Developing a Computer-Based Vocational Training Environment that Complements the Weak Skills and Career Development of Trainees

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Abstract— **The objective of this research is to construct a vocational training environment where "trainees" who need special consideration such as "developmental disorder" and "normal trainees" learn in the same classroom. In this study, we describe a method for developing and evaluating the assessment tool using 33 fundamental skills without any distinction between disabled and normal trainees. The 33 fundamental skills was developed by decomposing 192 problem behaviors which were observed during vocational training by reductionism. In this verification, we developed an assessment tool that set 33 fundamental skills for the representative problem behavior and applied it to 15 trainees. Based on the trial results, we can confirm that (1) skills are frequently detected in the best trainees and that (2) the unevenness of the skills can be detected in the considered trainees. The academic achievement of this study is that it clarifies "the validity of the 33 fundamental skills" and "the relation between the 33 fundamental skills and behaviors." Further, the vocational training instructors can find support and guidance corresponding to the skill characteristics of each trainee by learning the relation between the 33 fundamental skills and behaviors.**

Keywords-Vocational training; Theory of multiple intelligences; Assesment tool; Developmental disabilities; Polytechnic science.

I. INTRODUCTION

This study is an extension of our previous work [1], which was presented at the ACHI 2017 conference.

Nowadays, vocational training (VT) instructors (hereinafter referred to simply as instructors) are increasingly encountering trainees needing special consideration (hereinafter referred to as consideration trainees (CTs)) such as people with developmental disabilities (PWDD). The proportion of the CTs in VT has increased remarkably making it essential to have instructors who understand their particular needs. Developmental disorder can be observed because of the "development of unbalanced innate brain functions" and "mismatch of involvement with the environment." Thus, developmental disorders are considered to be distinct from personality. Developmental disorders include various types and symptoms such as ADHD(Attention Deficit Hyperactivity Disorder), autism, Asperger syndrome, and learning disability. People with developmental disabilities are assumed to constitute approximately 6% of the population. In addition, one third of the people with developmental disability are considered to be 2E (twice-exceptional) and possess some special talents. The instructors individually guide the trainees by considering the developmental disorders that are observed while verifying the operations in a small step. Further, the CTs can operate without any assistance from the instructors. Instructors need to use the good skills of CTs and supplement the weak points using the auxiliary equipment. Furthermore, it becomes possible to learn at an individual pace by constructing a computer-based individual training environment. The objective of this research is to develop a vocational training environment that learns through try and error using smart skills.

In previous works [1][2], we reported on (i) the development of an assessment tool (hereinafter referred to simply as the tool) for assessing VT, (ii) the use of that tool for a simulation based on theoretical values (typical

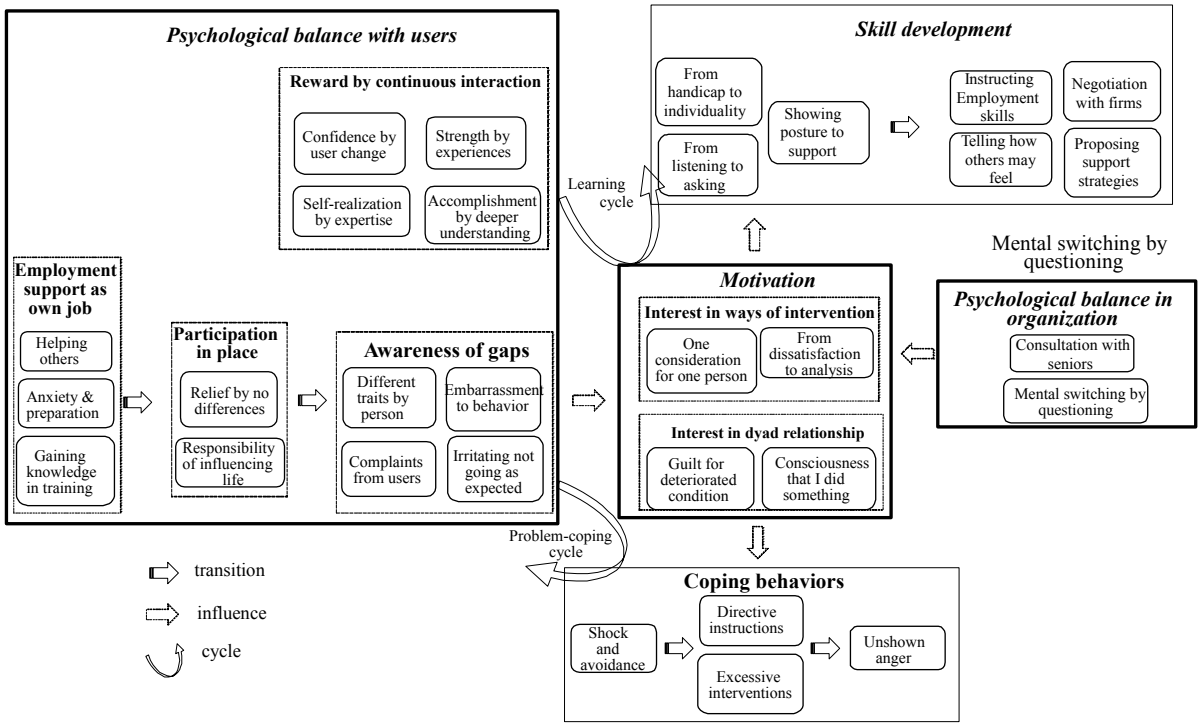

Figure 1. Psychological transformation process (PTP) for rehabilitation counselors (RCs)（Repeated from Ref. [2]）

TABLE I. CONCEPTUAL DETAILS OF PSYCHOLOGICAL TRANSFORMATION PROCESS (PTP) （REPEATED FROM REF. [2] ）

No	*Concept*	*Definition (This phenomenon is that ...)*
1	From dissatisfaction to analysis	A staff considers the causes of communication failure, without accusing the user.
2	Guilt for deteriorated condition	A staff feels responsibility because his/her intervention led user condition deterioration.
3	Anxiety & preparation	A staff thinks facing with users' disability traits as a part of own job.
4	Self-realization through expertise	A staff utilizes their experiences on their welfare and business practice through supporting users.
5	Helping others	A staff finds value in supporting other's life.
6	Shock and avoidance	A staff is shocked by user's background and trying to leave the user to his colleagues.
7	From handicap to individuality	A staff accepts the user's disability traits as individuality.
8	From listening to asking	A staff receives the user's reaction and asks the cause and background.
9	Unshown anger	A staff does not take attitude even if feels anger in the user's behavior, and dissatisfaction is accumulated.
10	Consciousness that I did something	A staff feels sad by thinking that he/she did something for the user but the user did not responded.
11	Accomplishment by deeper understanding	A staff feels accomplishment by understanding the background of a user's behavior.
12	Awareness of gaps	A staff notices the gap between the goals and the reality.
13	Consultation with seniors	A staff can ask a senior whenever he / she can not understand the user's behavior.
14	Relief by no differences	A staff pleasantly surprises because the users' behaviors do not differ from his / hers.
15	One consideration for one person	A staff notices that each user needs one consideration.
16	Embarrassment to behavior	A staff is surprised by the sudden behavior of user and feel uncomfortable.
17	Irritating not going as expected	A staff is irritated and exhausted, as having no sign of improvement of user's condition.
18	Telling how others may feel	A staff tell a user how the user's behavior is seen from the third party.
19	Mental switching by questioning	By being asked by seniors about the cause of user's behavior, frustration will switch to questioning.
20	Gaining knowledge in training	A business-experienced staff learns basic knowledge of supporting persons with disabilities in training.
21	Proposing support strategies	A mid-level staff creates and proposes support plans each other in various viewpoints.
22	Confidence by user change	A staff gains self-confidence by the progress of users.
23	Responsibility of influencing life	A staff feels responsible because his / her intervention influences the employment (life) of users.
24	Showing posture to support	A staff lets the user disclose thoughts and circumstances by showing posture to support.
25	Instructing Employment skills	A business-experienced staff trains necessary skills for employment to users.
26	Strength by experiences	By having experienced, a staff will not be upset by the disastrous background of individual users.
27	Different traits by person	Since the situation of users is different for each person, basic knowledge is not applicable.
28	Negotiation with firms	A staff can negotiate with the company about employment of users.
29	Directive instructions	A staff instructs and requests at the ordinary workplace level to a user.

characteristics of disabilities) and (iii) an empirical evaluation of the tool. However, for ethical reasons, the field validation of the tool was targeted at the best trainees with an electrician's license. In addition, we checked smart skills detection. For the present work, we obtained the consent of the ethics committee of the Polytechnic University of Japan (No. 607) to investigate the detection of weak skills and difference between the instructor-based and tool-based evaluation of the skills. In this study, the development procedure of the 33 fundamental skills and the verification result that has been applied to 15 trainees are described. Instructors can understand the support and guidance required for each trainee by learning the "relation between the 33 fundamental skills and behaviors."

The study can be structured as follows: the contextual background, including relevant research and the problem corresponding to various CTs in VT is provided in Section II. Section III describes the development procedure of the assessment tool whereas Section IV describes the result of the assessment tool verification. The conclusion and the future work are mentioned in Sections V and VI.

II. CONSIDERATION OF THE VOCATIONAL TRAINING ISSUES FOR GUIDANCE TO CONSIDERATION TRAINEES

VT for PWDD is based on individual support, whereas general VT is based on collective education. In case of the inclusive education provided in elementary and middle schools response to intervention (RTI) has been recommended worldwide. RTI provides a three-layer guidance including (1) high-quality overall guidance that can be understood by 80% of the students, (2) group guidance for 15% of the students, and (3) individual guidance for the remaining 5% of the students. However, in case of inclusive education, it is not possible to provide flexible support and guidance because there is no scale of rating skills that can be used by both disabled and normal students. In this Section, we describe the problem associated with offering practical guidance to CTs in VT from the perspective of special education. In previous work, we described the RC psychological transformation process (PTP) in detail [2]. Here, we summarize that work.

Figure 1 shows the RC PTP schematically while Table I lists the associated concepts (repeated from Ref. [2]). This PTP begins with RCs being interested in investigating the causes of problems dealing with PWDD. Then, RCs will "skill formation" against "user" and "organization." An RC can become experienced through this learning cycle. However, if a problem-coping cycle (PCC) occurs, an RC can become frustrated that the trainees are failing to meet her/his expectations and that an RC may be unable to get out of PCC. The plight of PWDD worsens and an RC who is interested in methods of intervention falls into a PCC as she/he adopts coping behavior. To escape from such a PCC, it is necessary to make a psychological balance in organization by consulting with seniors and mental switching by questioning. In other words, the theoretical model shows the need to improve the environment of "psychological balance in organization" and smooth circulation of the learning cycle. According to a skilled RC, it is important to focus on the smart skills as well as the weak skills of trainees while supporting PWDD. For example, the following steps support the skills for RCs: (i) (as preparations to promote self-recognition) praise the trainee and give her/him a challenge that requires smart skills; (ii) give the trainee a weak-skill task and make her/him aware of the weak skills; and (iii) provide advice on using smart skills and technologies to supplement weak skills.

This PTP allows us to understand the following three problems in VT.

1) There is no fundamental scale on which to assess the characteristics of the trainees. For example, in architecture training, if there are trainees who often taunt the hands on the side that supports the nails by mistake when nailing, "there is no concentration", "clumsiness", "Amblyopia." It will speak on various measures such as scale. In VT, there is no fundamental measure of the disability characteristics supported by clinical data (characteristics of disabilities).

2) There is a lack of information on teaching methods in inclusive education. Also, in collective education, there is a problem, because the individual support is difficult to provide, unless it is open to having disabilities. It is necessary to clarify the way of guidance in the collective learning based on a fundamental scale for understanding the characteristics of the trainees.

3) In VT, there is a shortage of instructors who understand how to give guidance to CTs. Consultation with the expert instructor is indispensable for escaping from a PCC. Also, if it is difficult for one faculty member to respond to CTs, the team must be able to deal with them.

A. Research Background

In most VT establishments, it is rare to encounter CTs who hold a disability certificate, and most instructors are not used to cooperating with rehabilitation counselors (RCs). In addition, the material that RCs provide tends to be in the form of support recommendations based on disability characteristics which are often difficult for instructors in the field to convert into practical guidance.

First, we describe why the existing assessment tools are problematic. Table II lists three intelligence tests and a social skills test; K-ABC [3] is an intelligence test that is intended for use in education. However, because its target age is 2-12 years, K-ABC cannot be used in VT. WISC-III [4] and WAIS-IV [5] are used in VT establishments for people with disabilities and in vocational rehabilitation centers mainly for medical purposes, such as diagnosing developmental disorders. However, from an ethical perspective, it would not be appropriate to use WISC-III or WAIS-IV in VT establishments that cater for many trainees who do not have a diagnosed disability. Social Skill is a skill test to measure conformity to society, but it can only measure some skills that are necessary for VT. Therefore, as just described, none of the existing assessment tools are suitable for VT. To establish a transfer from support to guidance, we require an assessment tool helping to (i)

TABLE II. THREE INTELLIGENCE TESTS AND A SOCIAL SKILLS TEST

	Field	Target	Age
K-ABC	Education	Intelligence	Age 2 to 12
WISC-4	Medical	Intelligence	Age 5 to 16
WAIS-3	Mediacal	Intelligence	Age 16 to 89
Social Skills	Education / Company	Skill	Free Age

TABLE III. MAIN MEASUREMENT METHODS OF ASSESSMENT

Method	Description
Psychological measure	Measurement by questionnaire using psychological scales. (Self-assessment)
Behavior Checklist	Measurement by checklist with your subjectivity. (Self-assessment)
Behavior observation	Measurement by observing for subject's activities. (actual behavior)
CBT (Computer Based Testing)	Measurement by computer using display a task. (actual behavior)

investigate problem behavior scene, (ii) clarify smart skills and weak skills from that scene, and (iii) evaluate the presence or absence of those skills. To link from "support" to "guidance", it is necessary to investigate problem behavior scenes, to clarify the lack of skills from that scene.

Table Ⅲ lists the main measurement methods of assessment. There are two types of measurement methods, namely evaluation by self-assessment and evaluation by actual behavior. For the evaluation by self-assessment, we have action checklists and psychological measures. However, that type of evaluation is problematic, because it is difficult to account for respondents who make false or socially desirable answers. Meanwhile, the evaluation by actual behavior involves real-time behavior observation and computer-based testing (CBT). The behavior observation is reliable, but evaluation takes time, and it can be difficult to make a rating scale. Meanwhile, most assessments based on psychological measures do not measure actual behavior or reactions. Hence, it is difficult to ensure that such self-assessed evaluation is both reliable and valid. Also, Behavior observation is based on obstacle characteristics. The objective of this research is to construct a vocational training environment where "trainees" who need special consideration such as "developmental disorder" and "normal trainees" learn in the same classroom. Herein, the ideal assessment tool for VT is one that uses CBT to measure skills from actual behavior. However, from an ethical perspective, it will be difficult to use such CBT in actual VT. Instructors could use the assessment tool as a self-learning tool helping them to learn the skills of CTs.

B. Development procedure

The tool under consideration evaluates the skills of trainees by CBT from behaviors in restaurant- part-time jobs. The trainee's skill evaluation scale extracted 192 cases [6] that occurred in VT to extract the 33 fundamental skills causing problem behaviors. If all the fundamental skills are smart ones, it is a trainee with sense. However, if a trainee shows unbalanced fundamental skills, she or he is likely to be a CT. If all skills are weak, all actions are problem behavior.

Figure 2 shows the hierarchical structure of the fundamental skills based on reductionism. A skill established in the upper hierarchy can be rewritten as a skill group in the lower hierarchy. In this way, the tool-design philosophy leads to an experimental design method of assembling the whole with fewer samples than covering all the elements in the hierarchy. The top layer of the tool comprises six of the eight intelligence categories in the theory of multiple intelligences (MI) [7][8]. We excluded the naturalist and musical/rhythmic categories, because they are not related to VT. By classifying the fundamental skills according to MI theory, we can take advantage of practical best practices using MI [9][10].

Table Ⅳ displays examples of MI practices [11]. The intelligence includes genetic limits as nuances. For this reason, we reconsider the invisible intelligence as skill. This table shows the direction of guidance in the framework of MI. When designing VT, we must pay attention to the smart skills of CTs. However, it is difficult to shift from that information to guidance. Therefore, we must bring together the best practices in MI and show them to the instructors. As an example of best practice in the bodily/kinesthetic category, we have the Total Physical Response that learns the language with the body, as advocated by Asher [12]. For instance, when studying English with Total Physical Response, one says the sentence "open the door" while physically opening a door. By collecting such a best practice, we can provide instructors with many examples of guidance. We explain this further in Section IV.

According to the Benesse survey [13], the favorite subject of the students in junior high school is physical education (over 60%), unchanged from 1990 to the present (2017). From this survey, it is efficient to target the bodily-kinesthetic component of MI. For example, the group index (five-point evaluation) by MI of Trainee A in descending order is bodily-kinesthetic (4.8), visual-spatial (4.5), logical-mathematical (4.0), verbal-linguistic (2.7), interpersonal (2.5), and intrapersonal (2.3). The instructors refer to the bodily-kinesthetic, visual-spatial, and logical-mathematical components of MI practice (Figure 3). Next, the instructors consider a more-detailed teaching method from the fundamental skills.

C. Guarantee of reliability and validity

Table Ⅴ summarizes all the scenes of this assessment tool. We measure multiple skills in one scene of the assessment while the tool has 37 scenes in total. The problem types are "work on computers" (nos. 6 - 17), "questions asking for behavior" (nos. 1, 2, 5, 18 - 37), and "free description" (nos. 3, 4). Numbers 13 and 15 cover the difficult subject of recognizing numbers and objects. This was added based on the advice from instructors specialized in teaching developmental disabilities at a school for people with disabilities. "Questions asking for behavior" has become a choice of five questions, but the "free description"

Vl1:Extract key points from conversation
Vl2:Understanding demonstrative words
Vl3:Understanding abstract expressions
Vl4:Basic kanji ability
Vl5:Correct interpretation
Lm1:Behaving and thinking sequentially
Lm2:Understanding priorities
Lm3:Understanding important information
Lm4:Breaking up work into specific tasks
Lm5:Compensating for missing or lacking data
Lm6: Correct interpretation
Lm7: Basic Mathematical Ability
Bk1: Manual dexterity
Bk2: Quick hand movement
Bk3: Body image (body sensations)
Bk4: Cooperative behavior
Ie1: Face-to-face interaction
Ie2: Interpersonal fear
Ie3: Understanding the situation of the others
Ie4: Tacit understanding
Ie5: Concern for others
Ir1: Link with experience
Ir2: Overall image
Ir3: Toggle feelings
Ir4: Understanding cause-and-effect relationships
Ir5: Adoption of different perspectives
Ir6: Understanding risky behavior
Ir7: Self-assertion
Vs1: Recognition of objects placement
Vs2: Short-term memory of objects
Vs3: Identification of objects
Vs4: Recognition of parallel lines
Vs5: Recognizing gist of visual information

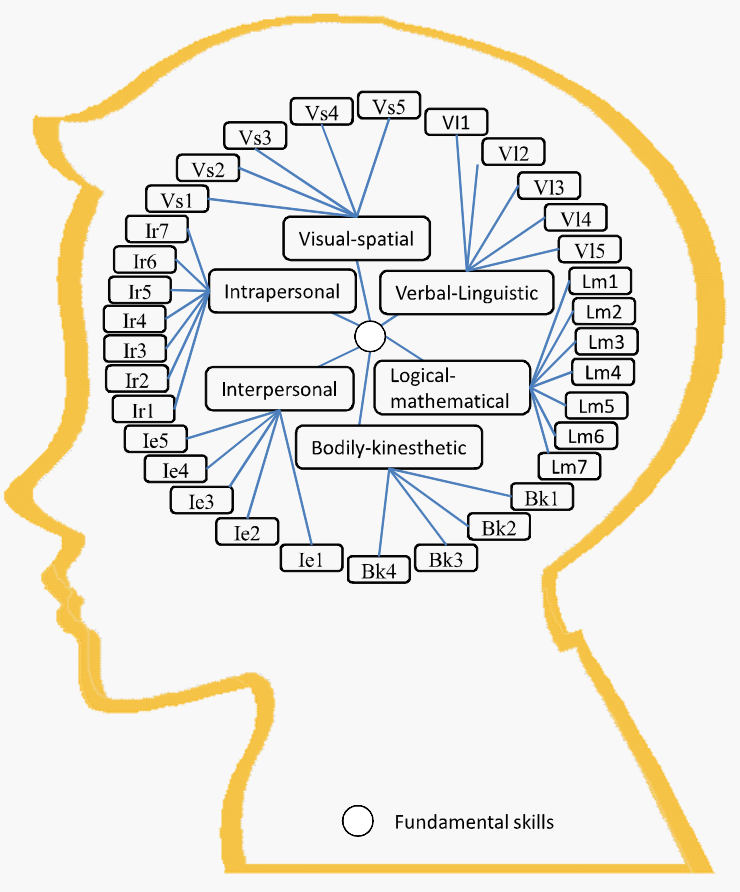

Figure 2. Hierarchical structure of fundamental skills.

TABLE IV. EXAMPLES OF MULTIPLE INTELLIGENCES PRACTICES BY ARMSTRONG

Skill	Teaching Activities (example)	Teaching Materials (example)	Instructional Strategies
Linguistic	lectures, discussions, word games, storytelling,choral reading, journal writing	books, recorders, typewriters, stamp sets, book on cd	read about it, write about it, talk about it, listen to it
Logical-Mathematical	brainteasers, problem solving, science experiments, mental calculation, number games, critical thinking	calculators, math manipulatives, science equipment, math games	quantify it, think critically about it, put it in a logical framework, experiment with it
Visual-Spatial	visual presentations, art activities, imagination games, mind-mapping, metaphor, visualization	graphs, maps, pictures video,Lego sets, art materials, optical illusions, cameras	see it, draw it, visualize it, color it, mind-map it
Bodily-Kinesthetic	hands-on learning, drama, dance, sports that teach, tactile activities, relaxation exercises	building tools, clay, sports equipment, manipulatives, tactile learning resources	build it, act it out, touch it, get a "gut feeling" of it, dance it
Interpersonal	cooperative learning, peer tutoring, community involvement, social gatherings, simulations	board games, party supplies, props for role-plays	teach it, collaborate on it, interact with respect to it
Intrapersonal	individualized instruction, independent study, options in course of study, self-esteem building	self-checking materials, journals, materials for projects	connect it to your personal life, make choices with regard to it, reflect on it

TABLE V. ALL SCENES OF THIS SYSTEM

No	Scenes
1	Greeting according to reality scene
2	Answering about driving a bicycle
3	Answer hobby (free description)
4	Sense of value of life and feeling fun (free description)
5	Confirmation of fear of contact with others
6-7	Complementing hidden parts of numbers (easy)(normal)
8	Select 10 match bars and make "TEN" letters
9	Distinguish line width
10	Nervous breakdown game
11-13	Find mistakes in objects (easy)(normal)(difficult)
14	Identification of single-byte and double-byte characters
15-17	Memorize number(easy)(normal)(difficult)
18	Memorize of conversation
19	Selection of suitable clothes
20	Explanation of reason(1)
21	Customer service
22	Confirm priorty of work
23	Correspondence when cash register is congested
24-25	Confirm priorty of work(1)(2)
26-27	Confirmation of correct customer service(1)(2)
28	Preparation of children's chair
29	Flexible response(customer service)
30	Response to complaints(1)
31	Correspondence when praised by customers
32	Response to complaints(2)
33-34	Money calculation (easy)(normal)
35	Responding to customers who do not need receipts
36	Responding to customers when a other card is presented
37	Explanation of reason(2)

is not subject to tool evaluation. The standard implementation time is 20 min. The tool was developed using the e-learning authoring tool Articulate Storyline [14].

Skills are subjective. The guarantee reliability and validity of the system by formative evaluation. The procedure for developing the tool consists of (i) defining the theoretical composition concept based on Card's cognitive information processing (CIP) model [15]. All the 192 cases that occurred in the field of VT can be explained by this diagram. Card's CIP model is renowned in the field of cognitive science and can be used to understand the intellectual system as well as the nature of intelligence from the viewpoint of information processing; further, the procedure comprises (ii) setting the scenes and creating the options, and (iii) repeated trials with 15 subjects to ensure tool reliability and validity (formative evaluation).

Fig. 3 shows an example of formative evaluation of "questions asking for behavior." We set option "I think that it is better for someone to help." Because, in actual training, one subject always helped the troubled trainee. However, the subject chose "I think that it is better to hurry." From interview with the subject answered "I am under training, so, I can not do selfish." In the formative evaluation of this scene, instead of changing the options, we changed the point of assignment to the options. From such formation evaluation, we increased the reliability of the system. Formative evaluation was conducted twice on average for 15 subjects, and a total of 67 improvements.

III. VERIFICATION EXPERIMENT

A. Detection of Trainees Needing Special Consideration

The tool evaluates the existence of the fundamental skills that are necessary for VT. This tool does not detect insufficient academic ability related to knowledge learned in middle school or high school.

Table Ⅵ displays the results of evaluating the skills of 15 trainees with a score in the range 1 - 5, where a score of less than 3 corresponds to a weak skill. The assessment was carried out in a computer room. In Table Ⅵ, the CT is trainee G, who had the lowest total score in the verification experiment. Also, the trainee G had three group indexes less than 3. In descending order, the group index by MI of trainee G (five-point evaluation, bodily-kinesthetic is scored as only 1 or 5) is bodily-kinesthetic (5.0), visual-spatial (3.7), interpersonal (3.2), intra-personal (2.9), verbal-linguistic (2.7), and logical-mathematical (2.5). In descending order, the trainee G's smart-skill group was bodily-kinesthetic, visual-spatial, and interpersonal. Trainee G's smart fundamental skills (excluding bodily-kinesthetic) were "compensating for missing or lacking data," "recognition of parallel lines," "recognizing gist of visual information," "link with experience," and "toggle feelings." Interestingly, the trainee G was correct while performing the difficult task of recognizing the numbers and objects (nos. 13 and 15).

Figure 4 shows an object-recognition task (no. 13), whereas Figure 5 displays a task involving short-term numerical memory (no. 15). Only four trainees answered these two difficult problems correctly.

By contrast, the weak fundamental skills of trainee G were "understanding risky behavior," "understanding demonstrative words," "understanding abstract expressions," and so on. The trainee should be aware of these weak fundamental skills and repeat the exercises while using complementary means and auxiliary tools, if necessary.

As described above, the ability to detect a CT from MI group and fundamental skills can be confirmed.

B. Differences Between the Instructor-based Evaluation and Tool-based Evaluation

Guiding a trainee begins with understanding her/his smart skills. Table Ⅶ shows the evaluation of trainee G by the instructors and tool. The instructors created the fundamental skills evaluation sheet. The fundamental skills evaluation sheet can be found in the appendix. The instructors were asked to indicate a smart skill of trainee G with the symbol "○" and a weak skill with the symbol "×". There were no fundamental skills that completely corresponded between the instructor- and tool-based evaluations; in this case, the instructors reported no smart

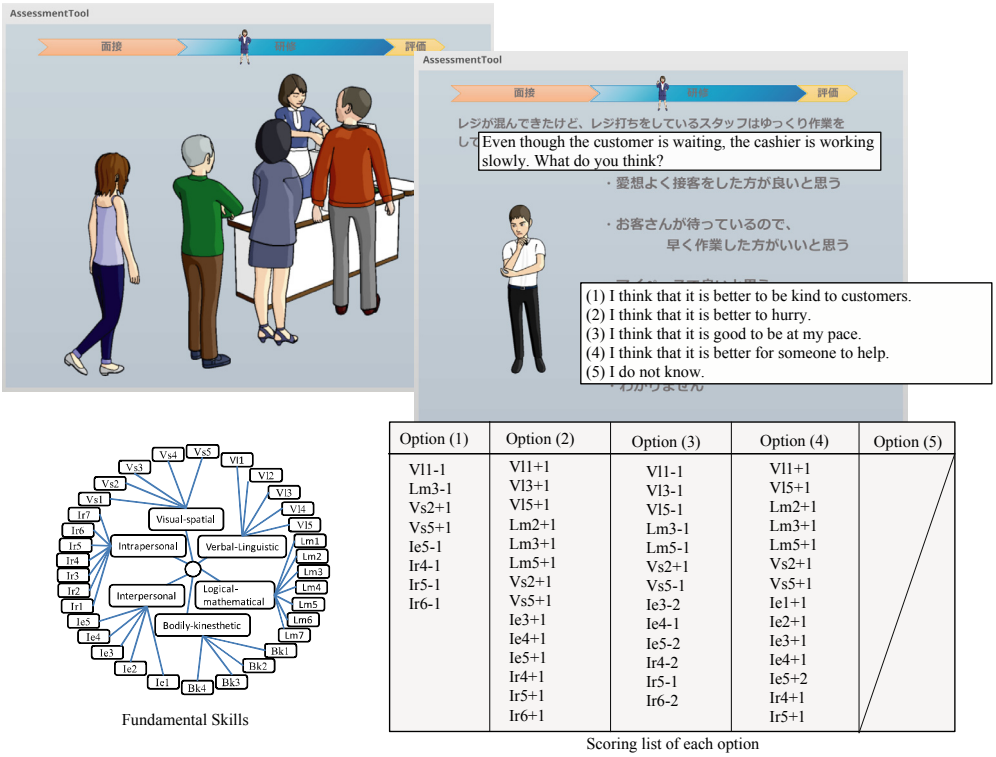

Figure 3. An example of formative evaluation of "questions asking for behavior."

TABLE VI. EVALUATION RESULTS OF 15 TRAINEES

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
*Vl (Ave)	46	44	39	48	46	46	27	46	45	46	31	35	44	31	45
Vl1	5	5	5	5	5	5	3	5	5	5	4	4	5	4	5
Vl2	5	4	4	5	5	5	2	5	5	5	3	3	5	4	5
Vl3	4	4	4	5	4	4	2	4	4	4	2	3	4	3	4
Vl4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4
Vl5	4	4	3	5	5	4	3	4	4	5	2	3	4	3	4
*Lm (Ave)	41	35	37	42	41	42	25	41	42	43	39	42	42	36	42
Lm1	4	3	3	4	4	4	2	4	4	4	4	4	4	3	4
Lm2	3	3	3	4	3	3	2	3	3	3	3	4	4	3	4
Lm3	4	4	3	4	4	5	1	4	4	5	4	4	4	5	5
Lm4	4	3	4	4	4	4	2	4	4	4	4	4	4	3	4
Lm5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5
Lm6	4	3	4	4	4	5	3	4	4	5	4	4	4	3	4
Lm7	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4
*Vs (Ave)	43	45	36	42	44	40	37	43	44	40	39	45	42	34	44
Vs1	5	5	4	4	5	4	3	5	5	4	3	4	4	4	4
Vs2	3	4	3	3	3	3	4	3	3	3	4	5	3	4	4
Vs3	4	4	3	4	4	3	2	4	4	3	3	4	4	3	4
Vs4	5	5	4	5	5	5	5	5	5	5	5	5	5	3	5
Vs5	5	5	3	4	5	4	5	5	5	4	5	5	4	3	4
*Bk (Ave)	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Bk1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Bk2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Bk3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Bk4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
*Ie (Ave)	35	39	36	34	31	37	29	36	37	34	41	36	36	32	37
Ie1	3	4	2	3	2	3	3	3	3	3	4	3	3	3	4
Ie2	2	3	2	2	3	2	2	2	2	2	3	3	2	2	3
Ie3	4	4	4	4	3	5	3	4	4	4	3	3	4	3	4
Ie4	4	4	4	3	3	4	3	4	4	3	4	4	4	3	4
Ie5	4	4	4	4	4	4	4	4	5	4	5	5	5	4	4
*Ir (Ave)	42	39	33	42	42	39	32	42	40	38	37	43	40	39	43
Ir1	5	5	5	5	5	4	5	5	5	4	5	5	5	4	5
Ir2	5	4	4	5	5	5	3	5	5	5	5	5	5	4	5
Ir3	5	5	4	5	5	4	5	5	5	5	4	4	5	4	5
Ir4	4	5	4	4	4	4	3	4	4	3	4	5	4	5	5
Ir5	4	3	2	4	5	4	3	4	4	4	4	5	4	4	4
Ir6	3	2	1	4	3	4	1	3	3	3	2	3	4	3	4
Ir7	2	2	2	2	2	2	2	2	1	2	3	2	1	2	2
Total	139	136	125	141	138	138	106	140	140	137	129	138	138	122	142

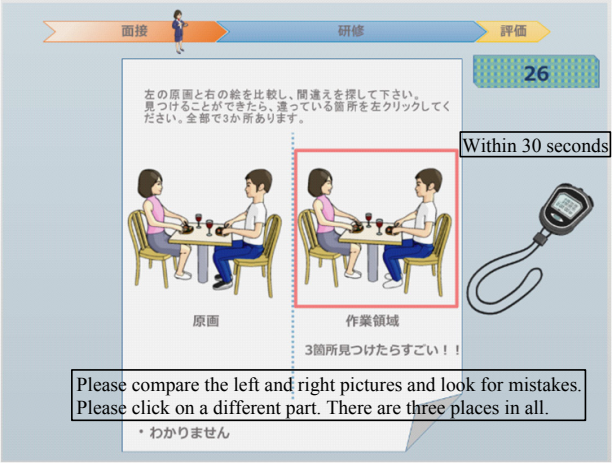

Figure 4. An object recognizing numbers and objects

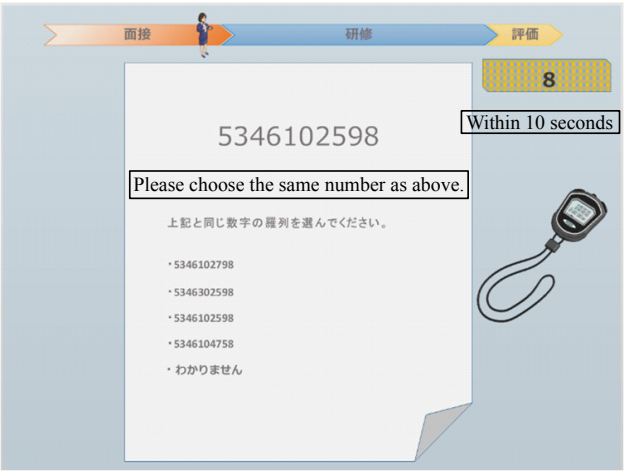

Figure 5. A task involving short term numerical

skills for trainee G. However, the system can be used to find the five smart skills of the consideration trainee G.

On the basis of interviewing the instructors, we considered which factors caused the differences in the skills evaluation of trainee G among the instructors and why no smart skills were reported. We found that the differences in evaluation were due to the training content. For example, even though explaining trainee G's weak skills in a causal relationship, other instructors just said that they did not experience such a scene. In particular, the instructor E was responsible for training and employment, and therefore he (she) had the most-frequent contact with trainee G, whereas the instructor E's evaluation of skills was similar to that of the tool. Instructor E observed that Vs4 was ×. However, the system evaluated Vs4 as ○. Based on this point, instructor E evaluated that trainee G sketched a figure using left and right reverse letters and straight lines that overlapped in the report.

TABLE VII. EVALUATION OF TRAINEE G BY INSTRUCTORS AND SYSTEM

	InstructorA	InstructorB	InstructorC	InstructorD	InstructorE	System
*Vl						
Vl1	×	×				
Vl2		×			×	×
Vl3		×			×	×
Vl4					×	
Vl5						
*Lm						
Lm1		×		×	×	×
Lm2			×	×		×
Lm3		×	×	×		×
Lm4				×		×
Lm5	×	×	×			○
Lm6		×				
Lm7						
*Vs						
Vs1						
Vs2						
Vs3					×	×
Vs4					×	○
Vs5						○
*Bk						
Bk1						
Bk2						
Bk3						
Bk4						
*Ie						
Ie1		×	×			
Ie2	×	×			×	×
Ie3						
Ie4						
Ie5						
*Ir						
Ir1						○
Ir2			×		×	
Ir3						○
Ir4						
Ir5						
Ir6						×
Ir7				×		×

Furthermore, we found that the reason why no smart skills were recorded for trainee G was a matter of prejudice. On the basis of interviewing the instructors, we heard many opinions about trainee G, such as "Could not understand even after explaining many times" and "Only have to respond with individual guidance." Also, all the instructors were surprised when we told them that trainee G was the top of the class for the skill of finding the different parts of the two pictures (no.13) and short-term numerical memory (no.15).

Statistically, 6% of all people have a developmental disability. Moreover, it is said that one-third of that 6% is 2E with special talent. Therefore, if there are 20 trainees in a class, there should be at least one CT, and the instructors need to identify that person's smart skills as soon as possible.

IV. FUTURE WORK

Instructors are struggling to establish the transfer from support to guidance. The present research aims to allow CTs to work on tasks without the assistance of instructors. Therefore, the instructors must deal with the diversity of

TABLE VIII. AN EXAMPLE OF CONTRADICTION MATRIX FOR MI BEST PRACTICES

weak / smart	Linguistic	Logical-Mathematical	Visual-Spatial	Bodily-Kinesthetic	Interpersonal	Intrapersonal
Linguistic		12,15,19,22	2,18,19,35	:	:	:
Logical-Mathematical	2,5,19		:	:	:	:
Visual-Spatial	7,8,11,15	:		:	:	:
Bodily-Kinesthetic	:	:	:		:	:
Interpersonal	:	:	:	:		:
Intrapersonal	:	:	:	:	:	

trainees adequately. In future work, we intend to structure the best practice in MI in the form of a contradiction matrix, as shown in Table Ⅷ. A contradiction matrix is considered to be a notational method for solving two contradictory matters, and the TRIZ [16] contradiction matrix is considered to be the best-known example. MI practice has been focused only on intelligence which is smart. As discussed herein, we consider intelligence replaced with skill. Then, by understanding what an effective teaching means, considering both smart and weak skills, we think that the instructors will be able to respond flexibly to trainee diversity by using such a confrontation matrix.

We also intend to fill the matrix by adopting approximately 40 cases (because the TRIZ contradiction matrix selects 40 elements) from previous research into educational practice.

In recent years, the trend has been to evaluate the effectiveness of learning using t-tests and effect size [17]. Many academies are obliged to show the effect size, and here we examine the effect size and t-tests. To calculate the effect size, a spreadsheet is available for calculating the effect size (http://www.mizumot.com/stats/effectsize.xls), and it is used in many fields. The effect size is a standardized version of the average difference between groups, the strength of the relationship between variables, etc., so as not to be influenced by the data unit. An effect size of 1.0 means that it is 1 SD(standard deviation) apart. That indicates that an effect size of 1.0 means that the SD has increased by 10. Using deliberate practice [18] to improve knowledge about physics was reported to have an effect size of 2.5 [19]. The educational methods that use deliberate practice attract attention. Other science and engineering classroom studies have reported [20] effect sizes of less than 1.0. An effect size of 2, obtained with trained personal tutors, is claimed to be the largest observed for any educational intervention [21]. In creating our confrontation matrix, it will be important to survey practical cases involving high effect size.

V. CONCLUSION

The objective of this research is to construct a vocational training environment where “trainees” who need special consideration, such as “developmental disorder,” and “normal trainees” learn in the same classroom. In this study, we described the development and verification of the 33 fundamental skills scale without distinguishing between disabled trainees and normal trainees. The 33 fundamental skill scale was divided by decomposing 192 problem behaviors, which could be observed in vocational training by reductionism. In the verification, an assessment tool that set 33 fundamental skills to represent the problem behavior was developed and applied to 15 trainees. Based on the trial results, we can confirm that (1) the skills are frequently detected in the best trainees and that (2) the unevenness of skills can be detected in the consideration trainees. The academic achievement of this research is that it clarified “the validity of the 33 fundamental skills” and “the relation between the 33 fundamental skills and behaviors.” Further, the vocational training instructors can find support and guidance corresponding to the skill characteristics of each trainee by learning the relation between the fundamental skill scale and behaviors.

The remaining tasks ensure further improvement of the accuracy by verifying the tool on a large scale and by collecting the examples of best practices in MI.

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APPENDIX