The INTELed pedagogical framework

Applying embodied digital apps to support special education children in inclusive educational contexts

Alejandra Martínez-Monés
Dpt. de Informática
Universidad de Valladolid
Valladolid, Spain
amartine@infor.uva.es

Sara Villagrá-Sobrino
Dpt. de Pedagogía
Universidad de Valladolid
Valladolid, Spain
sarena@pdg.uva.es

Yiannis Georgiou
Research center on Interactive media, Smart Systems & Emerging technologies (RISE)
Nicosia, Cyprus
ioannis.georgiou@cut.ac.cy

Andri Ioannou
Cyprus Interaction Lab
Cyprus University of Technology
Limassol, Cyprus
andri@cyprusinteractionlab.com

María Jiménez Ruiz
Dpt. de Pedagogía
Universidad de Valladolid
Valladolid, Spain
majiruiz@pdg.uva.es

ABSTRACT

The theories of embodied cognition and embodied learning have attracted the attention of researchers and practitioners due to the new possibilities opened up by new multi-sensory interactive technologies. The application of these theories and technologies to special education has been intense in the last years, but their introduction in inclusive educational contexts is yet scarce. The <project> aims at fulfilling this gap, by supporting teachers in acquiring knowledge and skills to use multi-sensory technologies to address the needs of special education children in inclusive educational contexts. This paper presents the work done in the first phase of the <project>, aimed at establishing the pedagogical framework and the main concepts involved in the <project>.

CCS CONCEPTS

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KEYWORDS

Embodied learning, Tangible Interfaces, Special Education Needs, Inclusive Education, Teacher training

ACM Reference format:

FirstName Surname, FirstName Surname and FirstName Surname. 2018. Insert Your Title Here: Insert Subtitle Here. In *Proceedings of ACM Woodstock conference (WOODSTOCK'18). ACM, New York, NY, USA, 2 pages.* https://doi.org/10.1145/1234567890

*Article Title Footnote needs to be captured as Title Note
†Author Footnote to be captured as Author Note

1 Introduction

Embodied digital learning apps, which compose an emergent category of educational digital apps that integrate bodily movement into the act of learning, are argued to have the potential to support the children with special education needs (SEN) [1]. Despite the promises they hold in-service SEN teachers are reluctant to adopt such educational innovations as they lack appropriate training. At the same time, while the application these technologies to special education has been intense in the recent years, their use in inclusive educational contexts where students with and without disabilities co-exist is yet scarce.

The <project> project aims at supporting teachers in acquiring knowledge and skills about the use of interactive multi-sensory learning technologies for addressing the needs of SEN children in inclusive educational settings.

To that end, the first intellectual output of the project was focused on proposing a pedagogical framework explaining the main concepts involved in the project and the relations among them. This conceptual structure should serve as the basis for presenting the key ideas regarding the use of embodied digital apps to its primary users, i.e., in-service teachers (both SEN and mainstream ones) involved in the <project> training events on how ICT multisensory technologies can be used for promoting learning in inclusive educational settings.

The rest of the paper is structured as follows. The next presents the main components of the <project> pedagogical framework- Section 3, the main challenges identified after the theoretical study, and the initial set of guidelines that should lead the definition of embodied learning activities applied to inclusive classroom contexts. Last section provides an overview of the project's ongoing and future work lines.

2. <project> pedagogical framework

The pedagogical framework of the <project> project is structured around three main aspects (see Fig. 1): (a) the theoretical background regarding embodied learning; (b) the identification of the embodied digital apps that are best suited to support the envisioned learning approaches; and (c) the description of the educational context(s) where the project will be put in practice. The rest of this section presents these three elements.

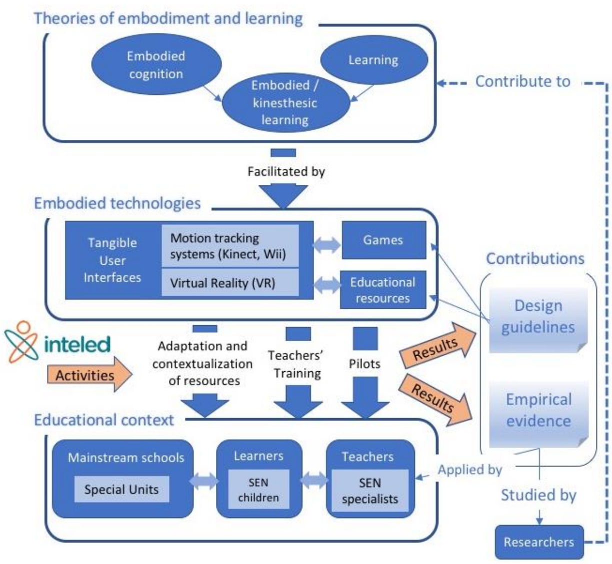

Figure 1. **<project> pedagogical framework, summarizing the work carried out in O1**

2.1. Theories of embodiment and learning

The theoretical foundations of <project> stem from the theories of embodiment and their confluence with theories of learning, that have resulted in the ideas of embodied learning [2]. Embodied learning is a contemporary theory of learning which emphasizes the use of the body in the educational practice [3] [4]. The concept of kinesthetic learning [5], although with different theoretical roots, can be used as a synonym, with an emphasis in promoting sensorimotor perception as a means of learning.

Although the concept of embodied learning is intuitively understood, the actual characteristics that have to be met by a learning activity in order to consider it a case of embodied learning are not yet completely defined. In <project> we drew on [6] to identify these characteristics that should be considered when designing embodied learning activities: the sensorimotor activity; the relevance of gestures to the theme that is to be reproduced; and the emotional involvement of the participant in the whole process.

An open issue that was identified in the review carried out as part of the project is that there is limited empirical research studying the use of embodied technologies in real classroom settings, which is one aspect in which the project <project> is meant to contribute.

2.2. Technologies supporting embodied learning

The emergence of new forms of interactive technologies has increased the interest in the theories of embodiment, as these technologies are seen as a new opportunity of implementing and studying the theory of embodied learning.

The definition of these technologies is rather blurred. We propose the term “Tangible User Interfaces” (TUI) [7] as the most widely accepted to refer to them. A TUI is an interface in which a user interacts with a digital system through the manipulation of a physical object, including her own body, augmenting the physical world by coupling digital information and everyday physical objects and environments.

The classification of devices as whether they can be considered or not TUIs is also issue of discussion. For example, gesture-based interfaces could be considered a basic kind of TUI, which would open up the field of embodied interaction to almost any kind of device used nowadays (tablets, mobile phones, etc.). However, this approach would broaden too much the scope, losing the opportunity to focus on the specific affordances of the technologies implementing higher degrees of embodiment.

To respond to this issue, we drew on the taxonomy proposed by [8] that classifies the technologies in four levels, depending on three aspects: the amount of sensorimotor engagement; the amount of gestural congruency and the amount of immersion.

Based on these three dimensions, the <project> consortium proposed to focus on the technologies with high levels of achievement in the taxonomy, i.e., motion-based interactive interfaces, (e.g., Kinect, Wii, and Leap Motion) as well as technologies implementing virtual reality (VR).

Once the scope of the project was defined, the work was complemented with a review of available digital apps for embodied learning applied to SEN children. This review showed that, although there exist proposals based on VR [9] most of the available resources are games implemented for Kinect cameras. The reason for the choice of this particular technology is given by Ojeda-Castelo, Piedra-Fernández, Iribarne, and Bernal-Bravo [10]. They analysed the benefits of Kinect cameras against similar technologies and they found that Kinect cameras offer good levels of accuracy in identifying the body movements, an open API, a voice-recognition system and an RGB camera, and it does not need calibration. Moreover, Kinect cameras are relatively affordable, and cheaper than other specific technologies that are used in special education.

The review to existing empirical work carried out in the project shows that these technologies have been mostly employed in special schools or special units in mainstream schools, by therapists working with children with some kind of special need. The most frequent special needs addressed so far are: motor impairments (like e.g. [11] [12] [10]), Autistic Spectrum Disorder (ASD), [9][13][14] and other cognitive disabilities, like mental retardation [15], Comorbid learning disorders [16], and Attention Deficit

Hiperactivity Disorder [17]. The results also show that there is still need of more empirical evidence on the effectiveness of these tools, and a lack of knowledge about their potential use and benefits in classrooms in the context of inclusive education.

2.3. Educational context

Considering the results from the review of the application of embodied learning to special education needs, <project> faces a challenge that has been not yet sufficiently explored, by aiming at exploring how these technologies can be applied in inclusive educational settings. However, education of children with special needs differs among countries and with the specific cases. For this reason the project consortium has decided to address the application of embodied learning: (a) in general classrooms where students with and without disabilities co-exist in inclusive educational settings, but also in (b) special units situated in mainstream schools to explore the possibility of using the embodied digital apps as a common pedagogical approach for ALL students as well as for bringing all students in the same classroom to use the embodied digital apps where it is possible.

The educational context is completed with the description of the participants of the pedagogical activities carried out in the project. These participants will be teachers, on the one hand; and students, on the other. The teachers participating in the project will be both mainstream teachers that have children with special needs in their classrooms, as well as specialists working with these children in mainstream schools (either as assistants of the main teachers or in special units). The second group of users will be the children themselves. The project is primarily aimed at SEN students that share totally or partially their time with the rest of their classmates at the classroom. The project will have to address the needs of these children while planning and evaluating the interventions.

The analysis of the educational context, and more specifically of the teacher training practices in each country participating in <project> carried out in the project helped to identify the requirements of teacher training in the context of the project. <project>’s teacher training events will have to provide support to the teachers in understanding and applying the principles of inclusive education; help them become familiar with the technological and pedagogical resources proposed by the consortium to implement course plans adapted to the children in their context, and to put in practice these plans and share the experiences in a community of practices.

3. <project> challenges, contributions and design guidelines

The analysis of the three elements presented in the previous section helped to identify the main challenges to be faced by the project, as well as the expected contributions derived from the activities, which are depicted in Figure 1.

3.1. <project> main challenges and contributions

The first challenge faced by the project is the adaptation of the embodied digital apps. There is a need to adapt and contextualize the affordances of the selected tools and resources (mostly grounded on motion tracking systems such as Kinect and Leap Motion) to the educational contexts where the project will be enacted, i.e., inclusive schools and special units within mainstream schools. To respond to the challenges related to teachers’ education regarding SEN and embodied learning, <project> has provided a complete program of teacher training, addressing the identified requirements. The training program includes pilot studies (currently in progress) where the participating teachers will be able to put in practice and validate the educational resources adapted by them to their particular context.

It is expected that these activities result in two main contributions. From the experience of the teachers applying the embodied learning technologies and the educational resources to the classrooms, <project> aims at collecting further empirical evidence about how this approach applies to inclusive educational contexts, which is an unexplored issue. The project also aims at providing incremental evidence about the usage of these ICT tools and resources in special units, and eventually to explore whether the work carried out in these units can benefit the children when they are with their classmates at the classroom. These pieces of evidence can help other teachers (organized in <project>’s community of practice) learn from others’ practices and apply them to their cases. The results from these experiences are also a very important input for researchers in embodied learning and may contribute to the theoretical foundations of this approach, which is still in need of more strong evidence and reflection. A second expected contribution of the project is the identification of a set of design guidelines for the tools and the educational resources for embodied learning applied to SEN children in inclusive educational contexts. From the review to the literature performed in the project, we were able to identify a first set of design guidelines, that are presented in the next section. However, we expect that our experience in the implementation of the embodied tools and resources in real and innovative educational contexts during the second year of the project will help enrich the design guidelines.

3.2. First approach to the <project> design guidelines

A first group of recommendations refers to the best ways of designing of embodied digital apps (mainly games) so that they comply with the requirements set by SEN children and their teachers.

Malinverni et al. proposed an inclusive design approach aimed at improving the poor quality of existing video games oriented to children with special needs (more concretely, ASD). The method presents strategies to integrate the expertise of the therapists, contributions of children, and experience of designers. Their objective was to design games that were at the same time effective in terms of therapeutic objectives and enjoyable for children.

Bossavit and Pina [18] present a framework, which aims at facing the challenge of adaptability, by including a set of actions that enable the system to create users' profiles and then, offer adapted games according to each user's profile.

Altanis, Boloudakis, Retalis, and Nikou [11] make two recommendations related to the design of games for children with SEN, which they applied to the design of the games included in the Kinems suite: adapatability to the content, the gestures, and the game elements; and integration of learning analytics modules for monitoring and assessment.

A second set of design guidelines refers to how to adapt games to the needs of children with SEN.

Malinverni et al. [14] applied their inclusive design approach to the design of the game "Pico's Adventures" and carried out an exploratory study with 10 children. From this experience they derived a set of guidelines and suggestions for future work in the design of therapeutic games for children with ASD:

- To promote behaviors related with social request, it is advisable to design cooperative game mechanics where different resources are distributed between the players to achieve a common goal.
- Game mechanics that use physical contact should be avoided, as they may hinder social communication by promoting an instrumental use of the other player.
- To facilitate social initiation potential solutions can be found in the use of surprising and unexpected elements.
- To promote exploration and avoid repetitive behaviors, relevant design solutions a can be found in the use of "peephole" strategies.

Bartoli, Corradi, Garzotto, and Valoriani [19] propose a set of principles that should be considered at the time of evaluating the appropriateness of a game. These are: distress (the sense of mental or emotional suffering and anxiety); positive emotion, need for intervention agency (autonomy) and usability gap (correctness of actions with respect to game logic and interaction rules). Although these are not design guidelines, the principles help guide the design and selection of games for a particular set of users.

A third set of guidelines refer to the principles of therapeutic interventions that could be applied when designing games for children with SEN. For example, the approach followed by Altanis et al. [11] is grounded on 4 principles of therapeutic-educational intervention: repetitive exercises, personalized flow of learning activities, combination of visual, auditory and kinesiology stimuli and step-wise activities with frequent feedback and reinforcement.

A final set of recommendations could be oriented to help SEN teachers and therapists orchestrate their classes when using these technologies and educational resources in settings different from the one-to-one model typical in special units. However, there are no guidelines like those, which is coherent with the fact that this type of inclusive scenarios is yet unexplored. <project> project aims at contributing to this challenge.

4. Final remarks and future work

This document has presented a summary of the work carried out in the first phase of the <project> project, synthesised it in the form of a pedagogical framework, which is depicted graphically and described in the text. The report includes a first approach to the set of guidelines for the design and enactment of embodied pedagogical resources in inclusive educational settings.

The pedagogical framework describes the current state of <project> partners' understanding of the issues related to the project and will serve as a basis for the methodological framework defined the second Intellectual Output, which will drive the teachers' training events and school pilots that complete the rest of the field work of the project. The framework is also meant to present the main ideas of the project to different stakeholders, and specially, to the teachers involved in the teacher training events and piloting experiences.

It is expected that the framework will evolve with the implementation of the teacher training events and especially with the implementation of the <project> pilots. The refinement to the framework will be published in new versions that will result from the intellectual outputs that follow the project.

ACKNOWLEDGMENTS

This work is part of the INTELed Project [INnovative Training via Embodied Learning and multi-sensory techniques for inclusive Education] (Project 2017-1-CY01-KA201-026733), which is co-funded by the Erasmus+ Programme of the European Union.

REFERENCES

[1] N. D. Leitan and L. Chaffey, 'Embodied cognition and its applications: A brief review', Sensoria J. Mind Brain Cult., vol. 10, no. 1, p. 3, 2014.

[2] M. L. Anderson, 'Embodied Cognition: A field guide', Artif. Intell., vol. 149, no. 1, pp. 91–130, 2003.

[3] M. Wilson, 'Six views of embodied cognition', Psychon. Bull. Rev., vol. 9, no. 4, pp. 625–636, 2002.

[4] N. A. R. Ayala, E. G. Mendívil, P. Salinas, and H. Rios, 'Kinesthetic learning applied to mathematics using kinect', Procedia Comput. Sci., vol. 25, pp. 131–135, 2013.

[5] R. Lindgren and M. Johnson-Glenberg, 'Emboldened by Embodiment: Six Precepts for Research on Embodied Learning and Mixed Reality', Educ. Res., vol. 42, no. 8, pp. 445–452, 2013.

[6] H. Ishii and B. Ullmer, 'Tangible bits: towards seamless interfaces between people, bits, and atoms', Proc. 8th Int. Conf. Intell. User Interfaces, no. March, pp. 3–3, 1997.

[7] M. C. Johnson-Glenberg, C. Megowan-Romanowicz, D. A. Birchfield, and C. Savio-Ramos, 'Effects of Embodied Learning and Digital Platform on the Retention of Physics Content: Centripetal Force', Front. Psychol., vol. 7, Nov. 2016.

[8] Y. Cai, R. Chiew, Z. T. Nay, C. Indhumathi, and L. Huang, 'Design and development of VR learning environments for children with ASD', Interact. Learn. Environ., vol. 25, no. 8, pp. 1098–1109, 2017.

[9] J. J. Ojeda-Castelo, J. A. Piedra-Fernandez, L. Iribarne, and C. Bernal-Bravo, 'KiNEEt: application for learning and rehabilitation in special educational needs', Multimed. Tools Appl., pp. 1–27, 2018.

[10] G. Altanis, M. Boloudakis, S. Retalis, and N. Nikou, 'Children with Motor Impairments Play a Kinect Learning Game: First Findings from a Pilot Case in an Authentic Classroom Environment', J Interact Des. Archit., pp. 91–104, 2013.

[11] Y.-J. Chang, Y. T. Chien, C. Y. Chiang, M. C. Lin, and H. C. Lai, 'Embodying gesture-based multimedia to improve learning', Br. J. Educ. Technol., vol. 44, no. 1, pp. 5–9, 2013.

[12] F. Garzotto, M. Gelsomini, L. Oliveto, and M. Valoriani, 'Motion-based touchless interaction for ASD children', in Proceedings of the 2014 International Working Conference on Advanced Visual Interfaces - AVI '14, 2014, pp. 117–120.

[13] L. Malinverni, J. Mora-Guiard, V. Padillo, L. Valero, A. Hervás, and N. Pares, 'An inclusive design approach for developing video games for children with Autism Spectrum Disorder', Comput. Hum. Behav., vol. 71, pp. 535–549, 2017.

[14] Y. Fu, J. Wu, S. Wu, H. Chai, and Y. Xu, 'Game System for Rehabilitation Based on Kinect is Effective for Mental Retardation', MATEC Web Conf., vol. 22, p. 1036, 2015.
[15] M. Kourakli, I. Altanis, S. Retalis, M. Boloudakis, D. Zbainos, and K. Antonopoulou, 'Towards the improvement of the cognitive, motoric and academic skills of students with special educational needs using Kinect learning games', Int. J. Child-Comput. Interact., vol. 11, pp. 28–39, 2017.
[16] S. Retalis et al., 'Empowering children with ADHD learning disabilities with the Kinems Kinect learning games', Proc. Eur. Conf. Games-Based Learn., vol. 2, pp. 469–477, 2014.
[17] B. Bossavit and A. Pina, 'Designing educational tools, based on body interaction, for children with special needs who present different motor skills', Proc. - 2014 Int. Conf. Interact. Technol. Games ITAG 2014, pp. 63–70, 2014.
[18] L. Bartoli, C. Corradi, F. Garzotto, and M. Valoriani, 'Exploring motion-based touchless games for autistic children's learning', in Proceedings of the 12th International Conference on Interaction Design and Children - IDC '13, 2013, pp. 102–111.