Sustainable Vocational Preparation for Adults with Disabilities: A Metaverse-Based Approach

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Abstract: This research introduces a sustainable, metaverse-based vocational preparation program designed to empower adults with disabilities, providing them with the necessary skills to secure and retain employment in a landscape drastically altered by the Fourth Industrial Revolution and the COVID-19 pandemic. After implementing the program with nine adults with disabilities, the Wilcoxon signed-rank test was used to analyze the differences in the pre- and post-tests of the study participants. As a result, the participants' interpersonal relationships, problem-solving abilities in the workplace, and online interview skills were significantly improved. This study holds significance in its innovative approach to vocational education, adapting to shifts in employment trends and providing interventions in the metaverse that transcend traditional educational settings.

Keywords: vocational education; online training; sustainable development; transition; adults with disabilities

1. Introduction

Occupation is an essential element of life that enhances an individual's economic independence and social status, which affect physical and mental health, and determine the overall quality of life [1,2]. In particular, for people with disabilities, occupation is a medium that increases independence and self-esteem and promotes social integration [3,4]. Although most countries' governments strive to employ people with disabilities, many such individuals are still unable to overcome the barriers to employment [5,6]. This may be attributed to their lack of social, communication, and social problem-solving skills and health problems [4,7]. Furthermore, changes in employment due to the Fourth Industrial Revolution and the prolonged COVID-19 pandemic have raised concerns about the unemployment of people with disabilities [8].

At the World Economic Forum in 2016, Klaus Schwab predicted that changes in the social structure and jobs would hit like a tsunami due to the Fourth Industrial Revolution. More precisely, owing to the convergence of information and communications technology (ICT) and the development of intelligent robots, simple and repetitive jobs mainly occupied by people with disabilities are gradually being replaced by machines [9]. Moreover, COVID-19 has reduced conventional face-to-face businesses and expanded non-face-to-face industries, and firms have accelerated change into agile organizations to secure flexibility through remote work and contactless digital methods of work [10]. Accordingly, there is a growing demand for human resources capable of using network and digital technologies [11]. In the post-pandemic era, the digital transformation of the labor community deeply affects vocational education and training. To preserve the sustainability of vocational education and training in the context of the digital economy and industrial advancement, digital talent training capabilities must be strengthened [12], something which is especially important in vocational education for people with disabilities. Thus, people with...
disabilities—who are vulnerable in terms of access to, competency with, and utilization of ICT [13]—are likely to be excluded from the labor market. As we navigate this era of rapid and unpredictable change, there is a pressing need to promote sustainable vocational preparation. Such an approach should empower individuals with disabilities with not only specific job skills but also the adaptability and resilience necessary to succeed in a perpetually evolving work environment. This commitment to enhancing adaptability and resilience is at the heart of our pursuit of sustainable vocational development.

However, the shift in the working pattern from physical workplaces to online may increase job opportunities for workers with disabilities [14] and may even enable flexible labor by avoiding discrimination against those with disabilities while seeking and maintaining jobs [15]. To fully harness the benefits of this shift and foster sustainable employment in this ’new normal’, it is essential that workers with disabilities possess a balanced set of hard skills, such as ICT, networking, and digital technologies, and soft skills, including the ability to form new interpersonal relationships, problem-solving, and communication in remote employment settings. In this context, the concept of ’employability’ is emphasized across fields such as human resource development, human resource management, and strategic management. Employability is defined as “the capacity of individuals to secure and retain employment while flexibly responding to changes in the labor market, thereby facilitating their professional success” [16]. This concept encompasses individual problem-solving skills, interpersonal relationships, drive, motivation, resilience (personality characteristics that determine one’s response to opportunities and challenges, stress, and pressure), control, and confidence [17]. In light of the rapidly evolving employment environment, enhancing the ’employability’ of workers with disabilities has emerged as a crucial task, underlining the importance of retraining and continuous adult education.

Specifically, people with disabilities need this education after school age to obtain and maintain employment while flexibly coping with changes in the labor market and the world of work; hence, such education should be prioritized over education for acquiring job skills. Much of the recently announced vocational education for adults with disabilities focuses on job-seeking skills or employment maintenance skills rather than on specific job skills. These education programs focus on job-seeking skills, such as employment information collection and job interviews [18–20] or workplace communication, emotional regulation, self-advocacy, and problem-solving skills [21–23], and have shown positive results such as improved employment outcomes. This sustainable approach extends beyond teaching specific vocational skills and leverages metaverse technology to cultivate a comprehensive set of skills that enhances adaptability in an uncertain and changing world. This emphasizes the need for continual adaptation to meet the evolving demands of the labor market and frames the importance of these programs within the broader context of sustainable vocational preparation.

As we explore the potential of the metaverse for vocational preparation, it is important to note that some studies have used elements of the metaverse, such as augmented reality (AR) and virtual reality (VR), as intervention tools. For example, Smith et al. (2021) reported an increase in job interview skills, self-efficacy, and employment rates among young people with autism due to interview training using virtual reality [24]. Moreover, Walker et al. (2016) utilized mixed reality to teach overt behavior, communication, and social skills related to interviews [25]. They confirmed that such skills were effectively generalized to face-to-face situations. VR provides users with a realistic interactive experience [26]. In particular, for individuals with autism spectrum disorder (ASD), a decrease in their levels of social anxiety has been observed when interacting with VR avatars.

Consequently, it is being increasingly used in vocational education environments [27]. The metaverse is defined as a “virtual world that transcends reality”, which includes AR, lifelogging, the mirror world, and the virtual world [28]. Following the outbreak of COVID-19, various metaverse platforms were used for a while because most school classes were conducted remotely, and companies had their employees work from home. In particular, the 3D-based virtual world in which users use avatars to represent themselves has recently
received considerable attention as it enables users to interact deeply and connect emotionally [29]. Despite the widespread use of the metaverse in general education environments, including elementary, middle, and higher education, research involving its use in education for students with disabilities remains markedly insufficient [30]. The research gap primarily lies in exploring how these platforms can be adapted and optimized for vocational education for individuals with disabilities. Recognizing this disparity, several studies are currently being conducted to improve the accessibility of the metaverse for individuals with disabilities [31,32]. As access to new technologies and the capacity to handle them are the precondition and foundation for people to participate and be included in the changing labor market [33], vocational education programs, using technology such as the metaverse, can be an opportunity to increase job opportunities for adults with disabilities. Recently, a study was conducted that noted positive student perceptions of the ease of use, satisfaction, and immersive nature of metaverse-based vocational preparation [34]. However, views on its effectiveness as a learning experience and its utility are mixed, and it is perceived to offer less interactivity compared to traditional face-to-face teaching. This underscores the need to establish key parameters for preparing metaverse-based vocational training programs. These might include considerations around accessibility, interactivity, immersion, and effectiveness in terms of learning outcomes. The current study addresses these concerns and contributes to the limited research on metaverse-based vocational training for individuals with disabilities.

Therefore, this study aimed to improve the online interview skills, interpersonal relationships, and problem-solving skills of adults with disabilities through metaverse-based vocational preparation education, reflecting employment changes since the Fourth Industrial Revolution and the outbreak of the COVID-19 pandemic. This aligns with our commitment to sustainable vocational development, acknowledging that job skills must evolve to reflect shifting industrial landscapes and societal conditions.

The specific research problems of this study are as follows.

A. What is the change in interpersonal relationships and problem-solving skills in the workplaces of adults with disabilities who participated in the sustainable metaverse-based vocational preparation program?

B. What is the change in online interview skills of adults with disabilities who participated in the sustainable metaverse-based vocational preparation program?

2. Materials and Methods

2.1. Participants

The study participants were nine adults with disabilities, either currently employed or actively preparing to secure or change employment. The disabilities represented within the group included cerebral palsy (three individuals), intellectual disability (three individuals), and autism spectrum disorder (three individuals). These individuals had work experience, ranging from a minimum of one year to a maximum of seven years, in diverse industries such as office assistance, design, and coffee shops. All participants were literate, able to communicate verbally, and possessed basic computer skills, including simple word processing and familiarity with online video conferencing platforms.

2.2. Settings

This study was conducted in a virtual classroom implemented on a metaverse platform called Gather.Town. As the program was implemented in a virtual space not bound by physical distance, the participants living in different regions accessed the metaverse classroom on their personal computers (PCs) at home. An online board was set up to overcome the limitations of non-face-to-face classes by providing individual feedback on the activity sheets filled out by the participants and their class participation attitudes.
2.3. Independent Variable

The independent variable in this study was the sustainable metaverse-based vocational preparation program designed to empower adults with disabilities. It was constructed based on an analysis of previous studies and vocational training programs, interviews with employers (managers) of workers with disabilities and vocational education and service providers, behavioral event interviews (BEI) with workers with disabilities, and the demand survey of research participants. Subsequently, it was completed with validity testing by experts. An analysis of previous studies revealed certain needs in the current situation that set it apart from conventional vocational preparation education. Stakeholders such as employers (managers), vocational education and service providers, workers with disabilities, and research participants highlighted the need for education in remote communication and interpersonal relationships, remote work performance, and remote job interviews in response to the Fourth Industrial Revolution and the COVID-19 pandemic. Additionally, they suggested that education should extend beyond the workplace to include aspects of economic and leisure life, as well as training for those involved in the employment of people with disabilities (employers and parents), to support sustained employment for this group.

Consequently, the program developed in this study comprised 15 sessions, primarily divided into two categories: ‘Job Search Preparation’ and ‘Job Adaptation and Employment Maintenance’ (Table 1). The program developed in this study employs unique content and methods at each stage to deliver differentiated vocational preparation education for the new normal era, an era rapidly evolving due to the Fourth Industrial Revolution and COVID-19. Firstly, all evaluations related to job searching (job aptitude, interest, personality test) were conducted using online testing tools. Secondly, while collecting employment-related information, we investigated jobs that had either disappeared or gained prominence due to the Fourth Industrial Revolution, setting employment goals based on these findings. We also sought information on the competencies and support needed to secure these jobs. Thirdly, in teaching job search skills, we covered how to submit job applications online, write an online self-introduction letter, and participate in online interviews. Fourthly, considering the potential for online violation of rights or workplace violence, we included strategies for dealing with online sexual harassment and cyberbullying in our self-advocacy skills training. Fifthly, training in interpersonal relationships, communication, problem-solving, and adaptability in the workplace was delivered, assuming that interactions could be face-to-face or remote. Sixthly, we provided specific instructions on using online conference platforms, an essential tool for remote work, and taught appropriate online communication skills and etiquette.

Table 1. Structure of the metaverse-based vocational preparation program.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Session and Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Prior education</td>
</tr>
<tr>
<td></td>
<td>2 Self-understanding</td>
</tr>
<tr>
<td></td>
<td>3 Employment goal setting and information collection</td>
</tr>
<tr>
<td></td>
<td>4~6 Job-seeking skills</td>
</tr>
<tr>
<td></td>
<td>7 Self-advocacy</td>
</tr>
<tr>
<td></td>
<td>8~9 Interpersonal relationships and communication</td>
</tr>
<tr>
<td></td>
<td>10 Problem-solving and coping with change</td>
</tr>
<tr>
<td></td>
<td>11 Economic life and leisure</td>
</tr>
<tr>
<td></td>
<td>12~13 Non-face-to-face task performance</td>
</tr>
<tr>
<td></td>
<td>14 Parent education</td>
</tr>
<tr>
<td></td>
<td>15 Completion ceremony</td>
</tr>
</tbody>
</table>

2.4. Dependent Variables

The dependent variables in this study were interpersonal relationships and problem-solving skills at work and online interview skills. To measure these variables, evaluation
items were first developed based on the Valpar Component Work Sample 17, Employment Readiness Scale (ERS), and interviews with employers (managers) of workers with disabilities and vocational education and service providers. Next, specifics were constructed to measure each item, and an evaluation tool, including related video clips, was developed to help understand the virtual situations clearly. These scenarios included not only face-to-face situations at work but also non-face-to-face interpersonal situations and work problems (e.g., situations in which there was a misunderstanding due to ambiguous expressions during online business contact or a technical problem occurring during an online meeting). To record the evaluation results, a rubric considered effective for soft skills assessment was used [35]. The rubric was developed based on the validity evaluation of five career and vocational education experts for students with disabilities and the test of two adults with disabilities.

To measure the online interview skills of the participants, an item pool consisting of 20 questions was developed, based on which 1:1 mock interviews (or simulated interviews) were conducted and comparatively analyzed through recorded videos. The mock interview videos were analyzed based on the interview rubric used by Walker et al. [25], which was partially revised and supplemented to test the effect of interview training for persons with intellectual disabilities (Table 2).

Table 2. Interview rubric.

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overt behavior</td>
<td>Did the participant make eye contact adequately?</td>
</tr>
<tr>
<td></td>
<td>Did the participant maintain good posture? (e.g., shaking head or body, appearance)</td>
</tr>
<tr>
<td></td>
<td>Did the participant adequately use hand gestures, nods, and facial expressions? (e.g., excessive use of hands, bright facial expression)</td>
</tr>
<tr>
<td>Verbal communication</td>
<td>Did the participant use inappropriate expressions such as slang or jargon? (e.g., Umm...uh...interrupting instead of listening to the end, trailing off at the end of a response, beating around the bush, speaking too quickly)</td>
</tr>
<tr>
<td></td>
<td>Did the participant show inappropriate communication habits?</td>
</tr>
<tr>
<td></td>
<td>Was their voice clear and the volume adequate?</td>
</tr>
<tr>
<td>Response details</td>
<td>Did the participant answer the question?</td>
</tr>
<tr>
<td></td>
<td>Was the response neither too short nor too long, but just right?</td>
</tr>
<tr>
<td></td>
<td>(e.g., enthusiasm, energy, willingness to get a job, emphasis on their qualities, confidence)</td>
</tr>
</tbody>
</table>

2.5. Materials

This study used the free version of Gather.Town as a platform for intervention because it can customize virtual space as necessary and has various features such as video, audio, real-time chatting, screen sharing, and external application insertion. Gather.Town is also suitable for people with developmental disabilities, as it is not difficult even for people with motor difficulties to manipulate and can be designed by simplifying the composition of space according to the cognitive needs of users. The virtual classroom was designed considering the content of the program, teaching and learning methods (lectures, presentations, and discussions, use of audiovisual materials, role play, practical exercises, and games), and the concept of barrier-free design [36] used in designing real space (convenience, identifiability, variability) (Figure 1).
In addition, to strengthen the digital work capabilities of research participants, we actively used online boards like Padlet, which enable real-time collaboration among colleagues, along with social network services and Google Workspace.

2.6. Research Design

This study used a one-group pretest-post-test design to determine the intervention effect. The pretest was conducted on the participants before the intervention, and the post-test was conducted in the same way as the pretest after 15 intervention sessions to compare the differences before and after the intervention.

2.7. Data Collection

To measure interpersonal relationships and problem-solving skills, the examiner presented a video of a virtual situation that may occur in the workplace and guided the participants to respond to four items sequentially according to the four stages of problem-solving. Responses to ten situations were evaluated, and the time required for evaluation was approximately 20 min. The entire evaluation process was recorded, and the researcher scored the participants on the rubric based on these data.

To measure online interview skills, the examiner and participants devised a hypothetical situation by discussing the occupation for which they were interviewed. The examiner conducted the interview by evenly selecting ten questions from the item pool consisting of 20 questions according to content classification and difficulty level. The time required was approximately 15 min, and all interviews were recorded and used as a reference for developing the rubric.

2.8. Reliability

To increase the consistency and accuracy of data collection, the secondary observer scored the participants on the rubric separately from the researcher. The evaluation criteria were thoroughly discussed before scoring. The pretest and post-test were scored by randomly selecting the recordings of three participants, who represented one-third of all participants. The average reliability of the pretest on interpersonal relationships and problem-solving skills at work was 92.0%, and that of the post-test was 99.0%. The average reliability of the pretest on online interview skills was 90.0%, and that of the post-test was 94.3%.

2.9. Fidelity

For evaluation, the researcher’s computer screen showing the intervention process on the metaverse was recorded using OBS software in all sessions. Out of all sessions,
four sessions were randomly selected and evaluated by the researcher and the secondary observer. Consequently, the researcher recorded an average intervention fidelity of 95.0%, and the secondary observer recorded an average intervention fidelity of 100%.

Social validity. After the program was completed, the social validity of the program was surveyed among the participants. The tool consisted of five multiple-choice items rated on a five-point scale. The mean of social validity was 4.6 points, showing a high level of satisfaction.

2.10. Data Analysis

Quantitative data, collected through the rubric evaluating interpersonal relationships and problem-solving skills at work and interview skills, were analyzed using SPSS 25.0. A Wilcoxon signed-rank test, which is a non-parametric statistical method, was conducted on the pretest-post-test score differences of the participants in order to analyze the meaning of score changes. The Wilcoxon signed-rank test was used because, as a result of testing normality using the Shapiro–Wilk W test, the data were found to be non-normally distributed.

3. Results

3.1. Interpersonal Relationships and Problem-Solving Skills at Work

The mean score of interpersonal relationships and problem-solving skills of the participants increased by 37.78 (SD = 18.17), from 138.56 (SD = 19.94) to 176.33 (SD = 3.74), after the intervention. This difference was statistically significant at the 0.01 significance level ($Z = −2.66, p < 0.01$) (Table 3).

<table>
<thead>
<tr>
<th>Category</th>
<th>Pretest M (SD)</th>
<th>Posttest M (SD)</th>
<th>Posttest-Pretest M (SD)</th>
<th>$Z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>138.56 (19.94)</td>
<td>176.33 (3.74)</td>
<td>37.78 (18.17)</td>
<td>−2.66 **</td>
</tr>
<tr>
<td>Problem recognition</td>
<td>27.00 (3.93)</td>
<td>29.44 (1.66)</td>
<td>2.44 (2.65)</td>
<td>−2.20 *</td>
</tr>
<tr>
<td>Information collection</td>
<td>20.89 (2.26)</td>
<td>29.22 (1.09)</td>
<td>8.33 (2.59)</td>
<td>−2.67 **</td>
</tr>
<tr>
<td>Solution suggestion</td>
<td>22.56 (4.64)</td>
<td>29.56 (0.52)</td>
<td>7.00 (5.02)</td>
<td>−2.67 **</td>
</tr>
<tr>
<td>Evaluation</td>
<td>23.78 (5.28)</td>
<td>29.22 (1.09)</td>
<td>5.44 (5.27)</td>
<td>−2.49 *</td>
</tr>
<tr>
<td>Volume and tone of voice</td>
<td>22.22 (3.66)</td>
<td>29.89 (0.33)</td>
<td>7.67 (3.60)</td>
<td>−2.67 **</td>
</tr>
<tr>
<td>Appropriate facial expression</td>
<td>22.11 (3.88)</td>
<td>29.00 (1.22)</td>
<td>6.89 (3.06)</td>
<td>−2.69 **</td>
</tr>
</tbody>
</table>

* $p < 0.05$, ** $p < 0.01$.

An examination of the performance of each of the four stages of problem-solving (problem recognition, information collection, solution suggestion, evaluation) and the changes in non-verbal communication (volume and tone of voice, facial expression) revealed that the mean increased by 2.44 (SD = 2.65) in problem recognition, 8.33 (SD = 2.59) in information collection, 7.00 (SD = 5.02) in solution suggestion, 5.44 (SD = 5.27) in evaluation, 7.67 (SD = 3.60) in volume and tone of voice, and 6.89 (SD = 3.06) in the appropriate facial expression after the intervention compared to before the intervention. Out of the four stages of problem-solving, performance in information collection, solution suggestion, volume and tone of voice, and appropriate facial expression had a statistically significant increase at the significance level of 0.01. Performance in problem recognition and evaluation had a statistically significant increase at the 0.05 significance level.

3.2. Online Interview Skills

The mean score of interview skills of the participants increased by 36.33 (SD = 20.49), from 228.89 (SD = 14.05) to 265.22 (SD = 10.29), after the intervention. This difference was statistically significant at the 0.01 significance level ($Z = −2.66, p < 0.01$) (Table 4).
Table 4. Pretest-post-test results of online interview skills (N = 9).

<table>
<thead>
<tr>
<th>Category</th>
<th>Pretest</th>
<th>Post-Test</th>
<th>Post-Test-Pretest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>Z</td>
</tr>
<tr>
<td>Total</td>
<td>228.89 (14.05)</td>
<td>265.22 (10.29)</td>
<td>36.33 (20.49)</td>
</tr>
<tr>
<td>Overt behavior</td>
<td>73.56 (12.21)</td>
<td>87.11 (2.31)</td>
<td>13.56 (13.58)</td>
</tr>
<tr>
<td>Verbal communication</td>
<td>82.89 (5.75)</td>
<td>88.11 (1.36)</td>
<td>5.22 (6.28)</td>
</tr>
<tr>
<td>Response details</td>
<td>72.44 (7.23)</td>
<td>90.00 (8.47)</td>
<td>17.56 (12.46)</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01.

Examining the changes in performance in the three categories evaluating interview skills (overt behavior, verbal communication, response details) revealed that the mean increased by 13.56 (SD = 13.58) in overt behavior, 5.22 (SD = 6.28) in verbal communication, and 17.56 (SD = 12.46) in response details after the intervention compared to before the intervention. There was a statistically significant increase at the significance level of 0.01 in response details and at the significance level of 0.05 in overt behavior and verbal communication.

4. Discussion

This study leveraged a virtual classroom on the Gather.Town metaverse platform to implement a social problem-solving program tailored for adults with disabilities, with a particular focus on employment. Upon intervention, the participants demonstrated improvement in their workplace interpersonal relationships and problem-solving skills. This outcome aligns with the findings of Bonete et al. and Liu et al. [37,38], who reported enhancement in problem-solving skills among adults with disabilities following a similarly employment-oriented social problem-solving program. The broader implications of these findings extend to the design of future vocational preparation programs for adults with disabilities, as it underscores the potential of virtual platforms like Gather.Town for delivering effective social problem-solving training. Furthermore, the results can inform the development of policies and initiatives to improve employment outcomes for this demographic, given the vital role of interpersonal relationships and problem-solving skills in workplace success.

Interestingly, while the participants exhibited proficiency in objectively recognizing problems in the pretest, they initially struggled with ideating, comparing, and selecting various problem-solving strategies. Nonetheless, repeated practice using audiovisual materials, discussions, role plays, and games seems to have significantly improved their capabilities in dealing with both face-to-face and remote work situations. This finding strengthens the arguments for the potential of comprehensive, interactive interventions for bolstering practical problem-solving skills in adults with disabilities. Moreover, it highlights the value of sustainable learning approaches that foster continuous skill development, enhancing long-term adaptability in the ever-evolving workplace. As work dynamics continue to shift, especially in the wake of the COVID-19 pandemic, these results suggest promising strategies for inclusive and sustainable vocational preparation and employment for individuals with disabilities, advocating for further research into these adaptable, skill-oriented training methodologies.

Meanwhile, the participants with autism spectrum disorder showed relatively lower scores in non-verbal communication (volume and tone of voice, facial expression) in the pretest compared to other participants; however, these scores increased to a similar level in the post-test. It can be assumed that using video clips of dramas about working life might have helped the participants with autism spectrum disorder, as visual learners, recognize and be immersed in the problem situation. This improvement suggests that audiovisual aids, such as video clips simulating workplace situations, might have facilitated visual learning, thereby enhancing their immersion in problem situations. Building on previous studies that reported on the positive effects of using video materials to improve social behavior [39,40], these results lend credence to the broader application of similar
multimedia learning resources, not only for individuals with ASD but potentially extending to other individuals with disabilities who may benefit from visual learning.

The improvements in online interview skills align with the results of references [18–20,24–26,41], all of which reported positive changes after conducting VR-based job interview training. Overt behaviors and verbal communication habits such as eye contact, postures, facial expressions, and gestures that appear during interviews had been fixed for a long time and were expected to be difficult to improve significantly through short-term intervention, but there was a statistically significant improvement after the intervention. Some participants often did not make eye contact and touched their heads or faces or even shook their bodies in the post-test; however, we observed substantial improvement after receiving feedback regarding the video recordings of their mock interviews, watching others’ interview videos, and evaluating them as an interviewer. Walker et al. [25] also provided opportunities for participants to practice repeatedly, provided feedback, and modeled appropriate and inappropriate behaviors, leading to significant improvements in interview skills. Considering the often-significant hurdles that job interviews present for individuals with disabilities, these findings have far-reaching implications for VR-based training programs, HR practices, and policies to enhance employability and inclusivity in the workforce.

In conclusion, our study underscores the significant role of interactive, targeted interventions in enhancing practical problem-solving and interview skills among adults with disabilities. It invites further exploration into the wider applicability of such programs, their adaptability in diverse contexts, and their potential long-term impact on promoting sustainable vocational preparation and employment.

4.1. Considerations

While this study has produced valuable insights, there are a few considerations. Firstly, due to the small number of study participants and limited disability types, it is difficult to generalize the study results to all adults with disabilities. In addition, due to the inherent nature of the study design, which used simulated situations for evaluations and training, some results might not fully translate to real-world work environments. Despite this, the training was comprehensive, although it might not have covered every conceivable work-life scenario. Moreover, assessing practical outcomes, such as the applicability of the problem-solving stages and strategies in real-life situations, presented a challenge.

Secondly, the program was applied to a single group without the comparison of a control group. This approach might make it somewhat challenging to attribute the program’s effects exclusively to the intervention. However, interventions and tests were completed within two months so that the natural maturity of the study participants did not affect the study results. In addition, the detailed questions of the pretest-post-test tool were changed so that the test experience of the study participants did not affect the research results. While providing interventions to a single group may present certain constraints on the internal validity of the study, the insights gained still offer valuable direction for future research and practice.

4.2. Conclusions

This study holds significance as it implemented a vocational education program that reflects the evolving trends of our time, including employment shifts due to the Fourth Industrial Revolution and COVID-19, along with the necessary skills for adaptation. This program also ventured beyond the traditional educational environment by providing interventions in the metaverse. While the metaverse is a rapidly expanding high-tech realm increasingly utilized in educational and industrial settings, its use in educational and welfare services for people with disabilities remains rare. Thus, this study represents a novel attempt to leverage the contemporary trend of the metaverse as a platform for implementing educational programs focused on job preparation, adaptation, and employment maintenance. Furthermore, the participation of adults with disabilities living in various re-
gions and having restrictions on independent mobility corroborates previous research [42], suggesting that the metaverse could play a role in bridging regional educational gaps.

The following suggestions can be made for future research and practical applications. Firstly, there is a need for custom, one-to-one interventions aimed at enhancing interpersonal relationships and problem-solving skills in a work setting. Recognizing and addressing the specific needs of individuals with disabilities is crucial. This involves a collaborative effort from their families, coworkers, and superiors. Such interventions should be tailored to the individual, considering the nature and severity of the person’s disability and their specific job requirements. By focusing on personalized strategies that consider the individual’s needs and the long-term sustainability of their employment, we can potentially improve work outcomes and overall quality of life for individuals with disabilities. This, in turn, fosters a more inclusive, resilient, and sustainable workplace environment that can adapt to the rapid changes in the digital era.

Secondly, considering sustainability, we must ensure that workers with disabilities are not marginalized in a labor market undergoing significant transformations due to the Fourth Industrial Revolution. The focus should be directed toward nurturing digital competence, communication, interpersonal, and problem-solving skills. Equally important is creating roles that align with the emerging industrial structure. Participants in this study exhibited a strong interest in innovative jobs (e.g., 3D printing specialists, drone specialists) spawned by the Fourth Industrial Revolution. Thus, concerted efforts are necessary to identify occupations that are resilient against automation and sustainable for individuals with disabilities, and to equip these individuals with the job-specific skills (hard skills) and soft skills necessary for each role. This sustainable approach empowers these individuals and contributes to an inclusive and enduring labor market.

Thirdly, while sustainable, the metaverse-based vocational program used in this study has certain limitations in its applicability to individuals with severe or multiple disabilities. Despite the intention of developing an accessible vocational education program for a wide array of adults with disabilities, we found its application difficult for those with severe cerebral palsy due to accessibility concerns. PC-based metaverse platforms are somewhat more manageable than their smartphone counterparts, but avatar movement still necessitates using a mouse or keyboard. This highlights the urgent need for a universally designed metaverse that is accessible even for individuals with severe cerebral palsy without requiring costly aids such as eye trackers or multiple switches. Furthermore, individuals with severe developmental disabilities may struggle to focus on metaverse-based education for extended periods. This difficulty may be exacerbated for those with impaired verbal communication, highlighting potential limitations of online-only classes. In such cases, a blended learning approach that combines online and face-to-face instruction or direct, in-person classes may be considered necessary. This observation underscores the need for continual improvements in the accessibility and adaptability of metaverse platforms in line with the principles of sustainability and inclusivity.

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