

## Research Studies about the effectiveness of the Kinems platform

As an evidence-based intervention, Kinems is supported by a growing body of peer-reviewed research. Scientists have been investigating the effectiveness of Kinems platform in a wide variety of child populations. The findings from peer-reviewed publications are repeatedly demonstrating viability, via pre- and post-test questionnaires, interviews and in-depth studies of kinetic and learning analytics, showing that it has a positive impact on children's academic performance and improvement of their cognitive, motor and academic skills.

Publications can be downloaded from the link: <http://www.kinems.com/research/publications.zip>

In the following paragraphs, a summary of the various research studies is provided.

### **Research Study 1** - A Study conducted at the premises of the ADHD unit of the University Children's Hospital with children diagnosed with ADHD

#### *Participants*

This study was conducted at the premises of the ADHD unit of the University Children's Hospital in Athens, Greece. The sample consisted of 11 children (10 boys and 1 girl) who have been diagnosed with ADHD. The average age of the participants was 6.87 yrs  $\pm$  1.03 (sd). Their parents had signed consent forms in order for the children to participate in the study. Each child was called to attend 2-3 weekly sessions for one month. The total number of sessions per child ranged from 8 to 11. Each session lasted approximately 30 minutes with no scheduled breaks. There was no use of external tangible means of positive reinforcement.

#### *Findings*

- The analysis of the pre & post tests showed that there was statistical significant improvement of concentration and inhibition of impulsivity ( $p=0.014$ ).
- The analysis of data of children's learning paths, that had automatically been stored, showed that all children improved the following skills:
  - Children could correctly solve exercises with mathematical operations at their grade level with an accuracy score of above 80%.
  - Children could correctly solve exercises with mathematical operations more quickly over time (reduced reaction time along the sessions).
  - Children managed to successfully recognize and repeat patterns with an accuracy score of above 80%.
  - Children improve their visual-motor and eye-hand coordination.
- Regarding the students' behavior during the sessions, according to the therapists' observations, all children showed strong interest and motivation despite their elevated levels of impulsivity and hyperactivity.
  - None of them children gave up. They were quite enthusiastic and frequently displayed signs of disappointment when they had to leave the session.
  - The level of satisfaction was quite high for the therapists who had very few problems directing the children.

- The parents made positive comments with regards to the enthusiasm and good mood of the children to participate to these sessions.

*Publication:*

Retalis ., Kourakli, M., Altanis, I., Siameti, F., Korpa, T., Skaloumpakas, C., Papadopoulou, P., Lytra, F., Boloudakis, M., Pervanidou P. (2014). Empowering Children With ADHD Learning Disabilities With the Kinems Kinect Learning Games, *8th European Conference on Games Based Learning ECGBL 2014*, 8-10 October, Berlin

**Research Study 2** – This Study was performed at the premises of two public mainstream elementary schools that offer Individualized Education Programs (IEP) in the form of “special units” for children with multiple learning disabilities. The sample consisted of 20 children with multiple learning disabilities, i.e. autism, dyspraxia, dyslexia and ADHD.

*Participants*

Twenty children aged 6–11 years (mean  $M = 8.91$  and standard deviation  $STD = 1.72$ ) from two elementary schools (11 and 9 students from each school respectively) participated to this study. School directors received the parents’ written permission for children participating in this study. The majority of the children were boys (i.e. 17 boys [85%]) and there were 3 girls (15%). According to the formal diagnoses or assessments from diagnostic assessment and support centers, these children had multiple learning disabilities and comorbid learning disorders such as dyscalculia, difficulty in regulating emotions, ADHD/ADD and dyspraxia. The two special educators at the schools who had been responsible for applying the Kinems-based intervention sessions, attended a training session about the Kinems platform and the evaluation tools. Children did not have experience with Kinect games and became familiar with the natural physical interaction just after playing a few games during the first day of intervention.

*Findings*

- There was improvement in children’s cognitive skills such as “Number recall-Gsm-Short term memory,” “Word recall-Gsm-Short term memory,” “Conceptual thinking-Gv Visual processing,” and “Expressive Vocabulary-Gc-Crystallized knowledge” as measured via pre- and post- assessment batteries
- Cohen d analysis showed a large effect size for “Number Recall” (1.13), “Word Recall” (2.45) and “Conceptual Thinking” (1.21)
- The qualitative feedback from the parents’ responses indicated that children has been very enthusiastic about the intervention program. Children made extensive references and highly positive comments about the game-based activities when they returned to their homes. There was high motivation of children to go back to school and participate to Kinems interventions the next day.

*Publication:*

Kourakli M., Retalis, S. Altanis J., Boloudakis, M., Zbainos D., Antonopoulou K. (2016) Towards the improvement of cognitive, motor and academic skills of pupils with special educational needs using Kinect learning games, *International Journal of Child-Computer Interaction*, Volume 11, January 2017, Pages 28-39

**Research Study 3** - Study performed in school year 2016-2017 The study was conducted in four different elementary classrooms in two primary schools that offer Individualized Education Programs (IEP) in the form of “special units” for children with multiple learning disabilities. A total

of 52 second and third graders (N=52) aged 7-10 participated. This study replicated the **Research Study 2** described above.

#### *Participants*

The study was conducted in four different elementary classrooms in two primary schools. A total of 52 second and third graders (N = 52) aged 7–10 participated in 13 intervention sessions of 45 min during a four-month period. Five teachers were involved in the research procedure. All sessions were conducted in a real classroom with the teacher of the class who was trained to implement the Kinect- based educational games with his/her students. Prior to the study, all the ethical approvals from Ministry of Education were obtained. Selection of children was by virtue of them being in the school class that was invited to participate. Both teachers and children participated in the study after providing proper consents.

#### *Findings*

- Statistically significant Improvement of memory skills was found based on children's scores in pre- to post testing and a paired sample t-test was conducted. There was a statistically significant difference ( $p$ -value  $< .001$ ), from pre- to post testing, with strong effect size (Cohen's  $d = 1.01$ ).
- The teachers discussed cognitive gains of children, specifically gains in short-term memory skills during the intervention period. The teachers claimed that the "unboxit" game enhanced the memory abilities of the children, particularly their ability to recall words and to practice their memory skills.
- The majority of the teachers' comments mention "absolute concentration," "focus on the game," "structure and organization of objects," "think aloud," and "use of body and especially of hands." In other words, based on teachers' observations, children managed to improve their memory performance by finding alternative ways to remember the visual objects and complete the game.
- Statistically significant improvement on children's language skills and particularly in expressive vocabulary were examined. In this case, we report the results from a paired sample t-test using the data from pre- to post testing, in which there was a statistically significant difference ( $p$ -value  $< .001$ ), from pre- to post testing, with large effect size (Cohen's  $d = 0.28$ )
- There was a positive strong correlation between scores on vocabulary test and time on task, which was statistically significant ( $r = .675$ ,  $N = 52$ ,  $p < .001$ ).

*Publication:* P. Kosmas, A. Ioannou, and P. Zaphiris. "Implementing embodied learning in the classroom: Effects on children's memory and language skills", 2018. In Valjtaga T. & Laanpere M. (eds) Digital turn in schools: Research, Policy, Practice. ICEM 2018. Lecture Notes in Computer Science, Springer.

**Research Study 4** - Study performed in 2017 by PACE University, NY. This research examined the use of the Kinems Learning Games, over the course of one academic year focusing on individualized interventions aligned to both academic and non-academic skills outlined in their IEPs and classroom curriculum.

#### *Participants*

The participants included five students who attended a public special education school in New York, devoted to working with students with severe and significant impairments. Students ranged in age from 14-21.

#### *Findings*

The findings of this study consisted of two parts, examining the individual students as well as the general themes of the group as a whole. This research found that students were able to develop and maintain both academic and non-academic skills that were addressed in the Kinems Learning Games sessions, across all students. Also, the research did not find any significant loss of skill even when a particular skill was not addressed consistently after mastery, the students were able to demonstrate maintenance of skill when it was reintroduced. Thus, data captured in this analysis provides a firm backing for the success of the skills using the Kinems Learning Games for both skill development and maintenance of skill over time. At the individual level, each student was able to demonstrate an increase proficiency in at least one variable being observed (time to complete, accuracy, difficulty level). Additionally, the instructor noted that once skills were mastered, she was able to use the Kinems Learning Games as an extension activity in which she could engage the students in turn taking skills.

*Publication:* Conference Presentation at NYSCEC 2018 with a supportive white paper. "Using Kinesthetic Movement to Increase Skill Development for Students with Disabilities. Exploring the use of kinesthetic learning for the purpose of reinforcing and assessing related academic and non-academic skills addresses an important topic for special education teachers." 2018 NYS Council for Exceptional Children Annual Conference, October 26-27, 2018, Hilton Albany, Albany NY

**Research Study 5** - A study in 2017 with 31 children with multiple learning disabilities in five (5) mainstream elementary schools in Cyprus

#### *Participants*

Participants were 31 children with special educational needs in five mainstream elementary schools in Cyprus. Most of them (N = 18) attended schools with special education units. Thirteen students (N = 13) attended schools with no special education unit (i.e., in-class support when needed). The complete sample included children 6-12 years, 68% were boys. According to the confidential school records, the participating children were diagnosed with one of more learning disabilities. Participants were also ten special educators (SEN teachers), who voluntarily agreed to participate in the study implementing a five-month program with their children.

#### *Findings*

- A Paired sample t-test was conducted to examine mean differences from pre-to post testing on "Word Recall". There was a statistically significant increase (p value < .05), from pre (mean performance score = 18.90 out of 31) to post testing (mean performance score = 20.84 out of 31)
- It was found a statistically significant positive correlation between time-on-task and Gsm performance (see Table 2). In other words, the more the child played "Unboxit" and "Melody tree" games, the better s/he performed on the memory test.
- The study also showed evidence of cognitive gains as perceived by the teachers. The teachers argued that the experience improved the memory skills of the participants, particularly their ability to execute a series of tasks and ability to make choices toward solving a problem.
- Quantitative data derived from children's responses to the attitudinal scale demonstrated that the experience was fully endorsed by the participants. Most students thought that the lesson was more enjoyable (79%) and that they would like to use this method in more courses (74%). Again, the teachers' perspective was fully consistent with these outcomes. As teachers explained, motion-based interaction enabled children to improve the emotional stage of the participants

demonstrated in the form of increased self-confidence, joy, enthusiasm, calmness, and motivation to participate in the learning process.

- According to the teachers, the method of motion-based interaction was very engaging and motivated the children to participate in the learning activities and to achieve better performance from session to session.

*Publication:* Kosmas, P., Ioannou, A., & Retalis, S. (2018). Moving Bodies to Moving Minds: A Study of the Use of Motion-Based Games in Special Education. TechTrends, 1-8.

**Research Study 6** - A Kinems related study completed in Sept 2018 with 5 autistic children enrolled in a special needs school for autistic children.

#### *Participants*

- 5 children diagnosed with autism aged between 4;01 (y;m) and 8;04 (M=5,63, SD=1,63), enrolled in a special needs school for children with Autism. All the participants were boys and their formal -classification was Autism. Families of the children have been informed about the research and its goals and have been asked for written permissions. Their comprehension age equivalent ranged between 1;01 (y;m) and 2;08 (M=1,91, SD=0,67) and their expressive age equivalent between 1,09 and 2,03. Students were selected using the following criteria:
  - Being in the Early Years Department
  - Not having physical impairment that obstructs the use of the Kinems games
  - Not knowing or having played before any of the Kinems games

#### *Findings*

- Improvement in the Reynell Comprehension Scales pre and post-intervention for each child and improvement of the sample's mean value, which increased from 21,4 to 32,2 was found. It is clear that all the children improved a great deal and the increase of the scores is statistically significant ( $p=0,00032$ ).
- All children, except one (A.J.), showed an improvement in their scores at the Reynell Expressive
- Scales. The mean value of their scores at pre and post-test improved, ranging from 5,4 to 10. Their improvement is statistically significant ( $p=0.016$ ).
- A difference between the CARS scores pre and post-intervention was also observed. Every child had, after the intervention, lower scores in CARS, which means that they are lower in the scale of autism severity. The change between pre and post measurements is statistically significant ( $p=0.002$ ).
- All the children's success rate improved between the first (M=51,46, SD=17,78) and the last sessions of the intervention (M=86,31, SD=10,78). This change is also considered statistically significant ( $p=0.008$ ).
- Teachers commented that
  - There was high motivation of children to play the games and the fact that during and, sometimes after, the sessions the challenging behaviors vanished or diminished.
  - The children's progress with regard to their vocabulary and verbal communication was remarkable since the beginning of the intervention; they had all made only small progress since the beginning of the school year before using Kinems.
  - Children appeared to be more sociable, not only during the Kinems sessions, but also afterwards. After the end of the intervention, children interacted more with the adults, were asking for help or were even initiating play.
  - The Kinems intervention seemed to induce less stress than other activities (e.g. messy play or yellow table)

*Publication:* Executive summary of the poster for the Autism-Europe Congress 2019

Kambouri, M and Armaganidou, M. "Can we use digital (Kinetic) learning games to enhance language development in young autistic children?" Accepted as Poster for the Autism-Europe Congress 2019.

**Research Study 7** - This study investigates students' performance in a collaborative embodied learning environment using motion-based games within a real classroom language learning context.

#### *Participants*

In the investigation 52 students participated (mean age:  $M = 8.2$  years, 25 boys, 27 girls) from four different elementary classrooms in two primary schools. All elementary students (second and third graders) were involved in embodied interaction activities using motion-based games in the classroom and completed 13 game sessions of 45 min during a four-month period. Five teachers were responsible for the delivery of embodied learning in their classrooms. Before the beginning of the study, teachers participated in a training workshop regarding the implementation of motion-based games in the classroom. Selection of children was by them being in the school class that was invited to participate. All participants (students and teachers) provided a consent form and all the approvals by the Ministry of Education were obtained.

#### *Findings*

The analysis is based on a students' questionnaire, direct classroom observations and semi-structured interviews with participating teachers. Findings indicate that embodied learning interactions enabled students to work more collaboratively engaging them in the learning activities, physically and emotionally.

- The vast majority of students (90%) said that the lesson using motion-based games was more enjoyable and that they liked to use their body movements in the classroom a lot.
- Most students (82%) claimed that they enjoyed the collaboration with their classmates during the lesson while only 25% of students said that encountered difficulties.
- All teachers claimed that the use of Kinems platform was a very important incentive for students to progress and complete their activities successfully.

*Publication:* Kosmas P., Zaphiris P. (2019) Embodied Interaction in Language Learning: Enhancing Students' Collaboration and Emotional Engagement. In: Lamas D., Loizides F., Nacke L., Petrie H., Winckler M., Zaphiris P. (eds) Human-Computer Interaction – INTERACT 2019. INTERACT 2019. Lecture Notes in Computer Science, vol 11747. Springer, Cham

**Research Study 8**- This study investigates the relationship between three degrees of Avatar Self-Representation (ASR) and children's affective and behavioural states, in the context of the Kinems movement-based learning games MBTG.

#### *Participants*

The experiment took place in a science museum and a local public elementary school in Trondheim, Norway. The sample was composed of 46 typically developing children (28 F,

18 M) with an average age of 10.3 years (SD = 1:32, min = 8, max = 12 years). 30 children participated at the science centre, and 16 at the elementary school. Children participated in 9 gameplay sessions lasting between 25–35 minutes in total. Each child received a gift card for their participation. All procedures were approved by the national human research ethics organisation and all children and their guardians provided verbal/written informed assent/consent, respectively, prior to participation.

#### *Findings*

The research team automatically and continuously monitored children's experiences using sensing technology (eye-trackers, facial video, wristband data, and Kinect skeleton data). This allowed to understand how children experience the different ASRs, by providing insights into their affective and behavioural processes. The results showed that ASRs have an effect on children's stress, arousal, fatigue, movement, visual inspection (focus) and cognitive load.

*Publication:* S Lee-Cultura, K Sharma, S Papavlasopoulou, S Retalis, M Giannakos (2020). Using sensing technologies to explain children's self-representation in motion-based educational games. Proceedings of the Interaction Design and Children Conference - IDC 2020: 541-555

**Research Study 9-** The present study seeks to investigate: (a) If and to what extent the combination of synchronous and asynchronous tele-education using the Kinems learning platform is effective for the development of academic and cognitive skills of children and adolescents with special education needs, (b) If and to what extent the intensive exercise with the Kinems learning platform can develop motor skills related to mouse use, fine-motor and hand stability and, (c) If and to what extent the Kinems learning platform is positively evaluated by parents, therapists and educators.

#### *Participants*

13 students with special education needs, 15 teachers and interventionists from three (3) special schools who have been using an innovative online education gaming platform in conjunction with a video conferencing platform during the period of school closure due to COVID-19 for 4-6 weeks. Specifically, 9 students were attending two public primary special education schools and 4 students were attending a public secondary special education school. Ten (10) out of 13 students have been diagnosed with ASD and the rest of them with other neurodevelopment disorders. Students' parents participated as well, supporting their children during the sessions when needed.

#### *Findings*

- Results regarding students' performance are considerably encouraging. According to practitioners' evaluation the majority of students achieved greater than the expected performance to the learning goals on the whole, regardless the duration of their participation.
- There was a dramatic rise in attention skills, in motivation and positive affect towards the platform, in the mouse use and finally in co-operation and interaction with the educators during the intervention regardless the students' level of functioning. 53,8% and 46,2% of the whole sample significantly increased attention, and specifically auditory and sustained attention, during the program.
- Most children exhibited an increasing tendency to play with the Kinems activities not only in their scheduled sessions during synchronous learning, but also asynchronously at their own pace as after school activities. This finding reveals Kinems as an attractive educational material which enhances children's motivation and positive affect towards the platform.
- The average of the possibility that teachers could propose the platform to colleagues is 4.7/5. Parents are also pleased from the use of the Kinems platform. Some viewpoints

from parents are: *"Our first impressions of the program are very positive. Our child is very happy. He has his own time on the platform and he enjoys the games", "Kinems is an innovative tool for SEN children. It is helpful for teachers and parents based on good learning strategies and occupational therapy techniques "*.

*Publication:* V. Aloizou, T. Chasiotou, S. Retalis, T. Daviotis & P. Koulouvaris (2021). Remote learning for children with Special Education Needs in the era of COVID-19: Beyond tele-conferencing sessions, **Educational Media International**, 58:2, 181-201