditional approaches often rely on analyzing individual cases and identifying causal relationships between specific factors and success or failure. However, these methods are limited in providing a comprehensive understanding of the diverse range of factors influencing educational outcomes.

In contrast, other fields have developed parameters to comprehensively grasp the characteristics of individuals and reflect them in national policies and education. While parameters for diagnosing developmental disabilities exist [2], there is a complete lack of parameters specifically designed from an educational perspective for vocational training.

Given the pressing challenge of effectively educating individuals with developmental disabilities in vocational training schools, this study aims to develop a comprehensive framework of fundamental skills for Learning Strategies, specifically designed for vocational training settings, to address the educational needs of these individuals.

In a previous study [1], we identified 32 fundamental skills for Learning Strategies that were associated with 192 cases of problematic behaviors hindering training activities in vocational training. Fundamental skills are essential skills that facilitate the development of effective Learning Strategies. To refine these skills and enhance their applicability to vocational training settings, we conducted a SCAT (Steps for Coding and Theorization) analysis on interview data from 11 vocational training instructors. This analysis allowed us to merge, split, delete, rename, and add skills, resulting in a revised set of 26 fundamental skills. The revised set of 26 fundamental skills offers a practical and effective framework for vocational training instructors.

The rest of the paper is structured as follows. In Section II, we present the methodology used to refine the Fundamental Skills, including the SCAT analysis and the integration of Multiple Intelligences theory. In Section III, we describe the results of the refinement process, highlighting the specific changes made to the skill set. Finally, we conclude the work in Section V, summarizing the key findings and discussing future directions for research and implementation.

II. METHOD

We conducted one-hour interviews with 11 vocational training instructors (hereafter referred to as instructors) who had at least two years of experience in the field. The purpose of these interviews was to clarify and refine the range of 32 Fundamental Skills that were associated with problematic behavior in 192 cases [3].

Instructors were asked to imagine individuals with significantly low or high evaluations of these skills and to describe their behaviors in the vocational training setting, including during breaks.

SCAT is a qualitative data analysis method developed by Ohtani [4]. It is used to analyze segmented qualitative data, such as linguistic data from interviews. The goal of SCAT is to construct a narrative by weaving together thematic constructs. The method consists of four coding and analysis steps, which are performed manually:

(1) Notable Words and Phrases:

Identify keywords and phrases that are significant and related to the Fundamental Skills. These are the specific terms and expressions that stand out in the interview data.
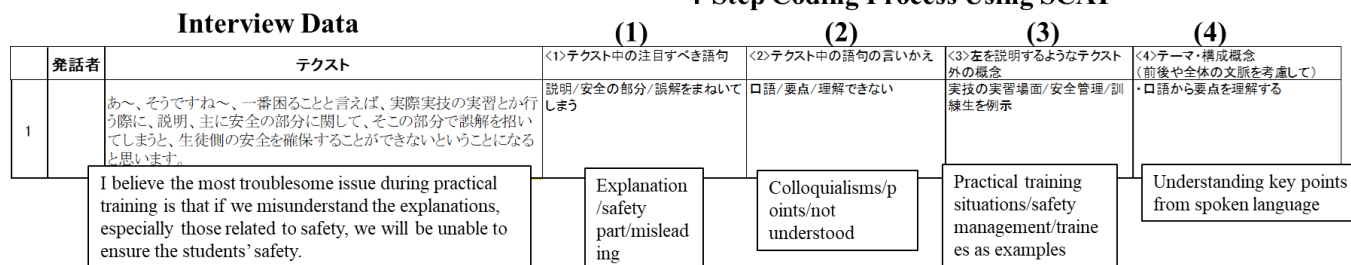
(2) Paraphrasing:

4-Step Coding Process Using SCAT

	発話者	テクスト	(1)	(2)	(3)	(4)
			<1>テクスト中の注目すべき語句	<2>テクスト中の語句の言いかえ	<3>左を説明するようなテクスト外の概念	<4>テーマ・構成概念（前後や全体の文脈を考慮して）
1		あ〜、そうですね〜、一番困ることと言えば、実際実技の実習とか行う際に、説明、主に安全の部分に関して、そこの部分で誤解を招いてしまうと、生徒側の安全を確保することができないということになると思います。	説明/安全の部分/誤解をまねいてしまう	口語/要点/理解できない	実技の実習場面/安全管理/訓練生を例示	・口語から要点を理解する
		I believe the most troublesome issue during practical training is that if we misunderstand the explanations, especially those related to safety, we will be unable to ensure the students' safety.	Explanation /safety part/mislead ing	Colloquialisms/p oints/not understood	Practical training situations/safety management/traine es as examples	Understanding key points from spoken language

Figure 1.   Concepts of the results of SCAT of the 11 interviews about "Understanding key points from spoken and written language".

Understanding key points from spoken and written language

①Extracting main points from conversations and texts
②Understanding the main points from oral language
③Understanding explanations
④Facilitating understanding of the purpose from colloquial language Extracting
⑤important words and phrases from conversations and sentences
⑥Does not understand the main points and subjects of conversations
⑦Cannot extract main points from sentences
⑧Cannot extract main points from spoken words and sentences
⑨Cannot understand the main points from colloquialisms
⑩Cannot understand the other person's intention in conversation
⑪Misunderstands main points from colloquialisms
⑫Cannot understand the main points from sentences
⑬Inability to extract important words and phrases from sentences

Figure 2.   SCAT Results for "Understanding key points from spoken and written language".

Generalize these identified words and phrases. This step involves rephrasing the notable words and phrases to capture their broader meaning and context.

(3) External Concepts:

Explain the text using concepts from outside the interview data. This step involves bringing in relevant theories, ideas, or concepts from external sources to provide a deeper understanding of the interview data.

(4) Themes/Constitutive Concepts:

Develop themes or overarching concepts based on the previous steps. This final step involves synthesizing the paraphrased data and external concepts to create broader themes or constitutive concepts that capture the essence of the interview data.

For instance, in the four-step coding process, the notable words and phrases "Explanation", "Part of safety" and "Misleading" were identified in relation to the fundamental skill of "Extracting main points from conversations and sentences." These were then paraphrased as "Colloquial" and

contextualized with practical training situations, such as safety management and examples of trainees. The overarching theme or constitutive concept was determined based on these elements and is labeled "Understanding the main points from colloquial."

Figure 1 provides an illustrative example of SCAT analysis, demonstrating how notable words and phrases are identified, paraphrased, and contextualized to develop overarching themes or constitutive concepts. The SCAT analysis of the Fundamental Skills aimed to establish a well-structured and coherent framework without redundancies. In consolidating the 32 Fundamental Skills into 26, the skill set was restructured to address three primary objectives: eliminating redundancies, clarifying ambiguous definitions, and incorporating essential new skills. By integrating overlapping skills, redefining ambiguous ones, and adding necessary elements, we created a more practical and applicable skill set. Furthermore, low-priority skills were either integrated or removed to enhance the overall efficiency and sentences.

Figure 2 shows the constructs from the SCAT analysis of the 11 interviews on "extracting key points from conversations and sentences. 13 different constructs were identified, indicating subtle differences in perception compared to the original Fundamental skills. There are individual differences in people's ability to extract key points from conversations and texts. Specifically, differences can be seen in how people identify information, their understanding of context, their ability to summarize, and many other aspects. Thus, each person processes information differently.

Figure 3 shows the process of redefining Fundamental Skills by clarifying the scope. This process entails creating, deleting, and integrating new Fundamental Skills to equalize the size of the scope as much as possible, and making changes to those that cover all problem behavior situations.

Through iterative refinement using the SCAT method, an initial set of 32 Fundamental skills was reduced to 26. This involved 13 skill name changes, 2 divisions, 6 mergers, 4 deletions, 12 modifications to skill descriptions, and 1 category shift, along with the addition of two new skills. The skill "Tacit understanding," initially categorized under interpersonal intelligence, was removed prior to data collection due to its reliance on socially acquired knowledge (common sense) that is difficult to quantify.

For instance, the skills "Distinguishing between objects" and "Distinguish between parallel lines and single lines," both under visual-spatial intelligence, were merged into " Identifying 3D shapes" and " Identifying 2D shapes," respectively. While the former originally assessed the ability to navigate physical spaces, instructor feedback primarily focused on the ability to visualize shapes and structures. Similarly, "Distinguishing between object " was initially intended to assess the ability to distinguish between objects like positive and negative drivers, but instructor responses frequently referred to the identification of line types in diagrams. Given the importance of this skill in vocational training, the two skills were combined, and the terms were adjusted to reflect the different dimensions involved. The skill "correct interpretation" under logical-mathematical intelligence was divided into "Subdivision of information" and " Relating to similar experiences." The former assesses the ability to break down information into smaller components, while the latter involves linking these components to prior knowledge. Skills such as "Image of completion" and "Grasping risky behavior" under intrapersonal intelligence were merged due to their predictive nature. However, "Image of completion," which involves visualizing a completed assembly from a diagram, was also related to visual-spatial skills. Furthermore, the concept "Understanding of jokes (playful language)" was added under linguistic intelligence to account for situations where trainees may misinterpret literal meanings in social interactions.

III. RESULTS

Figure 4 compares the original and redefined Fundamental skills using SCAT. The original 32 skills were reduced to 26 by merging, splitting, deleting, renaming, and adding. Only the skills in bold remained unchanged: the 26

Fundamental Skills fall into the six categories of MI theory, with the exception of Musical Intelligence and Erudite Intelligence, which are less relevant to manufacturing. Each category contains four to five Fundamental Skills.

SCAT eliminates duplication and ambiguity in the Fundamental Skills and creates practical common skills. Fundamental Skills allow trainees to train using skills in which they are proficient. Instructors can also train trainees to match their skill characteristics. Addressing the challenges of dealing with struggling students requires more than individual instructor efforts. Many schools rely on consultations with experienced instructors or establish leader-centered support systems, particularly in schools for individuals with disabilities.

The Fundamental Skills align with Gardner's MI theory [5], which emphasizes individual strengths and learning styles. In the U.S., many educational practices utilize MI theory to help learners identify their strengths and address weaknesses. This approach is particularly beneficial for individuals with developmental disabilities who often exhibit uneven skill characteristics. Low self-esteem can hinder learning by limiting individuals' expectations and motivation. Developmental disabilities can contribute to low self-esteem due to peer undervaluation and self-doubt. Additionally, many individuals with developmental disabilities have co-occurring mental health conditions.

Educational practices for individuals with developmental disabilities have evolved, with emphasis on self-regulated learning and leveraging individual strengths. Dennis Laird and others have advocated for teaching individuals with developmental disabilities to capitalize on their preferences [6].

The educational practice of MI theory emphasizes establishing personalized learning approaches that leverage individual strengths. When necessary, weaknesses should be complemented with strengths. Many trainees with developmental disabilities or other special needs struggle with uneven skill characteristics. The goal is to address these challenges by capitalizing on their strengths.

IV. DISCUSSION

In this paper, we defined fundamental skills based on 192 examples of problematic behaviors observed in actual workplace training situations. Unlike traditional key competencies and basic skills for working adults, which are based on expert opinions, we defined fundamental skills from multiple perspectives through qualitative analysis of actual problematic behaviors. In particular, the interview-based analysis provided an understanding of the diversity and depth of the skills, ensuring their reliability. Furthermore, classifying the extracted fundamental skills according to the Multiple Intelligences (MI) theory confirmed that the various intelligences in the MI theory effectively explain the diversity of the skill groups obtained in this study. The skill system was structured similarly to traditional basic work skills and key competencies, with each category containing multiple elements.

The issue addressed in this study is that students with special needs are unable to complete tasks without teacher

MI	Fundamental Skills	Scope	Reason for improvement	Refined Skills name	supplementary explanation
Linguistic-verbal	Extracting key points from conversations and texts	· Smoothly understand the purpose from colloquial language. · Inability to understand the other person's intention in conversation.	The term "oral" was changed to "spoken" because many situations were answered in which the instructor gave one-sided explanations rather than conversing.	Understanding key points from spoken and written language	Insert meaning of how correctly grasp the purpose from oral explanations and written questions.
	Understanding instructions	· Cannot understand the object of "this" and "that". · Can understand the object of "this" and "that".		Comprehension of directives (maintenance of skill name)	Insert meaning of how grasp of the subject of "this" and "that".
	Comprehension of abstract expressions	· Cannot generalize and understand mathematical properties. · Understand abstract expressions.		Comprehension of abstract expressions (maintenance of skill name)	Insert meaning of how correctly interpret and use ambiguous expressions.
	Basic Kanji Proficiency	· Cannot comprehend Kanji characters at the vocational level. · Can read and write daily life level Kanji characters.	The answer was changed to "Common Kanji(Jyoyo Kanji)" because many answers indicated the vocational training level and at the same time indicated that the vocational training level was within the scope of study in compulsory education.	Reading and writing of kanji for common use	Insert meaning of how to read and write kanji used in daily life.
			Added skills: Because there are situations where I have trouble getting a joke across in conversation with people.	Understanding of jokes (playful language)	Insert meaning of how understand the humor of others.
Logical-mathematical	Sequential action and thinking	· Can work according to the established sequence. · Deviates from work procedures.	Transition to "Subdivision of information" and "Understanding priorities".		
	Grasp of priorities	· Can determine priorities based on efficiency. · Cannot determine priorities based on deadlines.	Integration of "grasp of priorities" and "grasp of important parts": because the fundamental skills of both is "Grasp of priorities".	Grasp of priorities (integration of skills)	Insert meaning of how set the level of importance considering the conditions.
	Grasp of important parts	· Can grasp the important parts of things. · Can understand the important parts of multiple tasks.	Integration of "grasp of priorities" and "grasp of the important parts": because the fundamental skills of both is "Grasp of priorities".	Grasp of priorities(integration of skills)	(Insert meaning of how set the level of importance considering the conditions.)
	Subdivision of information	· Cannot separate information and understand its components. · Cannot separate work instructions and understand procedures.		Subdivision of Information (maintenance of skill names)	Insert meaning of how analyze information to identify its components.
	Completion of omissions	· Can understand the lack of processing and improve it. · Does not have the knowledge to accomplish the objectives.	Because many "Unknown points" were extracted as a composition concept.	Completion of unclear points	Insert meaning of how compensate for missing information by asking others, researching, etc.
	Basic mathematical skills	· Can perform four arithmetic operations including fractions. · Can perform the four arithmetic operations.	The reason is that "Four arithmetic operations" was extracted as a component concept in many cases.	Four arithmetic operations	Insert meaning of how perform calculations of daily life.
	Correct interpretation (of logical and mathematics)	· Make sense of numbers by calculation. · Interpret the significance of things correctly.	Transition from "(Logical-mathematical) correct interpretation" to "Subdivision of information" and "connection to similar experiences".		
Visual-spatial	Recognition of three-dimensional arrangements	· Inability to perceive three-dimensional distance and depth. · Cannot visualize three-dimensional shapes.		3D identification	Insert meaning of how correctly perceive location and space.
	Short-term memory of objects	· Cannot memorize numerical values in the short term. · Can memorize the shape of objects in the short term.	Memory is difficult to handle not only objects but also a wide range of numerical values, words, and phrases.		
	Identification of objects	· Understanding of line types is a prerequisite. · Cannot distinguish shapes.		2D identification	Insert meaning of how Correctly recognizes shapes and line types of figures.
	Color recognition	· Cannot distinguish colors close to the primary color. · Cannot distinguish colors.	The reason for this is that many of the answers were based on situations that require not only recognition but also identification, such as color codes and wiring.	Color identification (maintain skill names)	Insert meaning of how distinguish colors.
	Extraction of key points from	· Cannot focus on hazardous areas. · Cannot focus on important points.	The skill was changed to evaluate the ability to grasp information intuitively from visual information, since it is a characteristic of developmental disabilities to focus on details and not be able to overview the whole picture.	Intuitive grasp of the big picture	Insert meaning of how recognize the big picture and then check the details.
Body-kinesthetic	Manual dexterity	· Handling of fine parts. · Errors are introduced by precise work.		Manual dexterity(maintain skill names)	Insert meaning of how handle small parts.
	Hand agility	· Manual dexterity is more important than manual agility. · Perform detailed work smoothly.		Manual agility(maintain skill names)	Insert meaning of how finish the work within the specified time.
	Body image	· Imitates the body movements of others. · Does not have proper awareness of body range.	The body image is not a common word, so it was changed to an easy-to-understand word.	Correct recognition of body movements (body image)	Insert meaning of how awareness of invisible areas.
	Coordinated actions	· Can work with awareness of multiple parts of the body. · Can work with awareness of multiple parts of the body.		Coordinated actions(maintain skill names)	Insert meaning of how work with awareness of multiple locations.
Interpersonal	Face to face with others	· Inability to use appropriate body language. · Inability to express appropriate emotions.	The concept was changed to a skill that communicates because it included a lot of conversation and body language.	Communication of accurate information	Insert meaning of how communicate facts accurately.
	Resistance to interpersonal interaction	· Is uncomfortable in conversation. · Cannot establish positive rapport with new acquaintances.	Changed the content to emphasize the point of communicating without being overly nervous in front of others.	Normalcy in public	Insert meaning of how make eye contact with others.
	Understanding the other person's position and situation	· Cannot anticipate the feelings of others and act accordingly. · Cannot understand the other person's situation.	"grasp of other person's position and situation" is divided into "grasp of other's intention" and "grasp of other's feelings".	Grasp of others' intentions	Insert meaning of how understand the atmosphere of a place.
				Grasp of others' feelings	Insert meaning of how read other people's thoughts.
	Tacit understanding		The reason is that it is difficult to formalize the knowledge.		
	Caring for others	· Can build good relationships. · Has difficulty in building good relationships.	Moved to "grasp of other's intentions" and "understanding of other's feelings".	Communication of emotions	Insert meaning of how express their emotions appropriately.
Intrapersonal			Add skills: to be consistent with intuitive grasp of visual information.	Grasp of prospects	Insert meaning of how accommodate sudden schedule changes
	Connection to experience	· Cannot work following the example. · Repeats the same mistakes.	The reason is that we believe that the accumulation of related experiences, rather than completely different experiences, will enhance our ability to apply them.	Connection to similar experiences	Insert meaning of how use your past experience to solve problems
	Image of completion	· Clearly defines the target quality. · Can grasp the process from the image of completion.	Moved to "intuitive grasp of prospects".		
	Change of mind	· Can switch from break to work quickly. · Cannot let a bad event drag on.	Because emotions not only need to be switched, but also need to be controlled in diverse ways, such as suppressing anger.	Emotional control	Insert meaning of how turn on/off the negative emotions
	Grasp of cause-and-effect relationships	· Cannot investigate the cause of work failure. · Cannot understand the structure of equipment.	Moved to"Connect to Similar Experiences".	Connection to similar experiences	Insert meaning of how past experience can be used to solve problems
	Viewing from another angle	· Flexible in dealing with problems instead of sticking to existing methods. · Cannot consider multiple means to solve a problem.	Logical-mathematical intelligence is the ability to analyze things logically, and not sticking to one way of thinking can be achieved through "emotional control" and "Grasp of prospects".		
	Grasp of risky behavior	· Can predict and avoid hazards. · Can anticipate danger.	Moved to "Attention switching".		
	Asserting oneself	· Cannot express physical condition. · Needs to improve the work environment.	Moved to "emotional transfer" and "information transfer		

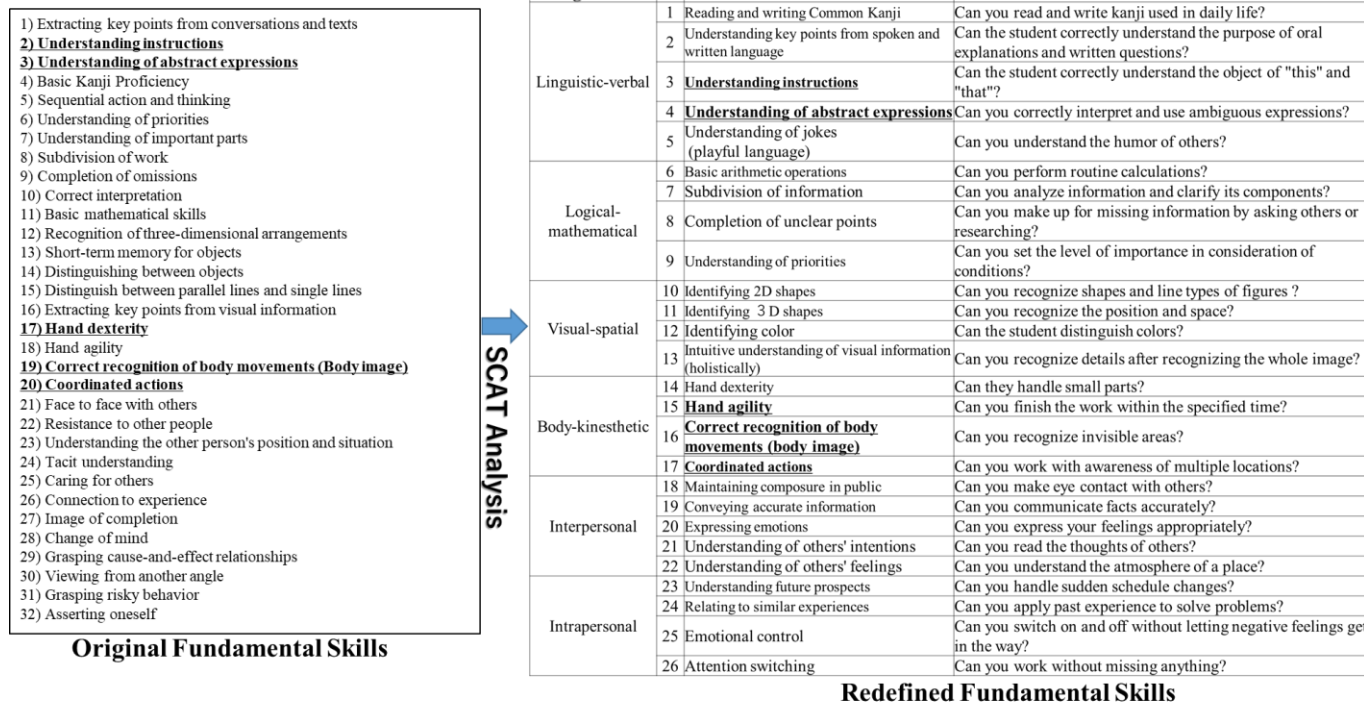Figure 3. Process of redefining the Fundamental Skills by clarified the scope.

Figure 4. The original and Redefined Fundamental Skills redefined using SCAT.

support, even after repeated individualized interventions. To complete tasks independently, these students need to master strategies that leverage their own specialized skills.

Students need to plan, monitor, and evaluate their own learning process, making adjustments as needed. In training, students are first taught the importance of goal setting and are asked to set specific goals. Next, we teach them how to regularly monitor their progress and review their strategies for achieving these goals.

We also help them develop self-evaluation skills and enhance their sense of self-efficacy through successful experiences. Learners need to understand their own learning style and discover the best way to learn. fundamental skills serve as the link between learning strategies and their individual learning styles.

Furthermore, the fundamental skills are categorized by MI intelligence, allowing for the use of educational practices based on MI best practices. Even if one does not excel in a particular intelligence compared to others, it is important to master strategies that leverage the intelligence one feels confident in. In a survey of white, middle- and upper-income children, 76% had at least one strong intelligence, 30% had no weak intelligence, and 20% had no strong intelligence [7]. Even if one does not excel in a particular intelligence, it is important to master strategies using the intelligence one likes and feels confident in. People with developmental disabilities often have excellent intelligence in some areas while having weaknesses in others.

The inspiration for this study came from a case where a person with a lack of body awareness, who often fell and hit walls, became proficient in gymnastics and skating. This im-

provement was due to an encounter with an instructor who taught with logic. The instructor said, "Put your left foot on the line, and your right hand will come off naturally," or "You lost your balance because the tip of your nose was not facing the line." This approach emphasizes the importance of teaching based on strengths, where strengths complement weaknesses. Instructional training for trainees using fundamental skills in Polytechnic University has been conducted since 1998, highlighting the duplication and granularity of the 32 fundamental skills. We have been using this improved version since 2022 and have not encountered any major problems.

V. CONCLUSION AND FUTURE WORK

This study has demonstrated the effectiveness of redefining fundamental skills using SCAT and aligning them with Gardner's MI theory to support trainees with special needs. By focusing on individual strengths and learning styles, we have created a more inclusive and practical approach to skill development. The improved version of the fundamental skills has been successfully implemented since 2022, with positive feedback from both trainees and instructors.

Future Work:

1) Longitudinal Studies: Conduct long-term studies to evaluate the sustained impact of the redefined fundamental skills on trainees' performance and independence in the workplace.

2) Broader Application: Explore the applicability of the redefined fundamental skills in different industries and

educational settings to ensure their versatility and effectiveness.

3) Technological Integration: Investigate the potential of integrating technology, such as AI and adaptive learning platforms, to further personalize and enhance the training experience for individuals with special needs.

4) Collaborative Efforts: Foster collaborations with other educational institutions and organizations to share best practices and continuously improve the fundamental skills framework.

By addressing these areas, we aim to further refine and expand the scope of our approach, ultimately contributing to a more inclusive and supportive learning environment for all individuals.

REFERENCES

[1] N. Fujita et al., "Developing a Computer-Based Vocational Training Environment that Complements the Weak Skills and Career Development of Trainees," International Journal on Advances in Intelligent Systems, pp. 279-289, 2018.

[2] P. D. Flanagan and A. S. Kaufman, "Essentials of WISC-IV Assessment," Hoboken, 2009.

[3] Japan Organization for Employment of the Elderly, Persons with Disabilities and Job Seekers, "Effective vocational training examples for people with developmental disabilities" Research Report No. 119, Japanese, 2007.

[4] Ohtani.SCAT Steps for Coding and Theorization: https://www.educa.nagoya-u.ac.jp/~otani/scat/ (in Japanese)

[5] H.Gardner, "Multiple Intelligences: The Theory in Practice," Basic Books; Reprint Edition edition, 1993.

[6] D. Reid and C. Green: Preference-Based Teaching: Helping People with Developmental Disabilities Enjoy Learning without Problem Behavior, Habilitative Management Consultants, Inc., 2005.

[7] H. Gardner, "Frames of Mind: The Theory of Multiple Intelligences," Basic Books, 2011.