Deliverable 2, Enhancing career decision-making: The role of Virtual reality and immersive aptitude tests in choosing career paths

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1 Problem background

High school students are often uncertain about their career decisions, what to study, or which career path to pursue due to limited exposure to real-world experiences and scenarios and limited knowledge of several professions[1]. Existing career counseling methods, such as aptitude tests, career counselors, and information booklets about specific careers, give theoretical guidance from others' points of view. However, they do not provide immersive or experiential learning to give them a clear idea of what to expect [2]. As a result, students tend to make wrong career decisions without knowing what they are getting into, leading to dissatisfaction, career mismatches, and wasted educational resources[3].

The rapid evolution of the job market and how technology influences people's interests, decisions, and jobs adds complexity to this matter, as many careers grow, change, or become obsolete because of the developments in technology[4]. Students may overlook careers that align with their interests and skills without practical insights into career paths. Existing aptitude tests are wordy, not immersive, and do not give a clear visual of the student's decision as to what might interest them, leading to inaccurate results.

2 Social relevance of tackling the problem

Solving this problem can have positive social impacts. It can improve career satisfaction, as immersive experiences can give more insight into career paths, leading to more informed decisions, as the student can decide based on their experience, their point of view and not others'[5]. Improved career satisfaction can also have benefits for the company/ organization. This will lead to higher retention, better performance, and increased profitability. It can also reduce dropout rates, as students will have a better vision of their desired career.

They will be more likely to remain committed to their educational path and studies for their selected career. Solving this problem will result in better workforce alignment and reduced job market mismatches as the students' skills align with real-world career demands. Lastly, it can improve accessibility to

career guidance, as not all schools have proper guidance for future careers. A Virtual reality (VR) system can bridge the gap by offering digital career guidance and interactive experiences.

For many graduates, it is hard to find jobs that align with their degree, for several reasons. One reason in particular being a lack of practical experience in their chosen field. A Virtual reality system with realistic scenarios can help to address this issue. This will assist graduates in gaining more practical experience, resulting in employment that aligns more with their field of study and will decrease underemployment.

3 Literature study of related relevant fields

3.1 Introduction

Career decision-making is a big challenge. Many graduates work in unrelated fields and many experience job dissatisfaction. Traditional career guidance methods, like aptitude tests and counseling, often fails to provide realistic job insights, leading to mismatches between education and employment. This mismatch increases dissatisfaction and lowers productivity. Virtual Reality is a promising solution and enables immersive career simulations, potentially improving career decisions. This literature review examines existing research on job satisfaction, existing career exploration tools, and immersive technologies to address the research gaps, leading to a potential immersive career exploration tool to improve workforce alignment and job satisfaction.

3.2 Job satisfaction and productivity

Job satisfaction is a multidimensional concept reflecting an employee's subjective evaluation of their work experience, encompassing contentment, fulfillment, and happiness derived from their role and attitudes toward pay, supervision, tasks, co-workers, and work environment. Job satisfaction is extremely important, leading to higher retention, productivity, engagement, and discretionary effort. For organizations, it improves performance and profitability [6].

This project can enormously impact job satisfaction, as the current rates are very low. A survey states that only 46% of employees are satisfied with their careers and that companies must reduce the gap between expectations and reality of the workforce. It also showed that employees unhappy with their company's growth are 3x more likely to actively seek jobs elsewhere. Employers and organizations that offer personalized career paths, internal mobility programs, and skill-building opportunities experience higher retention and engagement. Some organizations use AI-driven tools to help employees with opportunity growth and skills-based hiring and promotions, leading to higher job satisfaction rates [7].

A more recent survey indicates a few job satisfaction statistics. This is aimed at US employees, where only 65% are satisfied with their jobs. The top factors

in their job satisfaction were pay and benefits, work-life balance, career growth, and relationship with the manager. Happy employees are 12% more productive and 65% less likely to quit, which is good for the economy and the company, as companies with high satisfaction have 21% higher profitability [8]. Work-life balance and career growth factors match what this project aims to approach, as the employees will have a clearer idea of what they can expect in the real world.

Not all graduates use their degrees, and they work in fields different from what they studied for. Based on a recent study in 2024, only 27% of college graduates work in a job directly related to their career, whereas 26% work in unrelated fields [9]. Another study done in 2023 indicates that 33% of graduates work in unrelated fields [10]. Science, technology, engineering, and mathematics (STEM) graduates are more likely to work in their field compared to other majors, such as humanities or liberal arts. Job market demand, salary differences, and career flexibility influence these statistics. Many graduates value their degrees. However, many end up in unrelated careers due to economic shifts or personal interests [9], [10]. The repetition of high percentages in several studies indicates that there is a problem and that many graduates work in jobs different from their field of study.

Another example, explicitly aiming at South Africa, News24 states that many graduates get employed, but their degrees and jobs don't align. Many employed graduates are in roles that do not utilize their qualifications, leading to underemployment. The reason for this is limited job opportunities in specific sectors and the lack of practical experience to contribute to the mismatch [11]. Hence, a VR system can be beneficial to address practical experience gaps, leading to more employment that aligns with graduates' study fields.

Additionally, a study on whether recent college graduates find suitable jobs indicated that recent graduates aged 22 - 27 face higher unemployment and underemployment compared to graduates. They also state that the labor market struggles for new graduates to find a good job, and job quality has declined since 2000. Underemployment rose from 34% in 2001 to 44% in 2012. Resulting in students adjusting their majors to the job market. Policymakers and educators should address mismatches between skills and job demands [12]. Once again, this leads to the need for this VR system to assist students in career selection and to gain experience through the scenarios.

Lastly, the last study was about job satisfaction, underemployment, and career mismatch among college graduates. This study's results show that approximately 48% of unemployed US college graduates work in jobs that do not require a degree. Underemployment has worsened over time, and it is predicted that by 2020, the US will produce three college graduates for every job requiring a degree, increasing underemployment. One of the causes of underemployment is a lack of skills or experience in the field. Underemployment results from job dissatisfaction and career mismatches due to differing interests, economic pressures, and policy critique. The highlighted factor is differing interests, as some graduates choose non-degree jobs for lower stress or personal fulfillment, resulting in them not using the skill learned in their degree [13].

3.3 Career decision-making challenges and counseling

Students, in general, are unsure as to what they must study and which career field they must choose. Hence, they complete aptitude tests, but how effective are they? A study at three Eastern US colleges assessed how aptitude and interest scores from their first year related to their final year. Results concluded that aptitude tests and interests alone cannot predict significant satisfaction. More information is needed. However, 25% of all the participants were not satisfied with their major. Students also have mismatched aspirations, as students preferring some majors had lower relevant aptitude scores than some other majors, which suggests unrealistic expectations [14].

College/university dropout rates are influenced by a variety of factors, including differing interests and dissatisfaction with majors. In South Africa specifically, incorrect career choices and inadequate academic support are big contributors to dropout rates [15]. Many students pursue the wrong career fields or studies, that does not align with their interests, passions and strengths, that increases the dropout rates. World-wide, dissatisfaction with study majors, come from a lack of understanding of the chosen fields [16]. Based on a 2005 report, only 22% of 120 000 students graduated in the specified three years, 50% dropped out in first, second or even third year. This dropout rate cost the National Treasury R4.5 billion in grants and subsidies, without receiving any money in return [15].

Students often lack clarity about their career aspirations, leading to uncertainty and poor decision-making. Research shows that career uncertainty is linked to higher college dropout rates and lower wage attainment [1]. Their psychological well-being is also impacted negatively, as the uncertainty leads to stress and anxiety [1]. This uncertainty causes many to have less career stability, as they constantly switch jobs, hoping to find the right one to match their interests and needs [2]. Many young adults struggle with having clear occupational goals, exacerbated by inadequate access to mentors and resources [1].

Without accurate self-assessment or guidance, students may adopt a trial-and-error approach to career choices, prolonging dissatisfaction [2]. The indecisiveness can break confidence and perpetuate cycles of underemployment, as seen in studies and the above discussion regarding career uncertainty, dissatisfaction, and unstable employment [1]. Comprehensive career counseling that combines aptitude tests with mentorship and workplace exposure is critical to bridge these gaps and align students' aspirations with viable pathways.

3.4 Virtual Reality in Career Exploration

In 2024, Dasculu et al. explored the effectiveness of VR counseling through gamified scenarios by using VR headsets. The results have shown that many students envisioned themselves practicing in the explored careers. Over 76% of the participants linked the VR experience to future career choices. Students provided positive feedback and found the system not only useful but entertaining as well. This study highlighted the potential of VR as a tool for career exploration

and helping students engage more with the process of career decision-making by using the immersive nature of VR[17].

Another study examined the effects of Occupational VR through 360-degree videos, focusing on job interest. This study used stand-alone mounted displays to present realistic, immersive simulations of different careers. The results indicated a significant increase in job interest after exposure to the career by using these VR systems. The feedback from users was extremely positive, with participants stating that they have a better understanding of the job roles presented, as well as being more motivated to pursue those careers. The study supports the idea that VR can effectively raise awareness and interest in various professions among young people [18].

A study done in 2019 explored the idea of "Immersive job taste" to help young job seekers explore potential careers. The study's target audience was young job seekers, which included high school students and unemployed individuals aged between 18 and 25, with 70 participants and 45 various professionals who took part. The study aimed to provide participants with graphic presentations of occupations, incorporating elements of workplace training and real-world scenarios to help job seekers make informed career decisions. The results showed that the VR experience helped participants explore and better understand different professions. Both the job seekers and the welfare professionals gave positive feedback, mentioning that the immersive simulations were engaging and informative and boosted the participant's confidence in approaching career decisions. The study concluded that VR is a valuable tool to help young job seekers explore career options and gain insight into tasks and challenges associated with these jobs [19].

3.5 Augmented reality for skill training and education

Augmented reality (AR) is increasingly used for skill training and job interview simulations to prepare employees. This offers immersive, hands-on experiences that enhance learning and performance. AR significantly benefits both trainees and trainers when used in skill development programs. AR provides interactive and immersive experiences, allowing users to practice real-world tasks in safe, controlled environments [20]. A significant advantage is that it allows for real-time feedback, which enhances retention, leading to faster skill development [21]. AR-based training can lead to more rapid learning curves than traditional methods, especially in technical and procedural domains [22,23].

AR makes complex STEM concepts easier to understand in educational environments by letting students see and interact with them virtually. This makes learning fun and more interesting. It gives the students hands-on practice through virtual labs and engineering simulations [24,25]. AR provides the ability to receive immediate feedback and adjust lessons to fit each student's needs, making it a powerful learning tool [26].

AR reduces company costs by minimizing the need for physical equipment and high-risk training scenarios while ensuring scalable, consistent, and measurable training outcomes. Industries such as healthcare, manufacturing, and

aviation are already using AR to simulate scenarios, equipment maintenance, and safety drills [20]. Thus making it a powerful tool to use in modern workforce training to improve companies' efficiency, engagement, and performance. Additionally, AR ensures scalable and consistent training, enabling companies to standardize instructions across geographically dispersed teams [26].

The measurable outcomes of using AR as a training tool make it more appealing. Performance analytics in AR systems allow trainers to track progress, identify skill gaps, and customize learning pathways [26,27]. It creates a physical record and proof of the, making it more authentic. Industries such as healthcare have adopted AR for surgical simulations, where trainees can rehearse complex procedures without endangering patients [28]. Even in corporate environments, AR is used for soft skills development, including job interviews and leadership training [29].

A study that explored the impact of AR on perceived learning effectiveness, emphasized the role of cognitive load. The results of this study indicates that VR enhances technology's accessibility and quality, especially with learning tasks. Reflective thinking that is supported by accessible and high-quality VR, can improve learning outcomes. However, cognitive overload influences this negatively. A lower cognitive load supports the effect of reflective thinking, but excessive cognitive demands decreases learning effectiveness [30]. The importance of having easy, user-friendly VR tools for educational purposes to optimize learning without overwhelming the user, is emphasized in this study. The insights of this study suggests that VR as an educational tool's benefits depend on balancing immersion with manageable cognitive demands [30]. This can be seen as a recommendation to prevent bias against non-technical students, by designing simplified learning versions.

3.6 Existing Career exploration tools

Several studies and projects explore how VR influences people's decision-making and career choices. However, VR systems are not used in many education areas due to the high costs of required technologies [31]. Virtual reality for career exploration provides VR-based simulations to help users experience job-related activities, and aptitude tests are used to personalize career recommendations. This already makes career guidance more engaging and practical [17]. Other studies indicate that VR enhances students' interest in STEM by providing the expected experience in the industry. This emphasizes how interactive learning in VR can alter career preferences [32].

Augmented Reality is also used for skill training, which helps students develop hands-on skills and provides previews of jobs, and it offers 3D scenarios, which enhances decision making [20]. Many tertiary institutions use VR for teaching and learning, for students to learn concepts and scenarios they might experience in the industry without facing any consequences if they make mistakes [31]. Lastly, Web-based career exploration tools such as MyNextMove and CareerOneStop provide career recommendations based on interests and skills by

using aptitude and personality tests, which helps with career exploration ideas but lack immersive learning that VR will provide [33], [34].

Some studies indicate that more than just an aptitude test is needed to determine career counseling; it is also necessary for someone to truly know their interests and which career to choose that aligns with them. Some relation exists between aptitude tests (e.g., Differential aptitude tests) and intelligence tests (e.g., Standard Progressive matrices). These tests must be combined to determine career guidance, as the study indicates no correlation between some DAT subtests and IQ. For example, high IQ did not influence Educational aptitude or abstract reasoning. However, the DAT measured distinct abilities, supporting its use alongside IQ tests for career counseling. Resulting in the combination of interest and personality tests that can enhance career guidance [35].

Based on an experimental study comparing different test formats, results indicate that candidates have mixed preferences for immersive media [36]. To determine the results, the first study compared text-based, 2D animation, 3D animation, and live-action videos in their tests. The candidates reacted more positively towards the immersive formats, with the live-action video ranking the highest in realism, engagement, and organizational impressions. They suggest that increased media richness can positively influence candidates' perceptions of assessment processes and is recommended to be incorporated into tests [36]. However, the second study presented a more nuanced perspective. Their study confirmed that immersive elements improved technological sophistication, but they found no significant differences in broader outcomes, such as overall satisfaction or procedural justice perceptions across different media types. [37].

Both studies suggest that immersive media can enhance users' perceptions, but the choice of media should balance practical considerations, like cost and development resources. Live-action video seems to be particularly effective, but the simpler immersive elements can also offer benefits without compromising assessment quality. Some limitations to traditional career tools enhance student's challenges in career decision-making.

3.7 Aptitude test mechanisms used

Most aptitude test algorithms and formulas are private; however, several methods exist to determine the results of these tests. Methods that can be used include weighted scoring, factor analysis, and cluster analysis.

Weighted scoring model The weighted scoring model is a decision-making tool used to evaluate and prioritize options based on multiple criteria. Each factor criterion is assigned a weight reflecting its importance, and each option is scored against this criterion. The weighted scores are summed to produce an overall score for each option, enabling objective comparison and ranking [38].

Factor analysis Factor analysis is a statistical method used to identify underlying latent variables or factors that explain the patterns of correlations among

observed variables. It reduces the dimensionality of data by grouping correlated variables into smaller factors, making it easier to interpret complex datasets [39]. Example of output from formula to analyze and determine results in 1 down below. The default layout is the table with numerical values and no colors; however, color can be added, like in the figure below, to improve readability.

	PC1	PC2	PC3
Price is prohibitive	0.49	-0.16	0.13
Overall implementation costs	0.41	0.38	0.14
We can't reach a consensus in our organization	-0.03	-0.07	0.57
Product is not consistent with our business strategy	0.01	-0.03	0.45
I need to develop an ROI, but cannot or have not	-0.06	0.17	0.62
We are locked into a contact with another product	-0.21	0.08	-0.27
The product benefits don't outweigh the cost	0.68	0.06	-0.27
We have no reason to switch	-0.07	-0.77	-0.25
Our IT department cannot support your product	0.00	0.38	-0.25
We do not have sufficient technical resources	-0.21	0.58	-0.12
Your product does not have a feature we require	-0.40	0.05	0.08
Other (please specify)	-0.50	-0.06	-0.10

Fig. 1. Example of table output of factor analysis [40]

Cluster analysis Cluster analysis is a group of unsupervised machine learning algorithms used to partition a dataset into clusters, where objects within a cluster are more similar than those in other clusters. It is used for various fields of exploratory data analysis, pattern recognition, and segmentation. Several clustering methods exist, including K-means, hierarchical, mean shift, etc. [41].

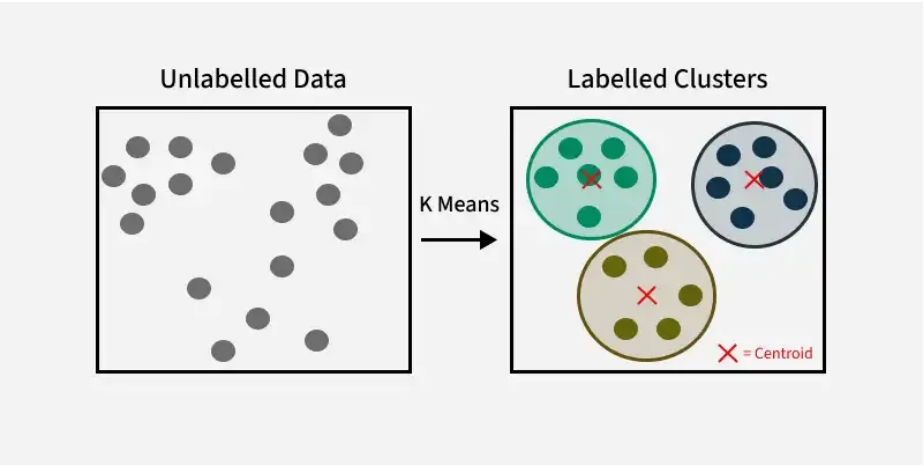

Fig. 2. Example of k-means clustering [47]

3.8 Bias in Virtual Reality

With everything in life, there is bias. However, studies show that VR can help mitigate bias through embodiment and perspective-taking. For example, Wu and Chen (2022) found that gender bias decreased when participants embodied opposite-gender avatars [42], while another study showed reduced racial bias after embodying outgroup avatars, with implications for fairer decision-making in high-stake contexts. These findings align with robust empirical evidence demonstrating VR's efficacy in bias intervention [43]. Another study done by Crone and Kallen (2022) revealed that immersive VR perspective-taking where participants embodied gender-incongruent avatars significantly altered STEM hiring preferences. With men favoring female candidates after virtual embodiment [44].

Similarly, Baker's (2020) research highlights VR's capacity to amplify behavioral and psychological markers of bias. For example, heightened risk aversion in high-threat simulations provides a measurable framework for bias assessment [45]. Further extending these insights, more research demonstrated the VR's utility in occupational therapy training, where 97.92% of students reported improved bias detection after immersive scenarios [46]. Together, all this research demonstrates VR's dual role in measuring and reducing biases, suggesting its potential for applications like career exploration tools, where users could immersively experience diverse professions to reshape perceptions.

3.9 Challenges with VR Systems

Some challenges of using VR systems for immersive career exploration include the cost of VR equipment as 1 set's cost can range between $299 and $3499, based on 2024's prices, which can be viewed in 3 below, where the prices of VR sets per brand has been compared [48]. These costs can limit accessibility and

further restrict the use thereof. There are also privacy concerns, as collecting data such as biometric tracking creates skepticism and doubt among users. VR users can experience several issues, such as motion sickness and eye strain from the headsets [49].

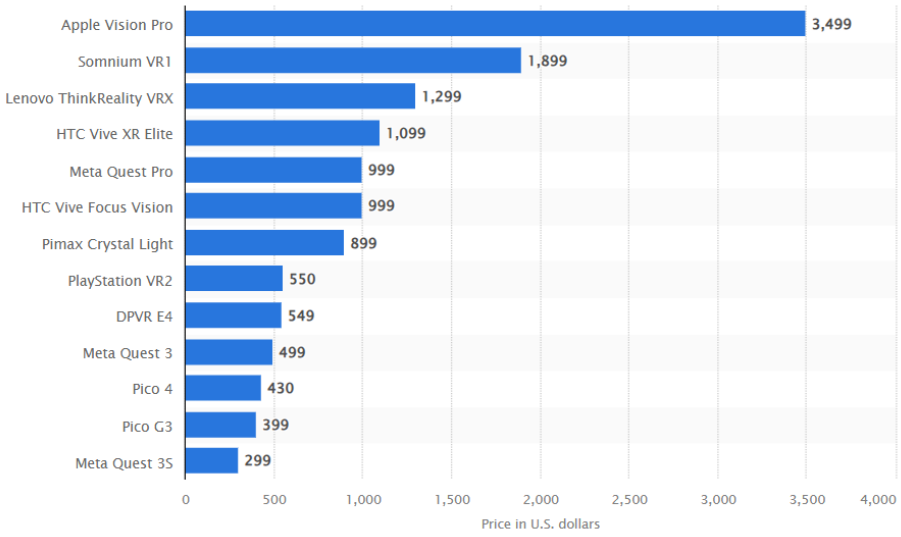

Fig. 3. Virtual Reality headsets cost worldwide[48]

On the technical side of VR, there are several limitations. These include hardware limitations, as a strong device is needed to run the software. More challenges include power and battery constraints and the need for high-speed internet and low-latency networks to ensure seamless performance. Some security risks, such as vulnerabilities in biometric data and past data breaches, underscore the need for robust legal and regulatory frameworks [50]. Health and safety concerns include physical discomfort and psychological effects from prolonged immersion [49]. Lastly, the market barriers, high costs, lack of demand, and the complexity of designing the intuitive interfaces further slow VR's growth [50].

Another challenge to consider is the potential of cognitive overload, as discussed in section 3.5 above, aimed at the fact that VR systems can be complex and cognitively overloading, cost-effective, and overwhelm the user, potentially causing them to disengage from the system.

These challenges must be considered when developing this system to ensure a safe, secure, and cost-effective system.

3.10 Summary of gaps in research

Integrating VR technology into career exploration is gaining momentum, with existing research showing that immersive exploration is useful and entertaining. It also boosts the user's confidence to make more informed career decisions. This leads to an increased interest in immersive career exploration. The lack of sources for immersive career exploration indicates the research gap, as it is new, and there is not much research. There are no sources regarding immersive aptitude testing and career exploration, leading to this gap that needs to be addressed.

The fact that existing aptitude formulas and algorithms are private does not identify a gap. However, existing methods can be expanded and developed further to ensure the correct method is used to calculate the best and most accurate results for aptitude tests and career recommendations. Some studies indicate that immersive aptitude tests enhance the user's perceptions. However, the results don't differ much from text-based tests, and candidate satisfaction or decision-making quality remains the same. Perhaps this can identify a potential gap, as immersive aptitude tests can potentially result in better decisions, as they can visually see the choices they make, and there are not many immersive aptitude tests that can support this gap.

This research field is very new, and there are not many official research papers for some sections. Thus, many of the sources are not official academic sources. This can also indicate a gap in the research market for this topic. However, the content and points discussed are more credible due to several of these articles and sources containing very similar content, statements, and conclusions.

3.11 Conclusion

This review highlighted the critical challenges in career decision-making, where traditional methods like aptitude tests fail to provide realistic job insights, resulting in many career mismatches and job dissatisfaction. The evidence shows that immersive technologies offer significant potential to transform career exploration through experiential learning and realistic job simulations. While existing research demonstrates VR's effectiveness in enhancing career awareness and decision-making, gaps remain in integrating aptitude assessment with immersive experiences. A VR-based career exploration tool combining aptitude and psychometric testing with realistic job simulations could bridge these gaps. Hoping that this will result in better career alignment and improved job satisfaction.

4 Similar systems identified

4.1 Existing aptitude test systems

Many aptitude test systems exist, with different variations of aptitude tests, such as career tests, psychometric tests or Differential aptitude tests. Each delivers different questions and yields different results.

Deloitte Immersive test simulates real-world scenarios where students can practice difficult interactions in an environment with no risk. Unlike traditional aptitude tests, immersive learning captures dynamic behavioral responses, including nonverbal cues and decision-making under pressure, offering a more holistic evaluation of human capabilities. These technologies have limitations and challenges, such as scalability, standardization, and ethical concerns regarding biometric data usage. [51].

More aptitude systems include CareerOneStop and MyNextMove, as discussed above in section 3.6. Additionally, another existing aptitude test system is Truity. Truity offers Career Personality Profiler Tests, which are designed to help users understand their personality traits and how they relate to potential career paths. These tests analyze results and provide personalized career recommendations, highlighting the user's strengths, preferences, and potential job matches that align with his/her personality. It also offers insights into the potential job's team dynamics and potential professional challenges in that workforce. Truity is free to use, but only to receive limited results. The user can pay to view more detailed results [52]. Truity seems like a reliable career exploration tool and has a 4.9-star rating [53]. However, it lacks in immersive interactions and questionaires, as well as immersive career exploration.

4.2 Existing VR systems for career exploration

There are several existing immersive career exploration software that have been developed very recently, such as Transfer, CareerLabsVR, and Meta-vr. Transfr, a company founded in 2017, launched a career exploration program named Transfr Trek in 2023[54]. This company is an immersive software solution designed for students. By using VR simulations, users can experience real-world job tasks and environments from different industries. The platform provides comprehensive career awareness through detailed databases, assessments, and career-matching tools. They also offer career planning resources for users to set and track goals. Additionally, Transfr Trek has an admin dashboard that allows the admin to track the student's progress and analytics. Overall, this system aims to provide equitable access to career exploration, help students make informed career decisions, and build relevant skills for the industry [55].

However, they do not have the aptitude tests or immersive assessments to narrow choices based on the results. This system only has short questions to assist in recommendations for potential careers.

CareerLabsVR offers subscribers a wide range of VR career experiences. This system is designed to give users an immersive experience in hands-on job tasks across a wide variety of professions. Each scenario allows the user to engage with realistic tasks, from operating machinery to troubleshooting systems, providing an in-depth understanding of daily job duties. Overall, the company aimed at enhancing career awareness and skill development through immersive and interactive VR simulations [56].

This system is subscription-based, meaning the user needs to pay to use the service, whereas the study is aimed at students, resulting in it being free. It

also lacks immersive aptitude tests or assessments to help narrow career recommendations that might interest the user, which can still lead to uncertain career decisions, as the user might find a scenario "cool", but not guidance as to whether it falls within their strong field or interest. Hence, the immersive aptitude test is needed.

Meta VR leverages VR to help job seekers explore various careers by simulating professional environments. Users can virtually step into different workspaces, engage in real-world tasks, and interact and interact with simulated colleagues through an interactive VR System. This technology offers a hands-on approach to career exploration, allowing individuals to practice technical skills and make informed decisions. By providing access to diverse professions and the ability to experience real-world job tasks without any risks or time commitments of traditional methods, Meta VR enhances engagement and decision-making for job seekers [57].

This system offers a free trial for 1 month, so the user needs to pay for the service, which results in the same downside as CareerLabsVR. Also, do not offer tests.

5 Novelty of proposed system

Algorithm used, adapted? Immersive aptitude test Exploration of careers immersively No such system exists that provides all the features

6 Conclusion

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