An integrative approach for designing collaborative technologies for social competence training in children with autism spectrum conditions

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Abstract — **The COSPATIAL project is exploring the use of two collaborative interaction technologies, Collaborative Virtual Environments (CVEs) and Shared Active Surfaces (SASs), as suitable media to support learning of social competence skills for typically developing children and those with Autism Spectrum Conditions (ASC)s. This paper describes the integrated approach used to design and develop learning scenarios in each technology.**

I. Technology And Autism

It is known that computing technology is particularly appealing to children with autism (Barry & Pitt, 2006) and may be uniquely suitable to support them in learning activities. Features of computing technology that may be particularly attractive for learners with ASC include automaticity (enabling tasks to be repeated), provisionality (that errors can be easily corrected), interactivity (providing active engagement) and sociability (to allow collaborative learning) (Hardy et al, 2002).

The COSPATIAL project investigates two categories of technologies for collaborative interaction that have previously demonstrated potential to be both feasible and effective for the social skills training and collaborative interaction for children with high functioning autism; Collaborative Virtual Environments (CVEs) Shared Active Surfaces (SASs). CVEs have been explored as a medium for demonstration and rehearsal of appropriate behaviour in social situation (Cobb et al., 2002). SASs have successfully been used for shared story creation to enhance collaboration (Gal et al., 2009). Thus there are distinct differences between these technologies with regard to how they may be applied to collaborative interaction; specifically CVEs enable distributed collaboration and offer the opportunity for 'perspective-taking' tasks and social communication via the technology; SASs support co-located collaborative interaction and face-to-face social communication that takes place alongside the technology.

II. Principles Of Cognitive Behaviour Therapy (CBT)

A range of social cognitive capabilities such as; adequate interpersonal problem solving, accurate processing of information, social perception and perspective taking, together with range of behavioural capabilities such as; developing appropriate social interaction with peers (including social conversation and cooperative skills), are required for appropriate social functioning. CBT offers a multimodal framework that takes into account cognition and behaviour for guiding intervention efforts. Several studies have focused on the enhancement of social and emotional understanding and promoting social cognitive capabilities such as theory of mind, emotion recognition, and the understanding of social

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scenarios through CBT techniques using, for example, social stories (Delano & Shell, 2006) or role play (Spence, 2003). Studies that have implemented an integrative model of CBT which included both cognitive as well as behavioural techniques seem to yield promising outcomes in social functioning for children with ASC (Hermelin & O'Connor, 1985).

III. Integrated Approach To Technology Development

The objective of COSPATIAL is to develop a framework to guide the design of CBT-inspired technologies to support learning of social competence skills in children with and without autism. An integrated approach to scenario design and technology development is illustrated in Figure 1 depicting the COSPATIAL 'sandwich' metaphor to describe this approach.

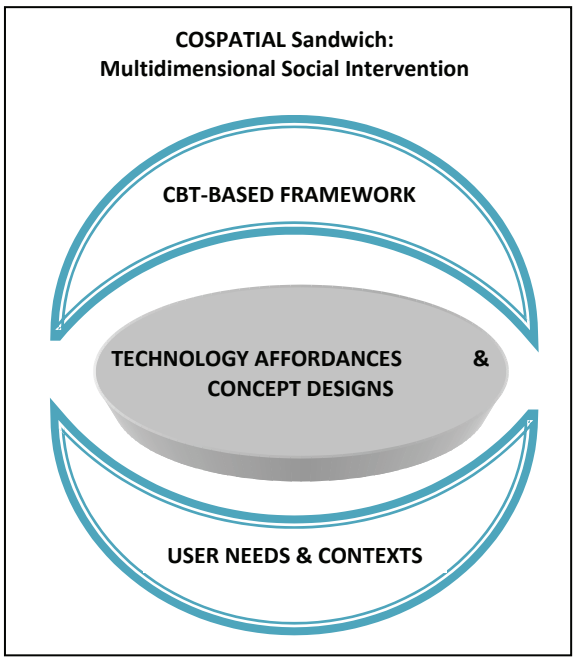

Figure 1. *The COSPATIAL sandwich metaphor for an integrated design approach.*

The sandwich has top and bottom layers with well-matched combinations of fillings inside. Represented as the top layer, the CBT-framework is used to inform scenario design with regard to how to integrate CBT principles into the scenario and how best to offer mediation for student learning. The bottom layer is concerned with understanding user-needs and contexts in which the technology will be implemented. The filling is represented by the affordances of the technologies as well as concept designs and how specific tasks are realised within and around the technology. Our final prototypes, and methods of implementation and evaluation, will only be true to our framework (i.e., make a good sandwich) if we take all of these factors into account. Thus, a purely CBT-driven (top-down only); or user-needs driven (bottom-up) or technology-driven (the 'filling') approach will not suffice – the final prototypes must take into account all layers, and how well they are matched with each other.

The COSPATIAL sandwich ensures that we take a considered approach to the design and development of educational technology and its implementation in different learning environments. This involves a number of factors that influence design and development of the COSPATIAL educational technology for children on the autism spectrum, as shown in Figure 2 and described below.

Figure 2. *Factors to consider when developing educational technology for children on the autism spectrum.*

3.1 Facilitation

The CBT conceptual framework highlights the crucial role of a facilitator or mediator in helping participants to explain and interpret the underlying concepts being taught. By taking a CBT-informed approach to design, we are able to identify the places within each scenario where mediation may be required. Observation of user behaviour and interaction between peer pairs as well as child-facilitator pairs helps to identify how facilitators offer mediation; this is used to inform decisions concerning whether the mediation can be 'built-in' to the program.

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3.2 Scaffolded learning

The role of a facilitator is central also to supporting learning, and 'scaffolding' remains an important conceptual as well as pedagogical approach. This involves consideration of who is doing the scaffolding and the context in which this occurs. For example, participants could be paired with an adult mediator or with peers of different functional levels to complete the task; there is good evidence that peer facilitation can have beneficial effects for children with ASC both in terms of learning and self-esteem.

3.3 ICT in context

One of the benefits we anticipate from the COSPATIAL project is that schools will be willing and able to use the information and communication technologies (ICT) and tasks developed. Thus, the legacy of the project is important and consideration needs to be given to this throughout development. It will be necessary, then, to report on both how the chosen technologies fit with existing classroom practice and equipment, as well as how they could be made more accessible in the future e.g., through creating inexpensive multi-touch surfaces using Wii remotes and projectors.

3.4 User-centred design (UCD)

Design for use in school classrooms does not only require technical considerations but also that we ensure that the technology is designed to be fit for the intended purpose of use. Observation of current use of technology in schools identified a need for bespoke software that is designed specifically to suit the usability and learning requirements of educational technology for children with ASC (Leach, 2010). Effective design of educational technology is complex and challenging and a key output of the COSPATIAL project will be a design framework defined through a process of iterative development and review. A UCD approach is applied to help inform and evaluate the framework. It is essential to include teachers as well as representatives of the 'end user' population, i.e., both typically developing children and those with ASC, in design decisions and prototype development and testing throughout. This seeks to ensure a better fit between the concepts and their pedagogical usefulness both in terms of the concepts being learned but also in terms of how the facilitation works; how much the children are engaged/motivated; and how much effort they have to make while using the technology. Pragmatic issues about when/where sessions take place will also be considered.

3.5 Participant groups

It is understood that no one solution will meet the needs of all children on the autism spectrum and so it will be crucial to obtain good information about participants' background characteristics, such as age, verbal ability, IQ, executive functioning and autism characteristics. This will enable the COSPATIAL project to identify for whom the CBT-informed tasks via these two technologies are best targeted. This will also enable us to make recommendations for future applications and their implementation.

3.6 Personalisation

Given the heterogeneity of children with ASC, the ability to personalise at least some aspects of the designs and/or implementation of the CVEs and SAS will be important (Leach, 2010; Davis et al., 2010). The extent to which personalisation will be appropriate or feasible with our chosen technologies is an open question that is being explored throughout the COSPATIAL project.

3.7 Understanding autism

Understanding user needs and requirements is fundamental to effective design of any technology. In this project it is important to focus on the 'core deficits' of autism when targeting psycho-educational approaches; this is true both in terms of the specific skills/understanding being targeted and also in terms of ensuring that outcome measures appropriately measure the anticipated improvements in the targeted skills/understanding. The COSPATIAL project focuses on interaction and communication difficulties in the social domain; specifically, in relation to collaboration and social conversation. Therefore, an important challenge will be to ensure that the developed tasks target these competencies appropriately and that we can sensitively measure and document changes in performance. There is a considerable number and range of behavioural and cognitive scales and tasks that could be utilised and we will need to ensure that our choices are 'fit for purpose'.

IV. CONCLUSIONS

The integrative approach to development of educational technology for children on the autism spectrum applied in COSPATIAL provides a robust conceptual foundation for considering how social competence may be facilitated through the application of innovative new technologies in conjunction with the principles of CBT.

The main challenge for the COSPATIAL project is to explore whether it is possible for our chosen technologies to support the multidimensional approach to developing social competence as required by CBT. Furthermore, we need to determine how to integrate CBT principles and collaborative technologies (CVE and SAS), and how they can offer an effective educational intervention for children at different points along the autism spectrum. Following on from this, we will also take inspiration from the CBT tenets to stimulate education on social competence for typically developing children (e.g., bullying, multi-cultural issues, etc.) which may constitute a new paradigm for the technology-enhanced learning domain.

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REFERENCES

Barry, M. & Pitt, I. (2006). Interaction design: a multidimensional approach for learners with autism. *Proceedings of the 2006 conference on Interaction design and children* pp. 33-36

Cobb, S., Beardon, L., Eastgate, R., Glover, T, Kerr, S., Neale, H., Parsons, S., Benford, S., Hopkins, E., Mitchell, P., Reynard, G., & Wilson, JR. (2002). Applied Virtual Environments to support learning of Social Interaction Skills in users with Asperger's Syndrome, *Digital Creativity*, Vol. 13, No.1, 11-22.

Crook, C. (1991). Computers in the zone of proximal development: implications for evaluation. *Computers & Education*, 17, pp 81-91.

Davis, M. Dautenhahn, K., Powell, S.D. & Nehaniv, C.L. (2010) Guidelines for researchers and practitioners designing paper software and software trials for children with autism. *Journal of Assistive Technologies*, 4, pp 38-48.

Delano & Shell (2006). The effects of social stories on the social engagement of children with autism. *Journal of positive Behavior Interventions,8,* 29-42.

Gal, E., Bauminger, N., Goren-Bar, D., Pianesi, F., Stock,O., Zancanaro, M. and Weiss, P.L. (2009). Enhancing social communication of children with high functioning autism through a co-located interface. *Artificial Intelligence & Society*, 24, pp 75–84.

Hardy, C., Ogden, J., Newman, J. & Cooper, S. (2002) *Autism and ICT: A Guide for Teachers and Parents*. London, UK: David Fulton Publishers Ltd.

Hermelin, B., & O'Connor, N. (1985). Logico-affective states and nonverbal language. In E. Schopler, & G. B. Mesibov (Eds.) *Communication problems in autism* (pp. 283–309). New York: Plenum Press.

Leach, C. (2010) The use of smartboards and bespoke software to develop delivery and deliver an inclusive, individual and interactive centred learning curriculum for students with ASC. *Journal of Assistive Technologies*, 4, pp 54-57.

Mitchell, P., Parsons, S. & Leonard, A. (2007) Using virtual environments for teaching social understanding to adolescents with autistic spectrum disorders. *Journal of Autism and Developmental Disorders*, 37, pp 589-600.

Spence, S. H. (2003). Social skills training with children and young people: Theory, evidence and practice. *Child and Adolescent Mental Health*, 8, 84-96