The Importance of Social Competence for Twenty-First Century Citizens
The Use of Mixed Reality for Social Competence Learning in Mainstream Education

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ABSTRACT
This chapter presents the results of a systematic review that investigated the use of mixed reality (MR) technology to assist social competence learning in mainstream education. Social competence represents our ability to interact with others and, therefore, is a key determinant for many of the possibilities that are presented to us across the lifespan. In today’s digital world, MR technology has been widely used in special and inclusive education for social competence training purposes, but has not yet been generally applied to mainstream education. This systematic review bridges this research gap. Findings support (i) the potential for MR technology as a medium for social competence learning activities, and (ii) how the MR approach can contribute to a Universally Designed (UD) learning environment.

Keywords: Systematic Review, Educational Inclusion, Virtual Reality, Augmented Reality, Reduced Inequalities, Soft Skills, Universal Design Learning
INTRODUCTION

Education is constantly evolving, from curricula developments to new approaches to teaching, learning, and assessment. Engaging the utility of one recent development of mixed reality (MR) technology to assist in developing important traits that lend students to personal success (social competence) is indeed novel. However, the authors posit that whilst much of this innovative work has been evident in the area of special and inclusive education, future developments should seek to apply MR to a wider variety of educational and training issues, and, importantly, be developed for wider application to the diversity of learners that we encounter in our work. Therefore, we conclude by advocating that such work be conceptualised and operationalised with supporting evidence.

This chapter explores the use of MR for social competence learning (SCL) in mainstream education with universal design. The initial motivation comes from the reflection of key competencies for 21st-century citizens, regarding how individual configures their world through the application of critical soft skills – collaboration, communication, critical thinking, interaction, creativity, emotional understanding, problem-solving, and decision making. The purpose of this research is (i) to discuss the importance of SCL in mainstream education, and (ii) to understand if MR can effectively assist SCL by reviewing previous studies. Next, we propose a hypothesis for the exploration of other relevant research — on reviewing the evidence we can then substantiate that MR could be an effective tool for supporting SCL in mainstream education. Finally, for ease of legibility, the research journey is set out in the following sections:

(i) Background - Challenges for Education in a Contemporary World
(ii) Theoretical Consideration – Introducing Universal Design and Universal Design Learning
(iii) An Introduction to VR, AR, And MR Technology, and Their Application in Social Competence Education
(iv) Research Gap Identified
(v) Method and Results of Data Analyses
(vi) Discussion – MR-assisted Soft Skills Improvement
(vii) Perspectives of Limitations And Challenges

BACKGROUND - CHALLENGES FOR EDUCATION IN THE CONTEMPORARY WORLD

Education systems are ongoing, being reflective of the changing society that they represent, and incorporating the latest knowledge from applied research. One issue that remains constant in education is the need for individuals to develop and hone their “soft skills”. Thus, it is necessary to review our understanding of soft skills and the social competencies that students need for success - both now and in the future (Kay & Greenhill, 2011). In a busy school curriculum, the development of these skills can become less urgent in the traditional areas of literacy, numeracy, modern foreign language, and science. What is required is a recognition of the increasing demand for one’s social competence as we continue to learn and adapt to various novel situations in life. Such an approach is needed to help the individual to develop social abilities and to cope with new and evolving challenges.

Social competence includes the ability to analyse social situations and enact appropriate responses (American Psychological Association, 2022). It encapsulates the ability to get on with others, to be able to have and maintain close relationships, and to be able to respond in adaptive ways on different social occasions (Orpinas, 2010). Given the complexity of human sociality, social competence covers a wide range of cognitive capacities, emotional and behavioural patterns, social awareness, and personal world values related to interpersonal interactions (Orpinas, 2010). Social competence is a key determinant for success in life, in that it is our social competence that frames our abilities and possibilities, helping us realise our true potential. Where social competence is a curricular outcome, particular skills are required - collaboration, communication, empathy, creativity, critical thinking, problem solving, and decision making (Rodriguez, 2018; Sanabria & Arámburo-Lizárraga, 2017; Wu et al., 2021). Whilst social competence learning (SCL) is a recognised term for this concept, it is not broadly understood in mainstream education.
Education has continually developed since that “…today no organization can achieve results without incorporating technology into every aspect of its everyday practices. It’s time for schools to maximize the impact of technology as well” (p. 2). Technology has become a necessary part of students’ learning experiences (Yoo, 2020) and is a powerful tool for students to engage with educational activities in a digital society (Young et al., 2020). Given the innovation and uniqueness of MR technology and its increasing implications in our twenty-first century digital society (Young et al., 2020), MR technology can present many opportunities for continuously changing learning environments. Thus, educational practitioners, stakeholders, and students need to engage with and harness these digital representations effectively (Niemi & Multisilta, 2016), and they also need to apply them to SCL. MR-assisted SCL has the very potential to enhance current educational approaches. If they are to develop the requisite skills for success in life, educators and students alike will need to embrace such innovations if they are to meet twenty-first century expectations.

THEORETICAL CONSIDERATION – INTRODUCING UNIVERSAL DESIGN AND UNIVERSAL DESIGN LEARNING

There is a recognised and accepted need to enhance the learning experiences that we provide for students. The simultaneous increase in engagement with different technologies among students makes it increasingly apparent that the learning environment itself needs retrofitting and redesigning. The concept of special and inclusive education has contributed constructively to the idea of retrofitting traditional education environments, as they continue to evolve from segregated to congregated education spaces that seek to be inclusive and representative of the variability that we find in terms of “ability” and “disability”. To some extent, these philosophical and practical advances have resulted in decisions and adaptations that enable learning for all students, where once such changes were an “add-on” to the curriculum (e.g., a spell-check function on a computer). Contemporary learning experiences and pedagogical practices need to continue to move beyond what was done in the past - if there is a sincere wish to achieve the targets for “inclusion” that have been espoused in the United Nations Sustainable Development Goals (e.g., Goal 4: Quality Education; Goal 10: Reduced Inequalities).

However, despite the ongoing developments that seek to embrace inclusive education theories, inclusion in education still largely operates from a deficit viewpoint (Braunsteiner, & Mariano-Lapidus, 2014) – focusing on the learner’s real or perceived impairment and not on what could be attained with the correct approaches and supports. Such developments include the acceptance of new ways of engaging in pedagogical practice, and embracing everything that technology and its innovations can offer in a truly contemporary environment. The corollary of this is that, if educational practitioners and policymakers aim to develop SCL in a meaningful and engaging way, it is time to rethink “new ways of doing things”. Technologies have been continuously adapting and delivering SCL in special schools and inclusive educational environments (e.g., special classes) through specific educational modules. However, this is not the approach in mainstream education, even though it is a powerful teaching and learning innovation that could be used to deliver SCL to all our future citizens. When considering this dilemma, we argue that Universal Design (UD) thinking and Universal Design for Learning (UDL) approaches can present a useful solution. Such a solution would design such approaches from the “get-go” and be applicable to the “universality” of learners and the individual differences that every educational setting represents.

Universal Design is about ensuring that change or accommodation is considered from the very outset, i.e. at the inception stage of any ideas and moreover that we need to be aware and considerate as we make inclusive changes (Quirke, McGuinness & Mc Carthy, 2022). Such an approach means “designing for a universality” resulting in greater autonomy for the great diversity of people that make up humankind (Story et al., 1998). Influenced by UD thinking, UDL was developed by CAST in the USA as a pedagogical approach (CAST, 2018), and has been increasingly applied to the broad landscape that makes up learning environments. UDL demands consideration of inclusion and difference from the get-go (Quirke et al, 2018, Quirke & Mc Carthy, 2022). Revisiting the origins of UDL thinking may make it easier for many pedagogues to embrace technological innovations. They can then appreciate the mindset necessary to embrace change in the learning environment and how
technological innovation such as MR can enhance SCL for a wider diversity of students. Technological innovations, including MR, have the potential to enable learners to experience, feel, and realise traditional curricula in new ways and moreover, engage with new curricula such as SCL in meaningful ways.

So how and why do we consider technology assisted SCL using the experience of UDL and inclusive practice? Using the approach as espoused in “Inclusion as Process” (Quirke et al. 2022), the authors of this chapter propose:

● Be solution focused with a difference - anticipate a diversity of needs while respecting we must engage all in the “design” process, most especially our teachers and educational leaders. Everyone must have an input.

● Seek workable solutions for all involved - for the universality of people in our learning environments and society. The output needs to work for all.

● Are respectful of all approaches as MR, SCL, and UDL require interdisciplinary and multidisciplinary thinking - such thinking necessitates an appreciation of different terminologies, language, an appreciation of different theories - while recognising the shared commonality in terms of making the world a better place.

● Recognise that such innovations, when grounded in “Inclusive thinking”, can offer added value in the learning environment - they are a new and fast way to learn how to problem solve, shorten the cycle of learning – and moreover offer an exciting and engaging learning experience for a wide diversity of learners.

More importantly, the development of SCL in mainstream education is in direct response to social and active inclusion policies and inclusive education policies. On the other hand, with the rapid development of immersive technology, MR has been widely used in education and has a great potential to change communication, collaboration, and the future of the workplace. Therefore, moving this curriculum onto MR platforms, including virtual reality (VR) and augmented reality (AR) while being considerate of designing for inclusion, means that learning can be very real if we are to strive for true inclusion both in education and society.

AN INTRODUCTION TO VR, AR, AND MR TECHNOLOGY, AND THEIR APPLICATION IN SOCIAL COMPETENCE EDUCATION

The Concept of VR and the Sense of Being There

VR is a technology that integrates computer graphics, visual presentations, motion taking, and sensor devices to serve users with a visual multi-sensory experience and a realistic simulated setting (Maples-Keller et al., 2017). It is a highly immersive technology that disconnects users from the surrounding reality. With the continuous improvement of computer-generated graphic technology, the virtual environment has been created as a replacement or extension of the physical world, allowing users to look in any direction and content in a 360-degree space. Moreover, VR can generate a “sensation of being there” in remote places that are displayed by advanced immersive technology, i.e., self-location and action possibilities can be distinguished. In doing so, spatially presented VR can provide users with vivid experiences of being situated in a virtual space and being able to connect with the virtual environment (Hruby, 2019).

The Concept of AR and the Enhanced Physical Experience

AR is a newer technology than VR. It can be defined as a later technological system in which virtual objects are combined with the real world for users’ real-time experience (Cipresso et al., 2018). It incorporates four systems: real environment, AR, augmented virtuality, and virtual environment (Milgram & Kishino, 1994). An AR system usually includes a combination of real and virtual objects in a real environment — a system running interactively and in real-time as well as the integration of the real and virtual objects. Technically speaking, although the AR system contains various elements, it usually exhibits three common components: a geospatial datum for the virtual object (e.g., a visual
marker), the surface to project virtual elements to the user, and the process of merging graphics and animation (Cipresso et al., 2018). It is a technology that aims to enhance parts of users’ physical world experience with computer-generated input.

**MR-Assisted Social Competence Education**

Simply put, VR immerses users into a simulated real world, while AR enables virtual objects to be superposed in the real world. MR is an authentic setting that facilitates users’ interaction with virtual experiences (Maas & Hughes, 2020). It has been recognised as one of the most promising technologies for next-generation mobile platforms (Zhan et al., 2020). The growing development of VR, AR, and MR technologies can be used simultaneously and contribute to an all-in-one reality framework; that is they can be used independent of each other or evolve into a mixture. MR simulates and interacts with the real world, empowering people to get the most realistic perception of reality in these different integrated systems. Given that this phenomenal advancement is rapidly developing in many ways and increasingly links our reality to the digital world; by focusing on the opportunities the integration of VR, AR, and MR technologies offers learning, we can realise a broader opportunity MR-assisted pedagogy offers across all aspects of education (Zhan et al., 2020). For example, MR has been applied to support social skills teaching and learning activities for clinical interventions and special education (Wang et al., 2021). MR-assisted SCL is a strategic combination of delivering social knowledge (e.g., social skills training, collaboration and communication, empathy fostering, creativity, critical thinking, and problem solving) within a diverse digital environment (e.g., VR and AR). Recent research has demonstrated that both VR and AR generate realistic and credible scenarios and interactive settings so that people can behave and respond in undifferentiated ways within their environments from what they do in the real world (Howard & Gutworth, 2020; Maruhn et al., 2020). Consequently, it allows students to acquire social skills in a safe, realistic simulated, controllable, and interactive setting and practice their acquisitions in real life.

**Research Gap Identified**

Social competence is a vital part of human development necessary at all stages of the lifespan, instead of only a necessity for individuals with additional needs (American Psychological Association, 2022; Junge et al., 2020; Ma, 2012; Orpinas, 2010). It encompasses complex competencies and plays a critical role for individuals in accomplishing positive developmental outcomes (Wang et al., 2021). When conducting SCL, well-designed MR applications simulate real life conventions and human interactions to support users to have a better understanding of emotional and behavioural patterns (Fagernäs et al., 2021; Pan & Hamilton, 2018).

Emerging studies have highlighted that MR-assisted SCL has been increasingly used for either individuals with physical disabilities, or with mental illnesses in the field of special education (Shema-Shiratzky et al., 2019; Susindar et al., 2019; Wallace et al., 2017), nevertheless, little research focuses on SCL and/or social skills training in mainstream education or social competence programs for individuals without additional needs. Due to these existing issues, this systematic review aims to bridge the research gap and provide systematic information for future studies.

**METHODOLOGY**

**The Necessity for Conducting a Systematic Review**

A systematic review rigorously reviews and sorts the data, formulating evidence and questions clearly and using explicit methods to identify, select, and critically evaluate (O’Brien & Mc Guckin, 2016). Given that the researchers have identified a lacuna between MR technology and SCL in mainstream education after a range of database pre-searching, we utilised a systematic review approach to explore highlighted hypotheses and bridge the research gap. It is a valid way to identify relevant studies and assess their quality and reliability.

**Searching Strategy**

This study used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model (Moher et al., 2009). The following keywords derived from our research questions were
employed for the systematic searching: (i) mixed reality, (ii) social competence, and (iii) education. Relevant synonyms are also identified to enrich the search string — virtual reality, augmented reality, extended reality, VR, AR, XR, social, social skills, and educational. Finally, the Boolean "AND" has been used to concatenate keywords, while the "OR" operator has been used to connect synonyms. All searches were completed by 01/04/2022.

**Databases**

In accordance with the interdisciplinary nature of this study, the selection of databases were those that were related to fields of education, psychology, and technology. Hence, the following eight databases were selected: EBSCOhost, Scopus, PsycInfo, ACM Digital Library, IEEE Xplore Digital Library, ProQuest, Web of Science, and Google Scholar. Since Google Scholar is a platform used to broadly search scholarly literature across a wide variety of disciplines and sources, it was also chosen to work as a complementary tool to retrieve further research.

**Searching Strand and Preliminary Searching Results**

The searching strand used in our research was the following: “mixed reality or virtual reality or augmented reality or extended reality or MR or VR or AR or XR AND social competence or social AND education or educational”.

Preliminary searching results were:

- 17 studies were retrieved by EBSCOhost (2010 to present),
- 20 studies were retrieved by Scopus (2010 to present),
- 250 studies were retrieved by ACM Digital Library (2010 to present),
- 23 studies were retrieved by IEEE Xplore Digital Library (2010 to present),
- 16 studies were retrieved by ProQuest (2010 to present),
- 1 study was retrieved by PsycInfo (2010 to present),
- 1 study was retrieved by Web of Science (2010 to present),
- 114 studies were retrieved by Google Scholar (2010 to present).

**Criteria of Selection**

Based on previous successful experience, the research harnessed the inclusion criteria and exclusion criteria from the study *A Systematic Review of Virtual Reality Interventions for Children with Social Skills Deficits* (Wang et al., 2021) to develop the scope of final selection. As a result, studies were selected and reviewed if they met the following requirements:

- Studies published in the last twelve years – between 2010 and 2022
- Discussing MR applications
- Targeting the use of MR technology to assist SCL in mainstream education
- Educational activities include discussions on human sociality and social skills
- Written in English

Meantime, research was excluded if studies were in accord with the following criteria:

- Research focuses on using MR to assist special education and/or clinical intervention
- Targeted groups are individuals with special needs
- Research mainly focuses on MR software/platform development and with little discussion and contribution to human development
- Research with a poorly structured methodology or without explicit findings
- Documents cannot be downloaded from the university library portal or are not open access sources
Searching Results

The preliminary retrieve resulted in 442 studies. Next, the first round of screening was implemented to remove duplicated research, which resulted in 124 compliant studies. After excluding studies written in languages other than English, retrieved records listed 112 manuscripts. Then the researchers conducted the third round of eligibility review, 91 studies were ruled out since they did not have a structured methodology, robust discussion, and/or validated evidence. Finally, 21 manuscripts were given an in-depth review and detailed analysis in this systematic review (Figure 2 & Table 1).

*Figure 1. PRISMA searching diagram.*
<table>
<thead>
<tr>
<th>Number</th>
<th>Authors, Year</th>
<th>Types of Research</th>
<th>Sample Size</th>
<th>Gender Identity</th>
<th>Average Age</th>
<th>Types of SCL</th>
<th>Types of VR</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Young et al. (2021)</td>
<td>Empirical study</td>
<td>20</td>
<td>M=11, F=9</td>
<td>34.1</td>
<td>Perspective-taking, mediated-empathy, VR empathy, and social empathy building.</td>
<td>VR</td>
<td>VR production techniques could successfully deliver empathy-driven materials. VR provides safe and repeatable environments for students to learn social skills. However, VR education needs to be further investigated via long-term practice.</td>
</tr>
<tr>
<td>2</td>
<td>Ip &amp; Li (2015)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Collaborative learning, communication skills, and problem-solving.</td>
<td>VR</td>
<td>VR and AR system may create a more cooperative environment and also helps students develop their social competence. AR environment is fun for learning, which can increase students' interest and motivation.</td>
</tr>
<tr>
<td>3</td>
<td>Papamastasious et al. (2019)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Critical thinking, collaboration, communication, creativity, emotional skills, and social skills.</td>
<td>VR &amp; AR</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rezende et al. (2017)</td>
<td>Case study</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>Development of cognitive skills, such as perception, attention, and decision making.</td>
<td>VR &amp; AR</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mukkawar &amp; Netak (2021)</td>
<td>Technological evaluation</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>Self-awareness, interpersonal skills, communication skills, teamwork, collaboration, leadership, critical thinking, problem-solving, and decision making.</td>
<td>VR &amp; AR</td>
<td>Both VR and AR are promising to create quality applications for SCL.</td>
</tr>
<tr>
<td>8</td>
<td>Wu et al. (2013)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Social interaction.</td>
<td>AR</td>
<td>Students’ social interactivity could be improved when collaborating through networked AR devices.</td>
</tr>
<tr>
<td>9</td>
<td>Dhur et al. (2021)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Understanding, practical skills, and social skills.</td>
<td>AR</td>
<td>AR-based learning improved students’ cognitive and practical skills, social skills, innovation, and creativity.</td>
</tr>
<tr>
<td>10</td>
<td>Martinez et al. (2016)</td>
<td>Empirical study</td>
<td>16</td>
<td>M=14, F=2</td>
<td>21.6</td>
<td>Collaboration, creativity, and imagination.</td>
<td>AR</td>
<td>Students had a better understanding of concepts and phenomena and gained social skills.</td>
</tr>
<tr>
<td>11</td>
<td>Wójcik et al.</td>
<td>Educational design</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>Development of the ability to understand and regulate emotions.</td>
<td>AR</td>
<td>Learners could have self-evaluation of their SCL.</td>
</tr>
<tr>
<td>12</td>
<td>Perryman et al. (2021)</td>
<td>Educational program assessment</td>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>Social competencies related to labor market needs.</td>
<td>AR</td>
<td>AR is useful for personal practical skills and social competencies.</td>
</tr>
<tr>
<td>13</td>
<td>Quarco et al. (2018)</td>
<td>Group study</td>
<td>29</td>
<td>NA</td>
<td>NA</td>
<td>Social communication and social validity.</td>
<td>VR &amp; AR</td>
<td>Students reported an increase in their perceived ability to apply social counseling skills. There are gaps in the application of VR and AR to specific educational levels.</td>
</tr>
<tr>
<td>14</td>
<td>Zhang et al. (2020)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Game-based Learning and social skills via VR.</td>
<td>VR &amp; AR</td>
<td>MR exhibit excellent performance in SCE-related knowledge presentation and assessment.</td>
</tr>
<tr>
<td>15</td>
<td>Bucesa-Manzanares et al. (2020)</td>
<td>Empirical study</td>
<td>1032</td>
<td>M=423, F=609</td>
<td>about 38.9</td>
<td>Social life, collaborative learning, and social media use.</td>
<td>VR</td>
<td>VR supports collaborative learning and offers advantages by facilitating deep comprehensive learning.</td>
</tr>
<tr>
<td>16</td>
<td>Ramirez-Montoya et al. (2020)</td>
<td>Educational design</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>Social skills, innovation, and creativity.</td>
<td>AR</td>
<td>The training course has positive impact on competence in social entrepreneurship.</td>
</tr>
<tr>
<td>17</td>
<td>Schifferer et al. (2018)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Social construction of knowledge, social interaction, communication, and collaborative working.</td>
<td>AR</td>
<td>Results show that robots can learn from humans. Also, it is possible to use robots in social learning processes.</td>
</tr>
<tr>
<td>18</td>
<td>Herbst et al. (2021)</td>
<td>Empirical study</td>
<td>14</td>
<td>NA</td>
<td>NA</td>
<td>Social distancing guidelines.</td>
<td>VR</td>
<td>VR in medical education can improve health care providers’ communication skills and practice behaviors.</td>
</tr>
<tr>
<td>19</td>
<td>Mosher &amp; Carreon (2021)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Perspective-taking, creativity, and empathy.</td>
<td>AR</td>
<td>VR is useful for providing student engagement and students' new perspective-taking, empathy, and creativity.</td>
</tr>
<tr>
<td>20</td>
<td>Papoutsis &amp; Skaritza (2011)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Social interaction, emotional skills, and self and social awareness.</td>
<td>VR &amp; AR</td>
<td>VR and AR are effective tools to enhance students' emotional and social skills.</td>
</tr>
<tr>
<td>21</td>
<td>Wu et al. (2013)</td>
<td>Review</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Social interaction, emotional skills, and self and social awareness.</td>
<td>VR &amp; AR</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Summary of reviewed articles.
Summary of Evaluated Studies

The 21 studies include 1211 samples, 1132 participants (477 males and 655 females), 8 educational programs, 9 system designs, and 62 assessments. These studies also incorporate a range of research methods, such as empirical study (n=7), reviews (n=8), technological evaluation (n=2), educational design (n=2), group study (n=1), and case study (n=1). Applied SCL in the reviewed studies consists of various components, i.e., empathy building (14%), collaboration (33%), communication (19%), perspective-taking (9.5%), problem solving (14%), critical thinking (9.5%), interaction (24%), creativity (19%), emotional skills and understanding (24%), decision making (14%), and others (48%). Each component makes up a different proportion, whereas shares similar and indispensable significance to relevant SCL activities (Table 2).

Table 2. Types of applied SCL from the 21 reviewed articles.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathy Building</td>
<td>14%</td>
</tr>
<tr>
<td>Collaboration</td>
<td>33%</td>
</tr>
<tr>
<td>Communication</td>
<td>19%</td>
</tr>
<tr>
<td>Perspective-taking</td>
<td>9.5%</td>
</tr>
<tr>
<td>Problem-solving</td>
<td>14%</td>
</tr>
<tr>
<td>Critical thinking</td>
<td>9.5%</td>
</tr>
<tr>
<td>Interaction</td>
<td>24%</td>
</tr>
<tr>
<td>Creativity</td>
<td>19%</td>
</tr>
<tr>
<td>Emotional Skills and Understanding</td>
<td>24%</td>
</tr>
<tr>
<td>Decision Making</td>
<td>14%</td>
</tr>
<tr>
<td>Others</td>
<td>48%</td>
</tr>
</tbody>
</table>

RESULTS OF DATA ANALYSES

MR Technology for SCL Environment

With the rapid development of cutting-edge technologies, advances in MR open new possibilities for innovative education. It contributes to the understanding of technology-mediated collaborations and tech-based programs, as well as offering new solutions for educational purposes (Wang et al., 2022). Existing MR technologies can further personalize the learning experience in a way that other educational technologies simply cannot (Young et al., 2020). For example, MR education supports students learning by doing instead of learning by listening. Learning in an MR system allows students to touch and control objects, forming a greater understanding of learning tasks. Students can interact with datasets, complex calculations, and abstract concepts that are more difficult to understand through a teacher’s verbal instructions (Dhar et al., 2021). At the same time, educational practitioners have also taken the major step of using MR technology to support a variety of educational activities. MR has created new digital platforms that prompt educators to rethink the pros and cons of traditional pedagogies and, furthermore, take advantage of leading-edge technology to create a more inclusive, engaging, and creative environment for students' SCL experience (Dhar et al., 2021). In many educational practices, MR facilitates embedding knowledge and social competence skills in the context of real life, reflecting daily life activities to virtual or augmented reality based scenarios. When compared to traditional contexts in education, it “feels more real” as students can flexibly...
transport themselves to a creative and effective learning experience within the MR system. The following cases are elaborations of how different MR technologies can positively support diverse learning experiences for mainstream education.

**Case 1. VR-based SCL Learning Environment**

VR based learning environment is a virtual setting that is developed with educational models. The entire system involves using one or more didactic objectives to demonstrate students’ learning experiences, experiences they may not have in the physical world (Herbst et al., 2021). VR-assisted SCL is a pedagogical approach to practice SCL through a VR system. It aims to achieve SCL learning outcomes based on the design of the VR learning system. Because VR simulations enhance SCL for students, the technology enables the learning of complex competencies by allowing the deliberate practice of necessary skills while adhering to current social occasions and social norms (Herbst et al., 2021). The design helps learners to react to social instruction that builds upon their interactions with VR avatars. Also, this learning process can be repeated in VR without extra expenditures, so that learners can gradually acquire social competence in specific learning domains (Ip & Li, 2015). It is the way that mainstream education should take advantage to inspire students to form new ideas and solutions for real life situations.

**Case 2. SCL Interactive Environment in AR**

As a superposition of virtual elements on the real environment, the use of AR in education allows virtual elements to be performed in the real environment, increasing more enrichment and diversification of learning experiences (Craciun & Bunoiu, 2016). AR-assisted educational designs support students to interact with complex platforms and communicate with one another. For instance, AR learning software is compatible with different learning devices, such as smartphones, tablets, laptops, and smartwatches, which directly leads to the result of a more accessible and affordable solution for future education, and a possibility of generalised SCL in mainstream education (Wu et al., 2013). Mukkawar and Netak (2021) have indicated that applying AR technology to education can improve student-teacher interaction and satisfaction. For example, AR-interfaced books provide a respite for students struggling with complicated or dull learning materials. It also can be used as an innovative learning toolkit to visualize and concretize learning resources with rich stereoscopic effects. Another example is that Mukkawar and Netak (2021) conducted an eye contact study and proved that AR-assisted SCL may improve abilities of communication and interaction, such as team group-based learning, real-life participation, and group communication.

Therefore, deducing from the above evidence, the authors believe that MR presents a real possibility to contribute to and enhance most conventional and modern educational methodologies and implementations. Although MR has been identified as an opportunity to revolutionize the way people perceive and interact with complex digital information (Zhan et al., 2020), the technology is not important since it does not cause or facilitate meaningful learning in and of itself. It is worth noting that when new technologies emerge in education, a majority of educators are usually excited about teaching and learning through technology-centred thinking, with little consideration as to “how” learners actually think and learn. Students may have a better sense of “being present” using MR-assisted learning systems, whereas MR cannot lead to better learning efficacy without a thoughtful and productive learning experience that has been well-designed in advance.

**DISCUSSION — MR-ASSISTED SOFT SKILLS IMPROVEMENT**

**Collaboration & Communication**

Collaboration and communication are deeply human social competencies that are vital for forming effective communication and obtaining one’s needs for normal community functioning (Meadan & Monda-Amaya, 2008). These capabilities increase likeability, productive teamwork and pleasant interpersonal relationships thus leading to improved life quality. It is worth stating that these necessary social skills are not natural or inherited equally by all humans. Collaboration and communication are learned competencies that develop over our lifetime, supported with educational input (Meadan & Monda-Amaya, 2008). Even though collaboration and communication are currently
integrated into our education processes, these competencies need to be practiced and adapted intentionally as we go about our daily lives. Squire and Jan (2007) have proved that AR game-based education can be used to engage students in collaborative learning and scientific thinking. Through the use of their AR curriculum — Mad City Mystery, students develop the ability to conduct various scientific discussions. In addition, collaborative learning is a constructivist approach that can invoke collaboration and communication skills among students. Many educational practices have employed MR-based learning programs for both classroom learning and distance learning, which can break through the limitations of traditional education since large scale collaboration can be realized virtually without many physical and geographical constraints (Ip & Li, 2015).

VR and AR have been valued as creative learning aids for twenty-first century education because these technologies enable users to access flexible learning through entertainment-based software and hardware, while also offering diverse support for personalised learning (Rogers, 2019; Sanabria & Arámburo-Lizárraga, 2017). The learning tasks in VR and AR environments require learners to apply and synthesize multiple skills in collaboration, spatial navigation, technology manipulation, interactive capability, and immersion interfaces (Radianti et al., 2020). These collaborative activities through MR platforms can strengthen positive attitudes towards social engagement, social interaction, positive learning, and communication (Beach & Wendt, 2014; Crowell et al., 2020). For example, a previous roleplay experiment illustrated that students were assigned identities to understand the working model of scientific investigations and related social situated nature. These identities include social activists, scientists, and environmental investigators. After a series of scene simulations and role-playing via the MR system, students learned how to use different ways of thinking to access information relevant to their roles during the experimental sessions (Squire & Klopfer, 2007).

Similarly, participation in MR enables each participant to work as interacting components of the dynamic MR system (Dhar et al., 2021). In turn, interactions among students can affect the outcomes of the computer-human interaction and MR system. Nowadays, collaborative learning is assisting inclusive research and educational challenges during the Covid-19 pandemic (Wang et al., 2022). MR-based collaborative learning, therefore, presents a further advantage to facilitate comprehensive learning and communication.

**Critical Thinking and Creativity**

Critical thinking is a capacity that refers to a complex process of evaluation and deliberation. It involves a wide range of skills and attitudes, including identifying other people's positions and reviewing the evidence for alternative perspectives (Stella, 2005). Creativity is the ability to generate ideas, and be imaginative while also applying new thinking so that one can efficiently solve problems (Kinga & István, 2012). It encompasses the ability to discover innovative thoughts, plans, and solutions for various issues. Individuals with creativity are good at fostering resilience, happiness, and self-actualization (Kinga & István, 2012). With this ability, students can effectively respond to situations where they encounter both familiar and unfamiliar circumstances, breaking through ineffective learning and building on successful experiences. Applying this concept in SCL, MR applications can be cutting-edge digital toolkits for teachers to foster students’ critical thinking and creativity in educational practice, which also gives a chance for students to engage in social events and understand digital life. For example, Craciun and Bunoiu (2016) have demonstrated SCL education in discovery learning and scientific learning activities by using location-aware AR technologies. In these educational activities, AR laboratories have become an innovative place to foster students’ creativity and critical thinking. These SCL experiences develop learners’ critical thinking while also providing scientific facts and concepts. Students have been encouraged to identify potential issues and find a solution through the AR system. Another example of MR-assisted SCL is the AR field trip in Romania. The AR platform is named Wikitude, which can be used to retrieve destination information through Wikipedia and automatically provides other sightseeing possibilities nearby. All attractions within Wikitude have visualized objects that are particularly designed for these field trips. Having these virtual trips applied in SCL education, students can have options to discover attractions individually or travel as a group, so that they can collaborate and communicate with their peers.
Reviewed studies have illustrated that MR has great potential to stimulate students’ critical thinking and creativity in massive learning experiences. For instance, Yang et al. (2018) have indicated that VR can simulate physical settings and realistic experiences, reducing spatial constraints and facilitating creativity through imaginary and immersive settings. The fully immersive VR system has the advantage of “being there” and generating various scenarios that cannot be simply or safely completed in the real world. Likewise, AR combines the real world and the virtual world by following the idea of constructivism learning, which allows learners to make use of unreal objects in an enlarged environment to have critical thinking and learning (Faridi et al., 2021). The controlled classroom environment by MR introduces students to different ways of digital creativity, enabling students to translate their experiences into broader social competence from digital social spaces without unnecessary effort. Therefore the MR-based learning environment may develop a positive impact on students’ critical thinking through learning activities. Furthermore, given the novelty of MR and its growing functions in the 21st century’s digital society, utilizing VR and AR to support SCL in mainstream education offers many educators and students unique exposures to a virtual and real-life mixed environment (Young et al., 2020). Thus, it is both timely and necessary to propose that all mainstream schools initiate the development of SCL curricula, with consideration and critical discussion of the meanings of digital representations and interactions.

**Emotional Skills and Understanding**

Emotional skills refer to the ability to regulate one’s emotions, thoughts, and behaviours. These skills determine how people manage their feelings, perceptions, as well as their surroundings and engagement (OECD, 2017). Perspectives from psychology demonstrated that understanding is one important aspect of emotional skills. It is related to “the knowledge gained from inside the intersubjective field formed by the intersection of two different subjectivities” (Orange, 1995). Meantime, understanding is “an intersubjective process of emotional comprehension, of reaching and or developing an understanding with each other” (Orange, 1995). Emotional skills and understanding are dependent upon situational factors and respond to individual and environmental change and development via formal and informal learning experiences. These skills may influence a wide range of personal and societal outcomes throughout one’s lifespan (OECD, 2017). MR-assisted SCL makes emotional skills learning exciting for students and the technology makes it easy to generate various scenarios that imitate various social occasions, social activities, and social manners, all of which are key factors for students as they form their emotional understanding.

In some cases, VR applications have been designed to generate body swap illusions. Within these illusions, virtual roles are designed to be controlled and selected. These virtual avatars are developed so that they play the role of social competence tutors, communicating and interacting with users through social skills activities. Immersing into a safe virtual setting, users have reported that they experience less social embarrassment and increased motivation for learning perspective-taking, imagining one’s situation, empathic concern, and emotional understanding (Martingano et al., 2021). Huang et al. (2016) have developed an AR botanical garden to support students to immerse in floristic exploration and interaction with AR-enhanced ecological settings. Findings show that this AR application prompted students’ willingness to learn more about nature and the local ecological system. Furthermore, they developed a positive attachment with the virtual plants and eco-setting and quickly understood the importance of environmental protection and climate change. Also, the AR system aroused students’ emotions for perspective-taking, interest, and happiness (Huang et al., 2016). However, certain types of VR do not trigger an individual’s psychological engagement to a sufficient level to arouse empathy, because affordable VR headsets (i.e., Cardboard VR) usually have less immersive and interactive developments. Also, challenges of AR learning settings involve a longer period of training times for students to use AR and low sensitivity to trigger students’ empathy and emotional recognition of the avatars. Therefore, it is hard to infer that VR and AR can significantly improve learners’ comprehensive emotional skills and understanding since research on MR systems in fostering emotions is still at an early stage, so there is insufficient empirical research to guide and examine relevant MR system designs.

**Problem Solving and Decision Making**
Problem solving can be defined as a behavioural process which makes a range of responses to deal with a problematic situation and improves the probability of choosing the most effective response from alternatives (D’zurilla & Goldfried, 1971). It enables us to identify the difficulties in the environment and exploit potential opportunities to control the future. Decision making is the process of identifying and selecting alternatives based on the decision maker’s values and preferences. The process of decision making refers to how choices are to be made, and in such a case people want to not only find options, but to choose the one that fits most with their goals, objectives, desires, and values (Harris, 1998). In SCL, fostering students with the capacity to solve problems and make decisions is crucial to their success in career and life development. This capacity has become even more significant in the context of educational reform efforts. Reviewed studies demonstrated that MR assisted educational games included problem solving and decision making features in the design (Ip & Li, 2015; Wu et al., 2013; Young et al., 2020). For example, Mathews (2010) employed a mobile device in interdisciplinary studies of language arts. This MR-based design helped students to identify issues within their community, and then recommended relevant GPS-based games that would solve problems both individually and collaboratively. Finally, some games from mobile devices have the potential to teach students and community members to think about learning related issues.

Given that SCL tasks in AR environments require students to exert multiple skills in social inferring, problem solving, and spatial navigation, they can gain the capacity for problem solving and decision making. Similarly, Hoppenstedt et al. (2021) substantiated that AR can assist learners to solve problems effectively during collaborative working experiences. The research team investigated different types of challenges encountered by collaborators as they interacted with a range of learning activities. The groups were divided into non-AR group and AR stimuli group, with the students from the AR group using AR features to address their learning difficulties. Results showed that educators believed AR might be useful for detecting potential learning issues in the classroom and could help students discuss solutions, thus preventing identified problems that negatively impact on future learning.

In conclusion, it is clear that MR offers many great possibilities for a wide variety of educational practices including SCL, allowing teachers and students to participate safely, supported by a virtual and augmented reality system before their learning can then be applied to life in the real world. However, MR is not without its limitations and this can affect user experience making it difficult to be applied in prospective mainstream education. In the next section, we summarise the most significant limitations and challenges for current MR technology, considerations both for the application of MR in education and moreover for future studies - where this analysis can be used as a reference.

PERSPECTIVES OF LIMITATIONS AND CHALLENGES

Challenges for Teachers and Learners

Prior to the rapid development of MR applications for mainstream education, Wu et al. (2013) indicated that AR environments could increase learners’ cognitive load, and in fact overload their thinking with a massive increase of information from the system. Also, learners had to learn how to engage with multiple AR devices in a short period of time, where the learning tasks were cumbersome. Meanwhile, in comparison to studies of other sophisticated technologies in education (e.g., information and communications technology-based education and multimedia platforms), MR applications in education are still in an early burgeoning stage. Although evidence shows that MR-assisted teaching and learning appears to show promise for future education approaches, many MR systems still focus mainly on technological updates and creating special effects, media and graphics (Kobayashi et al., 2018; Poux et al., 2020), rather than concentrating on the actual objective and designing the system for educational and human developmental purposes. Furthermore, educators experienced inflexibility in MR systems with teachers unable to make changes to the system content, resulting in them being unable to accommodate individual students’ learning interests, demotivation and subsequently not accomplishing their teaching tasks (Wu et al., 2013).
Limitations in Past Research

It must be appreciated that VR and AR are relatively new mediums for educational activities. Most research studies mainly focus on system design, case studies, and pilot studies. There was no research focused on long-term evaluations of MR-assisted knowledge and skills, and the transference of such learning from the virtual system to the students’ practice in reality. Most research has been on a small scale, which is limited and as such affects the generalisability and relevance of the findings (Rodriguez, 2018). Furthermore, many studies reported that some students and educators are more likely to use this approach just to enjoy the virtual world without using it as an actual learning tool since the technology is novel, exciting, and rich in multi-sensory stimulations (Huang et al., 2016). Hence, there is a limited understanding of MR’s efficacy, as reviewed studies have not presented any results about MR’s long-term impact on a wide range of students’ performance in both classroom education and/or online education.

Challenges for MR In and Off Itself

Last but not least, when discussing the use of cutting-edge technology in education, it is easy to get carried away by the enthusiasm for new solutions but ignore the reality and real circumstances (Wójcik, 2016). Practically speaking, many studies pointed out that MR education brings students chaos and confusion with virtual environment controls - this unfamiliarity might cause fear and distraction that can weaken students’ focus on the learning content. More seriously, users may have side effects from VR, which refers to cybersickness such as headache, nausea, motion sickness, eye strain, pallor, sweating etc (Rodriguez, 2018). In addition, from a macro level, the biggest hurdle faced by MR education is how to make this technology equitable and accessible for all educators and students across the world. The cost of developing and purchasing MR platforms and devices is pricey, which makes this technology impossible for students who live in under-developed regions (Dhar et al., 2021). Therefore, paying more attention to the challenges of MR education and coming up with solutions is essential if we are to consider generalizing this technology to a mainstream level. More importantly, prejudging and diagnosing potential factors that may cause problems in MR education would protect the application from becoming impractical for teaching and learning, eventually assuring new MR platforms serve teachers and students on a daily basis (Wójcik, 2016).

CONCLUSION

In this chapter, the authors discussed the importance of social competence for students as twenty-first century citizens, and conducted a systematic review to analyse the feasibility and effectiveness of using Mixed Reality (MR) to assist Social Competence Learning (SCL) in mainstream education. Findings support collaborations between MR technologies and SCL activities that fit with Universal Design for Learning (UDL) environments - contemporary learning environments that can meet the need of a diversity of students needing to develop social competence traits for today’s world. MR-assisted SCL particularly enhances students’ collaboration, communication, critical thinking, creativity, problem-solving, and decision making. Although MR technologies are not without their limitations (e.g., increased cognitive load, challenges for educators, limited research as to their efficacy, the gap between basic and advanced MR devices, and side effects of cybersickness), it offers great potential to support students’ SCL experience. Although schools do not currently have a designated SCL module or course in mainstream education while the need for such skills continues to increase, MR as an up-and-coming medium could be the solution to increased SCL input across mainstream education. Therefore, the authors suggest that future studies may consider universally designing and conducting comprehensive SCL programs with mainstream schools, enabling engagement on a large scale, while examining its related efficacy across a diverse student population. It is time we recognise the opportunity MR-assisted SCL offers - how it embraces the emerging role of technology in education, respects the importance of inclusion, and demands that we as teachers and learners redesign for approaches to learning - it not only promotes competencies necessary for future work but will also help them to thrive as outstanding twenty-first century citizens.
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KEY TERMS AND DEFINITIONS

Social Competence Learning: Educational activities for students to obtain the ability to engage in meaningful interactions with others.

Twenty-first Century Citizens: Active, informed, engaged citizens with important skills (i.e., collaboration, communication, creativity, critical thinking, and computational thinking) to succeed in today's workplace.

Mainstream Education: Education for all kinds of students regardless of their abilities in regular classes.

Special Education: Special education is the practice of educating students in a way that accommodates their individual differences, disabilities, and special needs.

Clinical Intervention: An intervention carried out to improve, maintain or assess the health of a person, in a clinical situation.

Inclusive Education: Inclusive education supports all children in the same classrooms and same schools to have equal learning opportunities for groups who have traditionally been excluded – not only children with disabilities, but speakers of minority languages too.

Sense of Being There: We are present in an environment - real and/or synthetic - when we are able to intuitively transform our intentions into actions within the setting.