VR SERIOUS GAMES FOR SPECIAL NEEDS EDUCATION ON LIVING SKILLS TRAINING

Yiyu Cai[1], Qi Cao[2]

[1]*Nanyang Technological University (SINGAPORE), email: myycai@ntu.edu.sg*
[2]*University of Glasgow, Singapore Campus (SINGAPORE), email: qi.cao@glasgow.ac.uk*

Abstract

There are many challenges in their learning journey for children with special needs. Prior research shows that Virtual Reality (VR) can be used as a teaching aid for children with special needs. With the aid of VR, it is possible to construct a virtual environment with various objects to replicate real-world trainings. Serious games assisted learning is getting popular in special needs education. The use of the serious games with VR can provide realistic rendering and interaction to players. Although it cannot entirely replace the physical intervention trainings, VR serious games provide complementary ways of training lessons at low cost and flexible times. In the research project, we work closely with special needs schools and special needs educators. A series of VR serious games have been developed to train children with special needs on the living skills.

Keywords: Virtual Reality, Serious Games, Special Needs Education, Living Skills.

1   INTRODUCTION

Some of children with special needs may suffer from developmental delays in areas of cognition, social skills, and so on [1], [2]. Depending on the seriousness level, some of them tend to have social difficulties [3]. Many of them may have difficulty in handling their daily life situations [4], in understanding emotions of people around themselves, in communicating to people socially [5], [6], and having attention abnormalities [7]. In addition, some children with special needs may encounter difficulty on learning new knowledge, on retaining information in memory, on processing multi-tasks, etc. [8]. Mastering basic vocational skills and housework are also challenging for some of them [9]. They may need a lot of attentions and cares from their guardians or parents before they gain independent living skills.

Prior research shows that learnings of children with special needs could benefit from structured instructions and repetitive practices, using multimodality approach such as verbal instructions, visual representation, etc. [10]. Special needs schools can also provide learning environments and knowledge being taught by special needs educators.

Serious games are reported as learning approaches for special needs education. Virtual reality (VR) is one of enabling technologies for serious games for mimic learning to children with special needs. VR serious games integrate education components providing safe learning environments to encourage enjoyments in the learning process [11]. Virtual learning is helpful to impart their self-independence skills, before practicing in real environments [7].

In our research project, we work closely with special needs schools and special needs educators in Singapore. A series of serious games have been developed to train children with special needs on some basic living skills. Equipping basic living skills is essential for children to be self-independence. Learning of basic living skills sound easy to most children, but may be tough for those children with special needs. These serious games provide convenient learning approaches for children with special needs for personal hygiene skills, road crossing skills, planning skills, shopping skills, etc. The use cases have been conducted with special needs schools in Singapore to evaluate the effectiveness.

The main development tools for these VR serious games including Unity3D, Autodesk Maya, Autodesk 3ds MAX, Blender, and Photoshop. Interactions between players and VR serious games are mainly implemented with Leap Motion sensing and Microsoft Kinect motion sensing devices. These motion sensing devices detect players' hand gestures and body motion movements as the form of human-computer interaction [12], [13].

2   VR SERIOUS GAMES FOR LIVING SKILLS TRAINING

2.1   Learning Daily Routine Tasks through Serious Gaming

Home is a place that most of children are very familiar with. Children feel safe and comfortable staying at their own homes. It is a good place for children to learn basic living skills, where parents can teach or guide children in the learning of daily routine activities. As children with special needs are usually dependent on their parents or caretakers for their daily activities, these tasks can be challenging when children are left alone. Children with special needs usually need longer training time to acquire and practice such activities independently. In the research work, a virtual home serious game is designed for children with special needs to learn basic daily routine activities [14]. The learning through serious gaming could be encouraging factors for them performing the daily routine tasks independently without helps of their parents. It could relieve the workload of their parents on the caring and guidance.

The story of the serious game happens in a virtual apartment attaching with virtual living room, bedroom, kitchen and toilet. Some daily routine activities commonly happen to children in the morning, such as wakeup by alarm clocks in early morning, brushing teeth, washing faces, making a cup of drink, having breakfast, before going to schools. Playing this serious game, children with special needs can learn how to perform these daily routine activities by themselves. At the beginning, teachers from the special needs school provide guidance to children. After few rounds of practices, children can then perform the serious gaming independently.

Case study has been conducted at a special needs school in Singapore, as shown in Fig. 1. Children enjoy the serious game playing in learning the daily routine activities.

Figure 1. A child with special needs playing "Waking up in the Morning" game scene.

2.2   Learning Shower Taking through Serious Gaming

Shower taking is a routine activity at home. Taking shower is very important to keep good hygiene. Starting from the childcare and kinder garden, children are taught by parents or teachers about hygiene and shower taking. Most children can gradually master the skills on bathing by themselves in young ages. But it may not be easy for children with special need to learn taking shower independently when they are young. There are many overwhelming stimulations when taking a bath of shower, such as the sound of running water in an enclosed area, the water falling on the skin, hair washing with closed eyes, smell of shampoo, etc. There are many objects such as shampoo, shower gel, etc. to be utilised during bathing.

In the research work, a virtual shower learning serious game has been designed to children with special needs [15]. It offers a training tool with step-by-step instructions can help them learn the shower taking steadily. At each step, participants need interact and use various virtual game objects, similar to the real bathing. difficulty levels. Game players can ramp up their learning gradually in multiple difficulty game levels. Children with special needs from another special needs school in Singapore have participated the experiment. Through playing this serious game, they can learn the virtual shower taking skills in the school or at home with the setup of necessary game equipment.

2.3 Learning Road Crossing through Serious Gaming

In modern cities, road and traffics are complicated. Crossing road junctions with zebra lines or traffic lights are common daily activities for residents of big cities such as Singapore. It takes time to learn and understand the traffic signals and rules. Different countries may use different traffic rules and road signs. But traffic lights in most countries are the similar with three colours of red, green and amber. It is a risky for young children crossing roads alone, before they fully understand the traffic rules. It is always necessary to have their parents or caretakers accompanying young children in road crossing. Children can use the opportunities to learn from observing their parents or caretakes on road safety with correct procedures. Road safety education is an essential skills component of teaching children, especially those with special needs to handle traffic situations safely [16]. Serious games with VR could be a safer learning environment for road crossing skills [17].

Figure 2. Crossing a road junction in the serious game.

In the research work, a VR serious game is built to training children with special needs to cross zebra lines and road junctions in the context of Singapore [18]. There are different activities to handle various road crossing scenarios. An example scenario is shown in Fig. 2 with the red standing-man light. The same serious game can be scaled up to other countries by incorporating the corresponding contexts and traffic rules.

2.4 Learning Planning Skills through Serious Gaming

Planning skill is a type of executive functioning for better managing time and resources. It is not easy to be acquired by young children. To achieve good learning outcome, the training on planning skills can be embedded into daily routine activities.

Schoolbags are necessary items to primary and secondary school students in their daily schooling routines. At lower primary schools, the items packing into schoolbags are limited and manageable. When they are at higher primary school or secondary school, the number of textbooks and items increase a lot. The weights of schoolbags become heavier burdens. Depending on the characteristics of children, some of them bring all textbooks and files in the schoolbag every day, while others may selectively bring only the textbooks needed for the day. It is relevant to the planning skill, for only packing necessary items into their schoolbag, according to school daily schedules. With good planning skills, children only bring along the essentials and necessary materials when going to school. For example, there will be no Mathematics lesson on the day, children do not need to place the Mathematics textbook and relevant files into their schoolbags. Such training may need certain time to be mastered by most of children. Children with special needs usually encounter even bigger challenges to build the competency of the planning skill.

A virtual serious game has been designed for children with special needs to learn the planning skills through schoolbag packing independently according to the daily schedule [19]. In this serious game, there is also an optional augmented reality (AR) game scene. AR overlays virtual objects with the real world scenes [20]. It gives different planning experience to children with special needs to collect virtual items scattering in real environment into the schoolbags accordingly.

2.5   Learning Shopping through Serious Gaming

Children are trained on the concept of money and purchasing stuffs, when they step in the primary schools. In the morning break, students in the primary school of Singapore are going to purchase their food at school canteens. It is a good practice for them on the sense of money and trade-in. Purchasing food at school canteens is not a complicated task, as the number of food stalls and food options are limited. But purchasing in the supermarket may be more overwhelmed for children, due to a lot of product, brands, items, racks, etc. as shown in Fig. 3. Parents and caregivers are good instructors to teach children for daily activities like shopping and purchasing necessities. Most of children are able to do the shopping independently after training. However, it is not an easy task for children with special needs, as there is a lot of information to be processed. In a supermarket, products are sorted by their categories at different sections. Children need know how to associate shopping items with their categories. For example, orange in a shopping list is a type of fruit. Children should look for the fruit section in the supermarket, instead of going through supermarket racks one by one.

Figure 3. An example scene in a real supermarket.

In the research, they can learn shopping through a designed virtual supermarket serious game [21]. The serious game generates a random shopping list each time. Children with special needs navigate through the virtual supermarket for all shopping items and put them in a virtual trolley.

3   DISCUSSIONS AND CONCLUSIONS

A series of virtual serious games are introduced for training of children with special needs on the basic live skills. It provides complementary approaches for their learning in different virtual environments. It could be helpful to relax the workloads of their teachers, parents and caregivers in taking care of them daily. The interactive engagement experiences are able to attract the attentions and focus of children. It is also flexible to enable or disable instructions and helps in various learning stages. Exhibiting many advantages of VR serious games, more learning activities or environments may be integrated in. In this research, various experiments have been performed with collaborating special needs schools and institute to evaluate these VR serious games. The results analyses indicate that VR serious games are effective in supporting the learning of children with special needs. Observed from experiments, most participants enjoy playing these serious games. Most of them make notable performance improvement in the learning.

ACKNOWLEDGEMENTS

REFERENCES

[1]   V. Shiri, S. Hoseyni, E. Pishyareh, V. Nejati, M. Emami, E. Shiri, "Is there any correlation between executive dysfunction and behavioral symptoms in autistic children? a systematic review", *Archives of Neuroscience*, vol. 5, no. 2, 2018. DOI: 10.5812/archneurosci.64303.

[2]   Y. Cai, Q. Cao (Eds), "When VR serious games meet special needs education". Series: Gaming media and social effects. Publisher: Springer Nature. 2021. eBook ISBN: 978-981-336-942-9. https://doi.org/10.1007/978-981-33-6942-9.

[3]   P. Mesa-Gresa, H. Gil-Gómez, J.A. Lozano-Quilis, J.A. Gil-Gómez, "Effectiveness of virtual reality for children and adolescents with autism spectrum disorder: an evidence-based systematic review", *Sensors* (Basel, Switzerland), vol. 18, no. 8, 2018. DOI: 10.3390/s18082486.

[4]   C. Schreiber, "Social skill interventions for children with high-functioning autism spectrum disorders", *Journal of Positive Behavior Interventions*, vol. 13, no. 1, pp. 49-62, 2011. DOI: 10.1177/1098300709359027.

[5]   E. Marchi; B. Schuller, et al., "The ASC-inclusion perceptual serious gaming platform for autistic children", *IEEE Transactions on Games*, vol. 11, no. 4, pp. 328 – 339, 2018.

[6]   S. Fridenson-Hayo, S. Berggren S, et al. "Emotiplay: a serious game for learning about emotions in children with autism: results of a cross-cultural evaluation", *European child & adolescent psychiatry*, vol. 26, no. 7, pp. 979–992, 2017. DOI: 10.1007/s00787-017-0968-0.

[7]   Y. Cai, R. Chiew, Z.T. Nay, C. Indhumathi, L. Huang, "Design and development of VR learning environments for children with ASD", *Interactive Learning Environments*, vol. 25, no. 8, pp. 1098-1109, 2017.

[8]   S. Chong, Q. Cao, Y. Cai, "Game-assisted vocational training", In *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 129-142. Springer, Singapore. 2021. https://doi.org/10.1007/978-981-33-6942-9_8.

[9]   L. Walsh, S. Lydon, O. Healy, "Employment and vocational skills among individuals with autism spectrum disorder: predictors, impact, and interventions", *Review Journal of Autism and Developmental Disorders*, vol. 1, pp. 266–275, 2014. DOI: 10.1007/s40489-014-0024-7.

[10]   M. Bennie, "Supporting executive function in children with autism", *Autism Awareness Centre Inc*, 2018. https://autismawarenesscentre.com/supporting-executive-function-in-children-with-autism-part-2/.

[11]   Y. Politis, N. Robb, A. Yakkundi, K. Dillenburger, N. Herbertson, B. Charlesworth, L. Goodman, "People with disabilities leading the design of serious games and virtual worlds", International *Journal of Serious Games*, vol. 4, no. 2, 2017. DOI: 10.17083/ijsg.v4i2.160.

[12]   M. Henry, "Senior project report: MIDI flapper, a Leap Motion MIDI controller", California Polytechnic State University, San Luis Obispo, 2014.

[13]   Z. Zhang, "Microsoft Kinect sensor and its effect", *IEEE Multimedia*, vol. 19, no. 2, pp. 4-10, 2012.

[14]   Y.P.J. Chung, Q. Cao, Y. Cai, "Design of a virtual home for special needs children to learn life skills". In *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 31-61, Springer, Singapore, 2021. https://doi.org/10.1007/978-981-33-6942-9_3.

[15]   S.E.M. Teoh, Q. Cao, Y. Cai, "Learning to take a shower through VR serious gaming", In *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 3-29. Springer, Singapore. 2021. https://doi.org/10.1007/978-981-33-6942-9_2.

[16] T. Self, R.R. Scudder, G. Weheba, D. Crumrine, "A virtual approach to teaching safety skills to children with autism spectrum disorder", *Topics in Language Disorder*, vol. 27, pp. 242-253, 2007. DOI: 10.1097/01.TLD.0000285358.33545.79.

[17] D.R. Dixon, C.J. Miyake, K. Nohelty, M.N. Novack, D. Granpeesheh, "Evaluation of an immersive virtual reality safety training used to teach pedestrian skills to children with autism spectrum disorder", *Behavior Analysis in Practice,* vol. 13, pp. 631–640, 2020. https://doi.org/10.1007/s40617-019-00401-1.

[18] Q. Zhang, Q. Cao, Y. Cai, "Learning to cross roads through VR playing", In: *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 63-75, Springer, Singapore. 2021. https://doi.org/10.1007/978-981-33-6942-9_4.

[19] M.A.B.A. Aziz, Q. Cao, Y. Cai, "Design of a home bag-packing serious game for children with ASD". In *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 143-156. Springer, Singapore. 2021. 10.1007/978-981-33-6942-9_9.

[20] L. Zhu, Q. Cao, Y. Cai, "Development of augmented reality serious games with a vibrotactile feedback jacket". *Virtual Reality and Intelligent Hardware*. vol. 2, no. 5, pp. 454-470, 2020. https://doi.org/10.1016/j.vrih.2020.05.005.

[21] J.H. Goh, Q. Cao, Y. Cai, "Design of a VR supermarket serious game". In: *When VR Serious Games Meet Special Needs Education*. Series: Gaming Media and Social Effects, pp. 177-197, Springer, Singapore, 2021. https://doi.org/10.1007/978-981-33-6942-9_11.