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Learning in motion for inclusion at school[1]

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Abstract

Spaced learning is a teaching methodology whose peculiarity is the articulation of lesson time, which maximizes students' concentration and memorization. Kelley & Watson (2013) developed this technique to test whether it was possible to encode complex information in long-term memory (LTM) in students using repeated stimuli in a very short time scale. Spaced learning conceives the lesson as an alternative situation that makes students participate and aware.

We are designing a training program to develop the spaced learning methodology in enhancing linguistic, mathematical, and scientific skills in children between 8 and 11 years old. We hypothesized an intervention in five phases, three moments of input and two intervals with distracting activities. Motor activity favors spaced learning because it stimulates students to consolidate knowledge and information through meaningful interactions between mind and body; this is also possible in children with special education needs.

To allow students to learn in a relaxed and effective way, lessons will be interspersed with motor activities and interactive games through a 10-minute physical setting. We will use spaced learning to strengthen hard skills in primary school: text comprehension, grammar, solving math problems, and scientific conceptualizations. The experimental research will be articulated into phases over the course of two years; it will be aimed at a sample made up of 70 classes of Sicilian schools.

1 Introduction

The study is placed within linguistic, mathematical and scientific difficulties areas, specifically focusing on hard skills such as reading comprehension, grammar, counting and numbering, units of measurement, geometry, scientific concepts and experiments, and how they can be practiced and improved through physical education activities, in primary school pupils between 8 and 11 years old.

The AMIS project (Apprendimenti in Movimento per l'Inclusione a Scuola, therefore Learning in Motion for Inclusion at School, LIMIS) aims to verify the implications of research results on Spaced Learning in the linguistic, mathematical and scientific areas, implementing and optimizing the teaching methodology

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even with students in difficulty and/or with disabilities.

Spaced Learning is a particular articulation of lesson time that allows the maximization of the concentration, memorization, and cognitive work of students. The approach with the students remains the traditional one, but Spaced Learning conceives the lesson as an alternative situation that makes the student participate and be aware, active, and critical.

The teacher can use Spaced Learning to introduce a new topic, for reinforcement activities in anticipation of the tests, to lighten a lesson that is too long or difficult, and to facilitate the acquisition of content in students with difficulty.

1.1 Background

Spaced Learning allows truly meaningful learning and transforms the direct instructional of the teacher into the experiential learning of the student. In this way, the teacher can verify both the actual understanding of the content and the ability to apply knowledge in a given situation and promote personalized learning. Spaced Learning concerns the lesson and teaching activity in an innovative temporal dimension through a structuring of class work that allows students to improve attention, memorization of contents, and elaboration of concepts.

Several studies, including those by Kelley (2007) and Kelley & Watson (2013), developed the Spaced Learning technique to test whether it was possible to encode complex information in LTM (Long-Term Memory) in students using stimuli repeated in a very short time scale. Over the course of the lesson, stimuli (inputs) are highly concentrated periods of instruction, while space is created through 10-minute distraction activities (intervals). In their research, the stimuli were highly compressed periods of instruction, and space/interval was created through 10-minute distraction activities. Interval learning in this form was used as the only means of instruction for a biology course (UK national curriculum) on 13 to 15-year-olds and resulted in very rapid LTM coding as measured by a high-stakes course test. Learning per hour of instruction/lesson, as measured by the test, was significantly higher for spaced learning groups ($P < 0.00001$).

According to a perspective that aims to identify the results of neuroscientific research that can best be used by teaching, Spaced Learning finds its origin in the studies of cognitive neuroscience that have contributed to understanding both the mechanisms involved in learning and the most effective teaching techniques in making the most of brain plasticity related to learning. On the basis of this new knowledge on how the brain learns, some strategies and methodologies are developed aimed at enhancing the learning process. Long-Term Potentiation (LTP), a form of synaptic plasticity, is widely regarded as one of the major processes underlying cellular and molecular mechanisms involved in memory and learning formation (Douglas Fields, 2005; Douglas Fields & Bukalo, 2020).

The continuous repetition of information strengthens the memory track and prevents forgetting. In fact, the process that concerns the processing of the perceptual stimulus up to its fixation in long-term memory takes place involving neural circuits of the hippocampus. In the case of excessive new information, the phenomenon of cognitive overload is possible (Carpenter et al., 2012). In this regard, the effectiveness of this method in learning lies in the fact that the processes of long-term memory, biologically determined and essential for learning, are favoured by this technique, which therefore highlights the close relationship between learning and repetition of the stimulus followed by the consolidation of synapses and the biochemical processes that lead to the fixation of long-term memory.

Long-term late potentiation and LTM studies, in different contexts and species, show that repeated stimuli interspersed with stimulus-free periods can lead to intracellular signaling mechanisms that activate genes that, by initiating protein production (Hernandez & Abel, 2008; Scharf et al., 2002), strengthen synapses.

The efficacy of interval repetition in creating long-term memories has been experimentally demonstrated in many species on minute timescales (Morris, 2003).

Motor activity favors spaced learning because it stimulates the consolidation of knowledge and information in students through meaningful interactions between the mind and body in the education of professionals in the field of care. This relationship is essential in health professions education (Versteeg et al., 2020) and also in care professions education.

The World Health Organization (WHO, 2010), the 2015 revision of the International Charter for Physical Education, Physical Activity and Sport of UNESCO (1978), and the European Charter of Sport (Rhodes, 1994), recently revised by the Committee of European Ministers (16 May 2021) reiterate, recalling the principles of the Universal Declaration of Human Rights and the Charter of the United Nations, whereas it is a fundamental right of persons with disabilities to participate in quality, adapted, safe and inclusive physical education and sports activities; in order to lead healthy lifestyles and develop authentic and participatory relationships.

Scientific literature (Gomez Paloma et al., 2017; Palumbo et al., 2019; Valentini & Marinelli, 2021) highlights how sports practice builds the positive concept of corporeality, especially in people with disabilities, since through movement and its free expression, the student finds himself, stimulates creativity and overcomes psychophysical blocks.

Several researchers (Dunn & Leitschuh, 2005; Kudlacek, 2013; Magnanini, 2021) underline how the importance of physical and sporting activity, carried out in a regular and constant manner, is a very important tool in maintaining a state of well-being and psychophysical health for all students (Poitrait et al., 2016), especially for children and adolescents with disabilities (Ross et al., 2016; Battaglia et al., 2019).

The sporting activity conceived and organized in its educational value is generally considered as the opportunity that children, preadolescents, and adolescents have to develop their motor potential (Landry et al., 2012), psychological and socio-relational (Findlay et al., 2008), as well as increasing functional independence and the process of inclusion (Murphy, 2008; De Anna, 2009).

We promote pupils' psycho-physical well-being by improving the various stages of education through a holistic approach that includes all stakeholders involved in pupils' school life, including families. We also aim to support teachers in their career path, with a view to continuous professional development, providing them with tools that can lead them to career diversification.

We promote interdisciplinary collaboration in order to develop key competencies and soft skills in marginalized pupils that will translate into benefits in social inclusion and future employability. We contribute to innovation in education and training for both pupils and teachers. We promote a healthy lifestyle by incorporating sports practice into study moments, referring to the concept of health as being understood as mental and physical well-being and not as the absence of disease.

After identifying the needs, we will enter the implementation phase, and first, the starting level of the pupils benefiting from the project activities will be surveyed.

2 Methodology

The AMIS Project aims to develop and use the Spaced Learning methodology to evaluate its effectiveness and efficiency in the field of primary education and teacher education. It will make use of quantitative and qualitative research methods through classical experimentation and action research. It will involve the randomized distribution of groups and data processing using statistical techniques, including cluster analysis.

The actions that will be implemented offer themselves as prerequisites for improving the quality and inclusiveness of education and training systems, improving educational outcomes, achieving the goals and targets of the European Education Area, as well as driving sustainable growth, improving well-being, and building a more inclusive society. While most empirical evidence on the evaluation of education and training policies comes from the United States or the United Kingdom, exploring and investigating how these policies can be improved in an EU member state such as Italy can enrich the academic literature in a

different context.

The process of educational inclusion, initiated in Italy since the 1970s, is a starting point from which to check whether the equity measures put in place in the education and training system really take into account the situation of disadvantaged learners; on the one hand, this requires a careful analysis of the conditions of in-success for the promotion of essential skills; on the other hand, it requires educational and didactic support capable of guaranteeing each subject personal self-realization and the construction of an authentic life project. Cooperation with a range of actors involved in the inclusive process will be strongly encouraged.

Our article is more like a project proposal than a finalized research project; actually, it is in progress, so the detected data will be presented in the next publication.

2.1 Design and objectives

We intend to study the relationship between reading literacy, mathematical literacy, science literacy (hard skills), and the development of motor skills (physical literacy). The focus will be on learning processes interspersed with motor exercises as provided by the Spaced Learning model.

The research question is as follows: Spaced Learning improves educational outcomes and outcomes in terms of knowledge and skills in primary school pupils aged 8-11 years, and in particular in children with linguistic and sociocultural difficulties and/or disadvantages or disabilities (especially neurodevelopmental disorders and genetic syndromes), who participate in Italian, mathematics and science lessons?

To answer the question of how to promote and evaluate in pupils the improvement of linguistic and mathematical-scientific knowledge, skills, and competencies, it was decided to use a two-year program of activities focused on Spaced Learning and a periodic verification tool; the research team will intentionally prepare both.

The training program will be developed through an action research, observing a continuous cycle of diagnosis, planning, action execution, investigation, and evaluation (re-application, review, balance). The validation of the training course will be carried out with two experimental designs: a) with two groups (experimental and control) and b) with a single recurring group with an interrupted time series (almost experimental plan).

Games and motor exercises, and physical activity in general, serve to distract the student while learning by reducing his mnemonic and conceptual effort and his concentration, allowing him to learn in a serene, relaxed, and effective way. We predicted that at the end of the experimental action, the positive performance in the sample group would significantly increase in text comprehension, grammar, calculation, and numbering, units of measurement, geometry, concepts, and scientific experiments.

Reading and comprehension activities of the text, grammar, solving mathematical problems, and scientific conceptualizations interspersed with motor exercises will be prepared. A physical setting of 10 minutes will be set up, during which students will intersperse the lesson with motor activities and interactive games.

2.2 Research questions

Recent international surveys show that the proportion of students with low skills in reading comprehension, mathematics, and science is increasing in Italy (OECD/PISA, Organization for Economic Cooperation and Development/Programme for International Student Assessment, 2018, 2022; IEA/TIMSS, International Association for the Evaluation of Educational Achievement/Trends in International Mathematics and Science Study, 2019, 2023).

The studies also analyzed the measures taken by the educational authorities of European countries to strengthen the motivation of students and raise the level of their achievements, with a focus on support measures aimed at those with poor results, through the analysis of the organization of teaching, of the

evaluation and the general context of education.

The conclusions highlight the importance of allocating sufficient teaching time and innovative and/or alternative strategies, providing timely teaching support, ensuring the training of specialized teachers, and systematically monitoring students' achievements.

In Italy, students' reading literacy has been detected, in recent years, by several international surveys including IEA PIRLS (International Association for the Evaluation of Educational Achievement - Progress in International Reading Literacy Study) regarding the assessment of reading skills of children in the fourth year of schooling and aged between 9 and 10 years, and national survey such as the INVALSI Tests (Detection of learning classes II and V primary, classes I and III secondary school of first degree, class II secondary school of II degrees).

The results showed that the problem of attributing meanings and meaning to the texts read becomes more relevant with the increase of their complexity, with the diversification of metacognitive strategies, and with the unfolding of motivational factors (engagement).

Even the results of Italian surveys underline the importance of a timely intervention of support, reinforcement, and strengthening. The difficulties regarding these competencies in Italian pupils emerge, particularly in their complexity, in the case of fragile and vulnerable students. The relevance of adequate development and mastery in students of linguistic, mathematical, and scientific skills was affirmed in the Recommendation of the Council of the European Union (2006, 2018).

2.3 Planning, target groups, and stakeholders

The training program will be realized into two years and will be divided into seven steps: awareness of the problem and teacher training; definition of assessment criteria and construction of observation instruments; activity planning; baseline detection; experimentation on the sample of activities; final trend analysis; reflective sharing and dissemination of the results (Fig. n. 1). The sample will be composed of 70 primary school classes, 1,400 pupils aged between 8 and 11 years.

The stakeholders are two national Paralympic federations: FISPES - Italian Federation of Paralympic and Experimental Sports; FISDIR – Italian Federation of Paralympic Sports of Relational Intellectuals – Regional Delegation of Sicily; two associations: Associazione sportiva dilettantistica Il Sottomarino (Palermo); Amateur sports association SporT21 Sicily (Palermo).

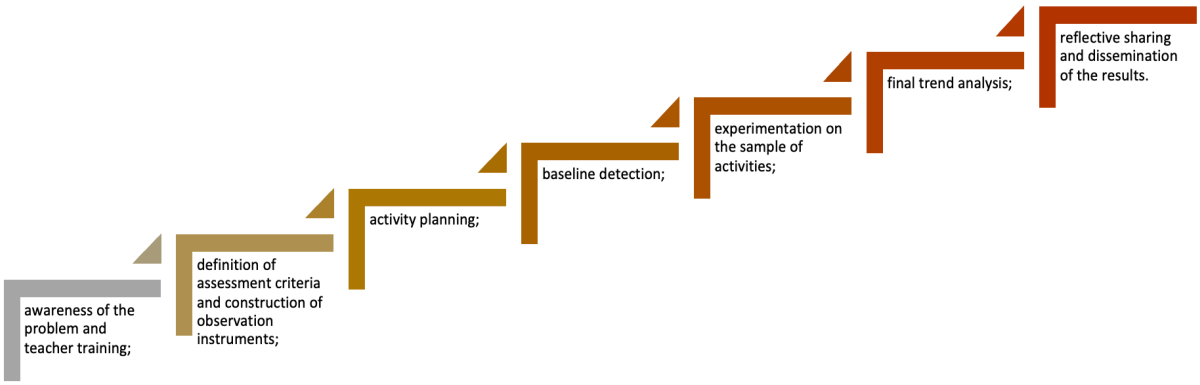


Figure 1 Planning

The work plan will be structured into five phases, as seen from the Gantt chart (Fig. n. 2).

- Analysis which, starting from the recognition of the scientific literature on the topic, makes a first comparison between the achievable goals, the constraints imposed by the context (instruments, time and budget), the starting conditions of the recipients of the intervention, and the focus on the problem with the character of an exploration of feasibility.

- Design concerns the rational anticipation of all the actions with regard to the objectives (definition of times, materials, strategies, tools) and the formulation of the evaluation criteria of the training process and products.
- Development, which concerns the preparation of actions, the preparation of the environment, the preparation of materials, and the realization of supports and actors.
- Implementation is characterized by the application improvement of the devices prepared and their putting into action, with the conduction of communication and relational dynamics and with the activation of regulation and monitoring processes that accompany the action.
- Evaluation concerns the assessment of learning, the functionality of the implemented teaching model (instructional design), and the coherence, significance, and effectiveness of the project itself.

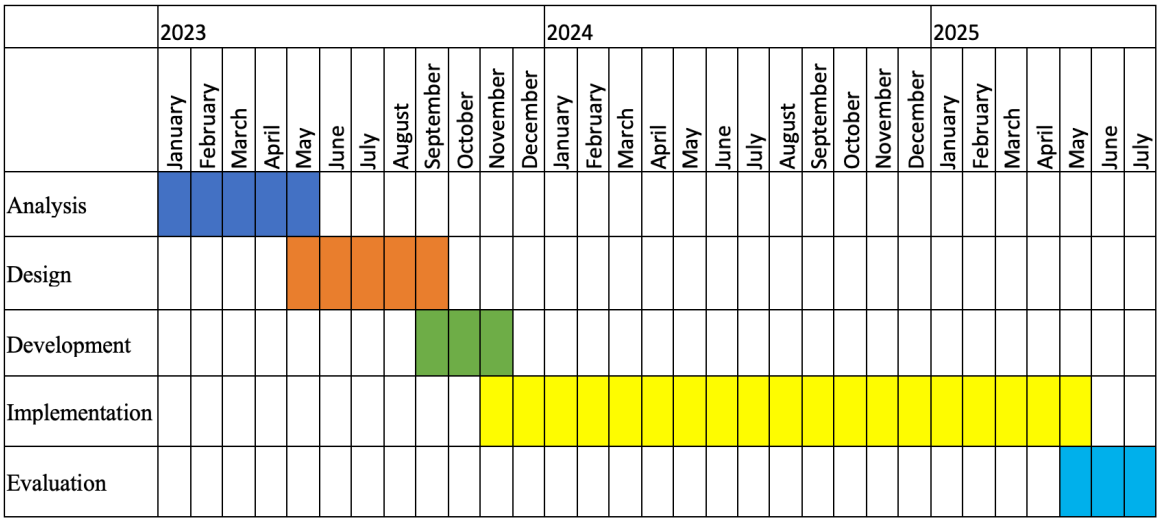


Figure 2 The gantt chart

The lesson time, through structuring with the Spaced Learning methodology, has a precise structure consisting of three input moments and two intervals. Of course, the structure can be adapted and modulated according to the needs of the teachers.

The structure of the LIMIS project has been standardized as follows (Fig. n. 3).

- First Input: The teacher administers the topic and all the information that the pupils have to absorb (30 minutes).
- First Interval: the duration of which is expected to be about 10 minutes. During the break, no reference is made to the previous lesson, but one of the 40 motor activities provided by the teachers is implemented.
- Second Input: The teacher proposes the same topic by adopting a different modality or completing it, then uses other ways of presenting it and lets the students interact on the theme.
- Second Interval: second break lasting 10 minutes. Again, there are no references to the previous lesson, and another motor activity has been implemented.
- Third Input: The teacher returns to the content of the first lesson, but the focus shifts to the students. The pupils will have to, through practical examples and actions, demonstrate that they have learned the content previously administered. Then, the teacher verifies the students' level of learning.

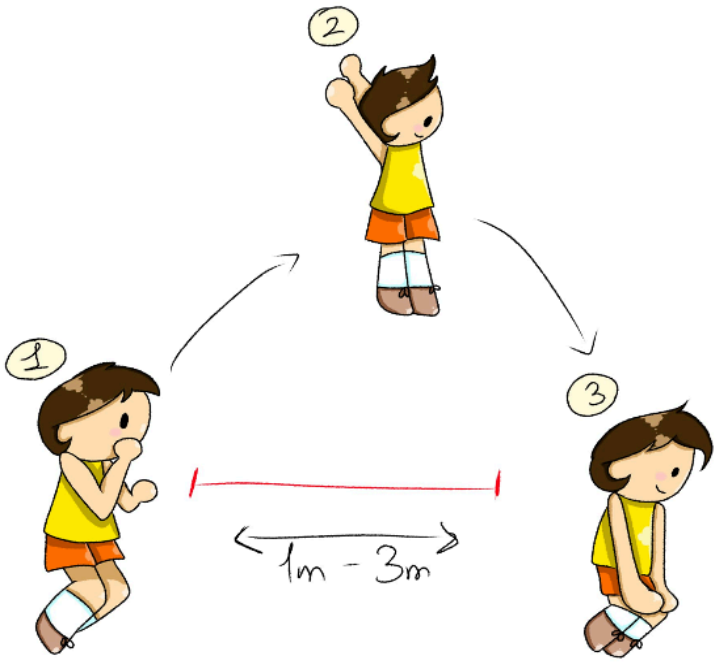
<table>
<tr><td rowspan="6">120 minutes total</td><td colspan="2">15 minutes of classroom management</td></tr>
<tr><td rowspan="5">100 minutes of action</td><td>30 minutes</td></tr>
<tr><td>10-minute interval</td></tr>
<tr><td>30 minutes</td></tr>
<tr><td>10-minute interval</td></tr>
<tr><td>20 minutes</td></tr>
<tr><td colspan="2">5 minutes closing</td></tr>
</table>

For example, one of the motor activities prepared for the realization of the project is reported below.

Activity 1: Side jumps

Short description: Children jump sideways on the basis of a straight line on the classroom floor.

Graphical representation:



Sequence:

- The teacher draws a line on the floor of the classroom with paper tape, at least one meter or three meters long;
- the children arranged in single file or in a circle wait for their turn and move at the teacher's command;
- At the teacher's command, the children jump sideways with both legs, moving first to the right and then to the left of the straight line created by the teacher;
- make multiple jumps along the entire length of the line;
- at the end of the jumps, the children return to their seats;

Note: Each child can do the activity once or more depending on how much time they have.

Structure: collective

Execution: Individual

Material: Tape-Paper

Figure 4 Example of motor activities

3 Impact and expected results

The AMIS Project intends to develop and use the Spaced Learning methodology to evaluate its effectiveness and efficiency in the field of primary education and teacher training.

The actions that will be implemented are a prerequisite for improving the quality and inclusiveness of education and training systems, improving education outcomes, achieving the goals and targets of the European Education Area, as well as driving sustainable growth, improving well-being, and building a more inclusive society.

It is about collecting evidence to evaluate costs and benefits in order to: (a) compare the applicability, generalization, and transferability of alternative methodologies with respect to ordinary and customary methodologies; (b) verify the efficiency of the research program to improve learning outcomes, as well as equity and inclusion measures of education and training systems; (c) developing educational and didactic recommendations, and operational guidelines to inform policy measures, programs, future actions in the field of education and training.

The expected results are: demonstrating that the use of Spaced Learning concretized through physical activity improves linguistic, mathematical, and scientific learning even in students with disabilities; constructing a Spaced Learning operating model; developing a platform for the dissemination of good practices and the sharing of materials for the implementation of Spaced Learning.

4 Conclusions

The process of educational inclusion, which began in Italy in the 1970s, is a starting point for checking whether the equity measures in place in the education and training system take into account the situation of disadvantaged pupils.

This requires an accurate analysis of the conditions of failure for the promotion of essential skills; it is also necessary to have educational and didactic support to guarantee each subject personal self-realization and the construction of an authentic life project.

The project's contribution is related to the dissemination of results and impacts in terms of size and composition of the target group. The benefits of the training intervention will be analyzed with regard to its significance and the conditions of its generalization.

The project is an important moment of experimentation with innovative teaching methods. The teacher and the pupil are at the center of the educational process, and the particular articulation of lesson time is used as a tool to facilitate learning, following a style and approach closer to the attitudes and differences of the pupils.

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