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The PoSE Project: the Potential of Technological Learning for Postural Education in Schoolchildren

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Abstract

Back pain in children and adolescents is quite common, so developing preventive strategies for back pain is highly desirable. This article describes a planned school-based postural education project (PoSE) to promote healthy behaviors among middle school students and their families and to moderate postural diseases. As first step, we evaluated which aspects of postural behaviors were integrated in children's lifestyle through a questionnaire. Then, the educational program consisted of interactive lessons on back posture and good principles both in class and at home. A participatory approach was used to evaluate attempts to involve all who have a stake in outcomes in order to take action and effect change. The strength of the participatory approach used in this study lies in the contribution to empowerment social change.

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1. Introduction

Recent epidemiological data showed that back pain starts early in life and that prevalence rates increase rapidly during adolescence, reaching adult levels around the age of 18 [1]. Furthermore, back pain increases the risk of poor spinal health later in life, with all its well-known consequences, including very high societal costs [2]. Back pain is a multi-factorial diseases, especially in childhood, which complicates the determination of predisposing factors and preventive measures [3]. Several authors considered long retained negative positions as a possible cause of postural diseases and they supposed their contribution in the development of pathological forms [4]. In this sense, early preventive interventions are desirable and during last decades back-care intervention studies in schoolchildren have been promoted, supported by the European Guidelines regarding the prevention of back pain [5]. In literature, several educational programs have been reported, varying considerably in many aspects, such as the type of intervention, teaching techniques, duration, magnitude and intensity of sessions, mode of intervention, characteristics of the participants, and how the interventions are assessed.

Considering the idea about three primary learning modalities (auditory, visual and kinesthetic), current interventions have focused on the first two showing positive evidences in terms of acquired knowledge and appropriate postural habits [6, 7]. However, without sufficient student participation and engagement, classroom activities can not create proper pedagogical opportunities for student to interact with content knowledge. The current state of art shows that the introduction of ICT resources to schools seems to have relatively little impact on the ways that teachers teach [8].

The objective of this study was to create a postural consciousness in young children and their families in order to moderate postural diseases by stimulating their bodily - kinesthetic intelligence. Schoolchildren are receptive to back-care-related knowledge and

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postural habits, representing a key role for back-pain prevention in adulthood. The school is the primary social environment of youth and no other institution has as much contact with children. In particular, middle school was selected as representing a strategic time and place in which to study interventions to influence postural behaviors on health. Children in the 1^{st} to 3^{rd} grades are generally 11 - 14 years old and in early adolescence and, as recent studies investigated, students at this age are developmentally capable of increasing and assuming personal responsibility for behavior change and choices [9].

The research team approached the School Principal of the "Materdona - Moro" Secondary School in Mesagne, Italy, to introduce the KISS-Health Project (Knowledge Intensive Social Services for Health) and the opportunity to implement a school-based postural education program, called PoSE Project (Postural Education at School), to avoid the possible negative physical effects of retained bad posture. The KISS-Health has adopted recent developments in gesture-capture technologies, in particular the Microsoft Kinect System, to recreate a Mobile Diagnostic Lab able to evaluate postural diseases [10, 11]. Furthermore, the KISS-Health aims to introduce in the schools the idea of "Technological Learning", which is poised to become an even more important determinant of growth through its impact on innovation and the Kinect has the potential to facilitate the process.

A community-based participatory research design was selected for this health promotion project, because it was considered the best approach to integrate the knowledge gained with action to improve the health and well being of community members, as previous studies suggested [12]. As discussed in previous studies [13], the likelihood that members of the school community (students, teachers and parents) will promote and/or adopt health-enhancing behaviors is based on a combination of knowledge, attitudes and skills and opportunities for change afforded within the culture of the school.

The PoSE project provides principles that are based on working with people in environments, communities or settings in which they live and work: an Holistic process to evaluate and promote healthy postures in schoolchildren. Health promotion has moved beyond the provision of information and education to operate at many levels to empower people and communities to determine their needs for well-being. In this sense, the PoSE represents an Holistic Learning Model [14] with six defined key variables for learning: Attention, Motivation, Emotion, Memory, Physiology and Environment, with their individual determinants extruded. In the PoSE Project, learning is not limited to the school, but it happens in the context of their community. A lasting improvement in the safety and health of children and young people in school, or in other educational contexts, requires a preventive approach that considers: the physical, psychological and social factors; the school as a whole, as a relationship of organizational components, individual and environmental. A "holistic" approach aims to: a) create or enhance the behaviors and perceptions of individuals in to health and safety in schools; b) conceive the school as a workplace tailored to the needs of the students and teachers.

2. Materials and Methods

2.1. Subjects

We recruited pupils from the 1^{st}, 2^{nd} and 3^{rd} grades (11 - 14 years of age) in a middle school of Mesagne, Italy. There were no exclusion criteria. Our aim was to include 813 participants for the intervention program and we enrolled 34 classes in the project: 248 children for 1^{st} grade, 283 children for 2^{nd} grade and 282 children for 3^{rd} grade classes. We also involved children's families in order to understand the social environment surrounding the young students.

2.2. Ethics and Data Collection

In order to deal with the problems set out above, where necessary, a request to guarantee the quality and the safety of the data will be send to the data Protection Commissioner entitled "Authorization to the processing of student and family data for scientific research", in observance to the Code for the protection of personal data (Provision of Guarantor No 2 of 16 June 2004, Official Gazette of August 14, 2004, No 190). Regarding ethical problems arising, we have achieved a positive opinion from Ethics Committees of the School. The data collection will be archived in KISS-Health data center to ensure the security in accordance with all applicable regulations. Students and their families were informed by the Head of the School about the preliminary process to assess the data. If necessary, we would recruit single groups of students and families to sign a written consent.

2.3. Design

The PoSE Project (Postural Education at School) is a planned school-based postural education intervention to promote healthy behaviors and awareness among middle school students with the involvement of the class teachers during the school year. The project consists of three phases: Phase I, understanding the cultural level; Phase II, intervention program (Figure 1); Phase III, evaluation for a socio-economic perspective.

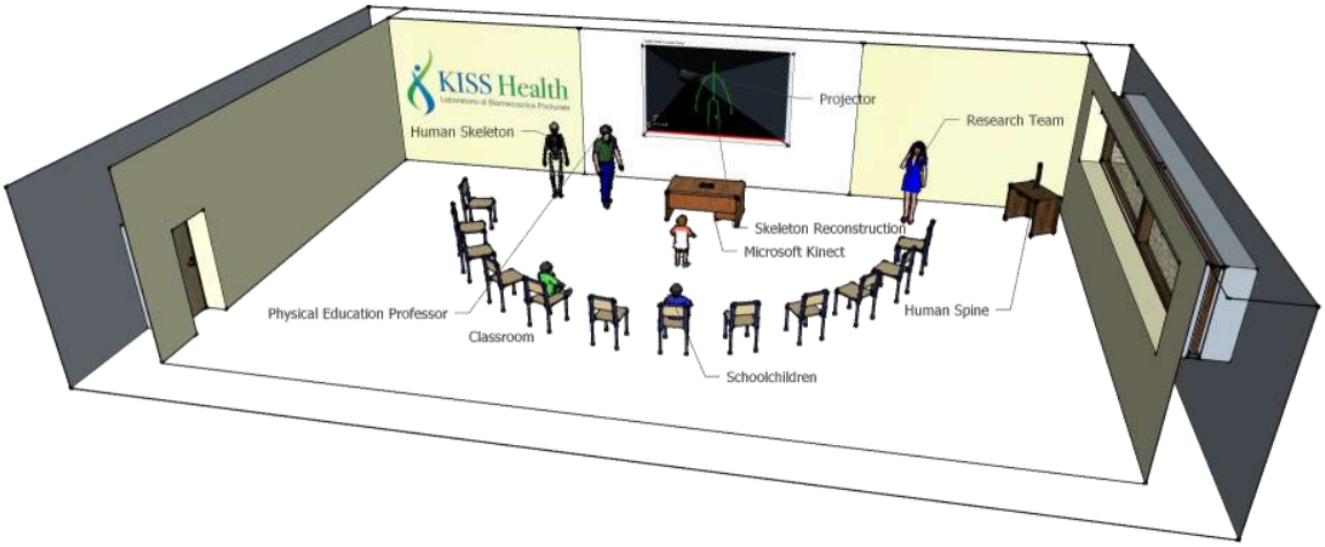

Figure 1. Virtual reconstruction of the PoSE Scenario

Phase I: Understanding the cultural level The PoSE Project expanded Physical Education (PE) from typical physical fitness and sports into the movements and postures associated with educational tasks. Previous experiences on similar approach can be found in [15]. The teachers were four Physical Education Professors from the pilot school, with several years of experience, and the KISS-Health team (a bioengineer, a biologist and a biotechnologist). At pre- and post-intervention, children completed a questionnaire at school with regard to their postural behaviors and social factors, which was elaborated by the KISS-Health group in collaboration with the PE teachers and a multidisciplinary team, taking in consideration previous experiences reported in literature [16]. To minimize socially desirable answers, questionnaires were signed with a code and they were informed about the anonymous data processing. In addition, guidelines on postural behaviors were provided for the class by teachers in order to optimize integration of the learned back posture principles.

Postural behaviors were questioned through 16 questions about: back posture principles during daily live (8 questions); postural behavior in class during lesson time (2 questions) and during studying at home (3 questions); postural aspects with regard to spinal loading during regularly sitting on a chair (3 questions). Socio-economic factors were investigated through 4 questions about: use of technological devices and internet applications (2 questions); lesson's contents (2 questions). A similar questionnaire with 22 questions was submitted to children's parents to be completed independently at home, but it was arranged to include other socio-economic factors, such as parental working activity (2 questions), educational level (2 questions) and their opinion about their children's education (3 questions).

Phase II: Intervention Program The study was carried out over 8 days spread over a 2-week period in February and April 2014. The main issues of the educational program for school as taught in the middle school in Mesagne are summarized as follows:

The human body

(i) The planes of motion;

(ii) The lower limbs - movement, pathologies;

(iii) The spine - structure, movement and posture;

Sitting

(i) Analysis and type of sitting position during the school day and at home;

(ii) The difference between comfortable sitting and correct sitting;

(iii) Sitting in front of the computer work-stations in school and at home;

Lifting, pushing and carrying

(i) General aspects of lifting, pushing and carrying of different objects;

(ii) Lifting and carrying schoolbags.

The teaching methods involved more practical and interactive experiences with the use of various objects (human skeleton, human spine, ...), videos and games

in order to install the relevant knowledge through different senses. We proposed a change in pedagogical practices by adopting educational technologies to contribute to successful teaching and learning. We supposed that interactive lessons could be the more appropriate approach to reach the specific issues required by postural education, including reciprocal opportunities for talk, appropriate guidance and modeling, environments for participation and an increase in the level of student autonomy.

At the end of the lessons, a personalized cross-puzzle including 27 words related to posture and body biomechanics was submitted to children grouped by two to encourage the development of a specific terminology. At the end of each lesson, students were asked to reflect on the learning experience. The research team arranged a daily poster where students were invited to put their notes about posture and what they have learned.

Phase III: Evaluation for a socio-economic perspective Traditionally economic evaluations involve the identifying, measuring and valuing both the inputs (costs) and outcomes (benefits) of alternative interventions [17]. The inputs and the outcomes included in this study depend on both the questions being addressed and the perspective of the study. For example, in our study, the education sector in a health promotion intervention (PoSE) may be compared to other uses, such as the teachers time for prevention, or the use of alternative equipment in terms of value for life-style. The main steps that will be developed through the project for a balanced socio-economic evaluation will be:

(i) Life-style of students and families in the school life (input);

(ii) Digital divide of students and families (input);

(iii) Level of education (input).

The focus of these results will be relevant in term of professional training, assessment of new technologies and adaptation of operational procedures for a health promotion intervention, like Postural Education at School.

2.4. Data Analysis

Statistical analysis was performed using SPSS 21.0. The pre- and post- intervention data on children's postural behaviors during school time/work and daily activities were reported as prevalence and they were compared performing Fisher's exact Test. We considered as dichotomous variables the possible answers, assuming good postural behaviors as value 1 and incorrect behaviors as value 0. We also reported the comparison between children and their parents.

3. Results

Here we present the results of the PoSE Project according to the Phase of the intervention. Table 1 presents group differences between students and their parents in personalized aspects of postural behavior conform to a biomechanical favorable lifestyle. The non-responders' percentage (indicated as NR) was here reported, but it was not considered for the Fisher's exact Test. It should be considered that in the parents' test the question "When you make your work, do you stop your sitting activity?" was related to the question "Is your work sedentary?", which resulted positive for 31.4% of all parents.

Significant differences were found for 10 of the 13 postural behaviors, while evaluation of the reports on some daily attitudes showed no differences between both groups. Further, the major part of the children reported that paying attention to the natural curve of their body, joining sport activity 3 times a week, carrying object as close as possible to their body and stopping their sitting activity were common habits (>60% of all children). Similar results were reported by parents, except for joining sport activity and stopping their sitting activity (<42%). A very limited percentage of children and their parents (<16% of all) reported that they relax with lifted legs and place book on inclined surface. Finally, a large percentage of children and their parents reported they had included postural aspects preventing spinal loading during sitting activities (back rest use; arm support; feet on the floor).

Subsequently, we analyzed good postural attitudes between students grouped by class grade (1^{st}, 2^{nd} and 3^{rd} grades). Only the results of significant differences are reported in Table 2.

A large percentage of 1^{st} grade students showed a better back posture awareness than the students of higher classes, while a higher percentage of 2^{nd} and 3^{rd} grade students reported changing their posture and interrupting their sitting activity as common habits. Finally, we assigned a score for postural behaviors to each student and their parents who answered the questionnaire and we reported in Figure 2. No significant differences where found with regard to the score reached by students stratified by class grade, even when compared with the score assigned to the parents (Figure 3).

We then analyzed the questionnaires submitted to the students after the intervention program has been carried on during physical activity classrooms. The comparison is illustrated both in Figure 4 and in Figure 5, respectively as a box plot and as a histogram of the mean scores reached by the students grouped by class grades.

In Figure 6, we would like to give an idea of the capabilities of the students to improve their

Table 1. Comparison of personalized good back posture principles between students and their parents (Fisher's exact Test)

Questions about Postural Behaviors	Students		Parents		p-value
	R(%)	NR(%)	R(%)	NR(%)	*<=0.001 **<=0.005
Postural Behaviors					
Do you pay attention to the natural curve of your spine?	68.8	5.5	75.0	9.7	0.000*
Do you do sport 3 times a week?	63.8	5.2	35.8	10.3	0.000*
When you relax, how do you lie down?	14.0	7.3	15.7	11.2	0.176
When you lift an object, how do you do?	53.9	5.4	57.3	9.7	0.010*
Do you ask for help to lift a heavy object?	52.1	5.3	63.8	9.7	0.000*
Do you carry an object as close as possible to your body?	73.8	11.3	81.6	10.5	0.000*
Do you check the weight of schoolbag?	42.4	12.7	75.9	10.0	0.000*
When you read, how do you put books?	10.7	5.2	10.1	9.8	0.952
When you sit in classroom/at work, are you aware of your posture?	50.8	4.7	60.6	10.0	0.000*
When you make your homework/work, do you stop your sitting activity?	71.3	4.9	41.4	39.4	0.010*
When you sit on a chair with a backrest, do you use it?	76.1	4.9	67.6	10.8	0.049**
When you sit, how do you make that your arms are supported?	81.4	4.7	66.7	10.1	0.000*
When you sit, do you sustain your both feet to the ground?	73.3	4.7	69.2	11.7	0.485

Table 2. Comparison of the number of students with good back posture principle grouped by class grades (Fisher's exact Test)

Questions about Postural Behaviors	Students						p-value
	1^{st}(%)		2^{nd}(%)		3^{rd}(%)		*<=0.001 **<=0.005
	R(%)	NR(%)	R(%)	NR(%)	R(%)	NR(%)	
Postural Behaviours							
Do you pay attention to the natural curve of your spine?	77.8	4.0	64.0	5.3	65.6	7.1	0.001*
When you sit in classroom, are you aware of your posture?	61.7	2.4	47.7	4.9	44.3	6.4	0.001*
When you sit in classroom, do you change your posture?	63.3	3.6	72.1	4.2	77.7	6.7	< 0.001
When you make your homework, are you aware of your posture?	56.4	2.8	38.2	4.6	44.3	7.1	< 0.001
When you make your homework, do you stop your sitting activity?	66.1	2.8	76.0	4.2	74.5	6.4	0.003**

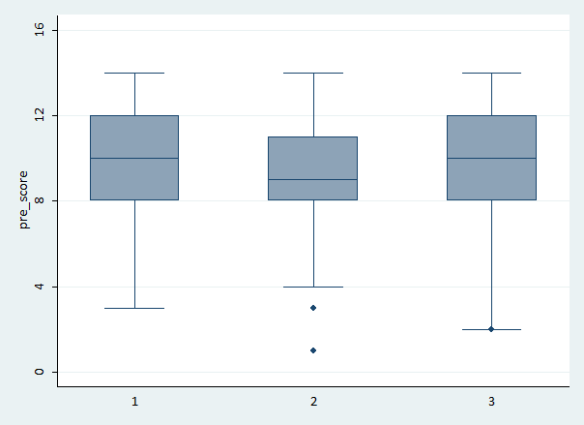

Figure 2. Box-plot of Postural Behaviors' Scores of Students and their Parents stratified by Grades

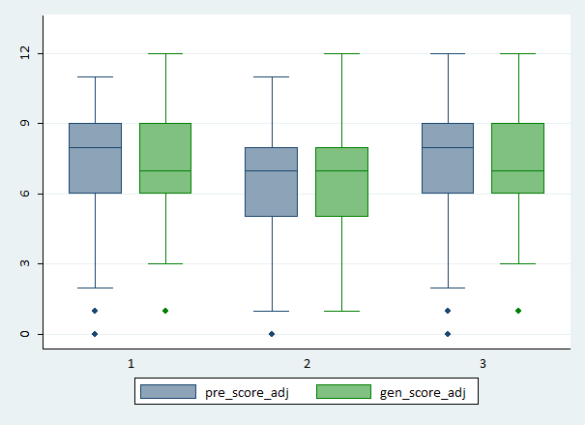

Figure 3. Box-plot of Postural Behaviors' Scores of Students and their Parents stratified by Grades

knowledge in terms of postural behaviors after the school based intervention. As it is illustrated, we grouped the students by class grades and the histogram quantifies the mean difference (in percentage) between the number of positive, negative and missing answers given in pre- and post- questionnaires. It can be stated that students from 2^{nd} grade significantly improve their prior knowledge on postural attitudes.

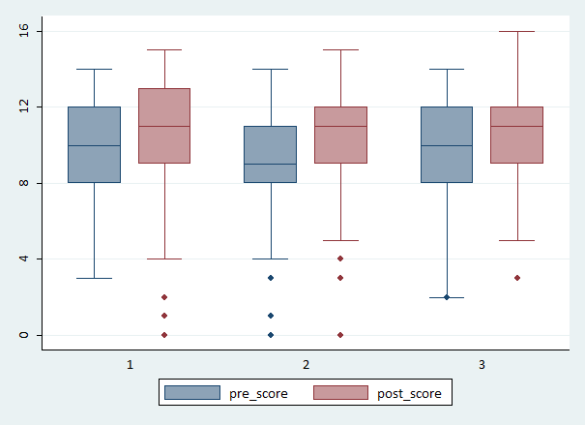

Figure 4. Box-plot of Pre and Post Postural Behaviors' Scores of students stratified by Grades

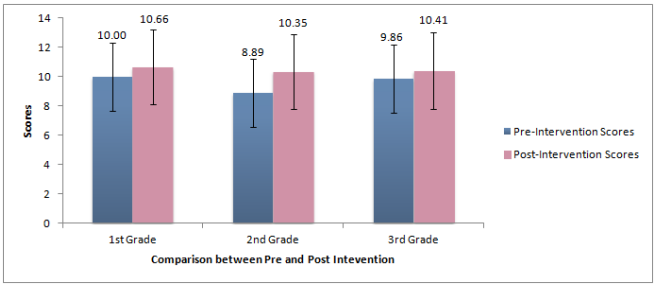

Figure 5. Histogram of Pre and Post Postural Behaviors' Mean Scores of students stratified by Grades

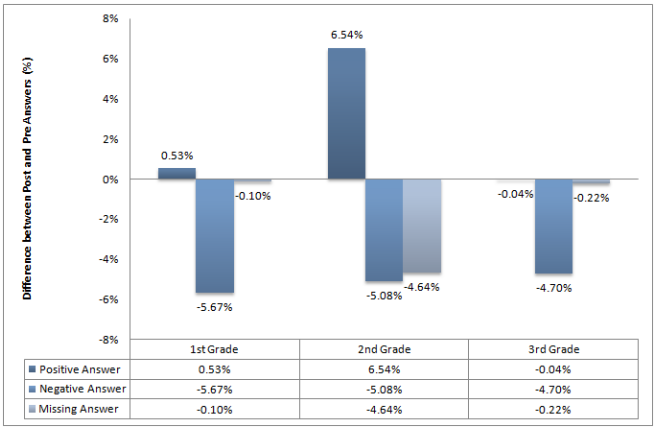

Figure 6. Histogram of the Trend of Pre and Post Postural Behaviors' Answers of students stratified by Grades (%)

4. Discussions

The main aim of the current study was to present an innovative approach to promote healthy postures in schoolchildren and to create a postural consciousness. The present total study sample consisted of 1516 subjects (only 9.35% of parents and 4.43% and 8.86% of students did not respond to the questionnaire, respectively in pre- and post-intervention). This sample size is relatively large compared to other intervention studies [15, 16] and may suggest some general relevance. It is important to say that the children cooperated in an amazing way and they were excited about the initiative. We received also positive feedback from the families and the school management.

Comparable results to a previous study [16] can be found in the prevalence of children reporting that carrying an object as close as possible to the body, joining sport activities 3 times a week and preventing spinal loading were included postural aspects of their daily life. However, no previous studies have investigated the role of families and school in postural behaviors and awareness. A right knowledge of biomechanical favorable postural behavior is a necessary but not sufficient condition for the development of a conscious and healthy lifestyle with respect to good body mechanics. In this sense, the integration of good postural principles has been investigated with the results of the post-intervention questionnaire. Results confirmed that the interactive approach here adopted stimulated students knowledge and comprehension of postural behaviors, in particular 2^{nd} grade students obtained a higher score after the PoSE program. This is particularly encouraging for our research because it opens new scenarios for technological learning in a school based approach. However, it is important to underline that the analysis here conducted is not exhaustive of the overall behavior of the students and their family when dealing with their posture, but a detailed socio-economic perspectives is going to be conducted in terms of value co-creation in subsequent works.

Finally, we believe that the Microsoft Kinect needs to be situated in combination with software and other hardware in order to create meaningful classroom interactions. In this preliminary phase, the sensor was introduced in the classroom environment as a support for teaching to impact on student participation, but subsequent works are required to exploit the potential of kinesthetic and gesture-based technologies in this context.

5. Perspectives and On-going Work

The research team is currently working on the extension of the work by increasing the statistical sample both by number and by age group involving other schools in the pilot project. Furthermore, the temporal analysis will be extended in relation to the quantitative assessment of postural diseases that the KISS-Health Project will execute in the School with the Mobile Diagnostic Lab realized under this social innovation initiative [10, 11]. To our knowledge, no previous studies have investigated the role of introducing educational technologies to vehicle preventive postural interventions. We are also exploring the possibility

to submit a new questionnaire to both children and families with more specific questions about postural principles to avoid any possible confounding factors related to social desirable answers.

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References

[1] Jeffries L.J., Milanese S.F. and Grimmer-Somers K.A. (2007) *Epidemiology of adolescent spinal pain: a systematic overview of the research literature* 32(23):2630 - 2637, Spine

[2] Aartun E., Degerfalk A., Kentsdotter L. and Hestbaek L. (2014) *Screening of the spine in adolescents: inter - and intra - rater reliability and measurement error of commonly used clinical tests* 15(1): 37, BMC musculoskeletal disorders

[3] Cardon G. and Balagué F. (2004) *Low back pain prevention's effects in schoolchildren. What is the evidence?* 13.8: 663 - 679, European spine journal

[4] Shalavina A.S. (2013) *Qualitative and Quantitative Assessment of the State of the Posture of Junior School Children* 27 (7): 860 - 862. World Applied Sciences Journal

[5] (2006) *COST B13 European guidelines for the management of low back pain* 15 (Suppl 2): S125 - S297, Eur Spine J

[6] Calvo-Munoz I., Gomez-Conesa A. and Sanchez-Meca J. (2012) *Preventive physiotherapy interventions for back care in children and adolescents: a meta-analysis* 13.1: 152, BMC musculoskeletal disorders

[7] Kovacs F., Oliver-Frontera M., Plana M.N., Royuela A., Muriel A. and Gestoso M. (2011) *Spanish Back Pain Research Network: Improving schoolchildren's knowledge of methods for the prevention and management of low back pain: a cluster randomized controlled trial* 36(8): E505 - E512, Spine

[8] Hsu H.M.J. (2011) *The potential of kinect in education* 1(5), 365 - 370, International Journal of Information and Education Technology

[9] Venditti E.M., Giles C., Firrell L.S., Zeveloff A.D., Hirst K. and Marcus M.D. (2014) *Interactive learning activities for the middle school classroom to promote healthy energy balance and decrease diabetes risk in the HEALTHY Primary Prevention Trial* 15(1): 55 - 62, Health promotion practice

[10] Bortone I., Argentiero A., Agnello N., Santo Sabato S. and Bucciero A. (2014) *A two - Stage Approach to Bring the Postural Assessment to Masses: The KISS-Health Project* pp. 371 - 374, In Biomedical and Health Informatics (BHI), 2014 IEEE-EMBS International Conference on, IEEE

[11] Bucciero, A., Santo Sabato, S. and Zappatore, M. (2014) *A Biomechanical Analysis System of Posture* In: 8^{th} International Conference on Pervasive Computing Technologies for Healthcare, Oldenburg

[12] Ciccarelli M., Portsmouth L., Harris C. and Jacobs K. (2012) *Promoting healthy computer use among middle school students: a pilot school-based health promotion program* 41 Suppl 1:851 - 6, Work: A Journal of Prevention, Assessment and Rehabilitation

[13] Egger G., Spark R. and Donovan R. (2005) *Health promotion strategies and methods* McGraw - Hill, North Ryde, N.S.W., 2nd ed

[14] Riding R. and Rayner S. (2013) *Cognitive styles and learning strategies: Understanding style differences in learning and behavior* Routledge

[15] Heyman E. and Dekel H. (2009) *Ergonomics for children: An educational program for elementary school* 32.3: 261 - 265, Work: A Journal of Prevention, Assessment and Rehabilitation

[16] Geldhof E., Cardon G., De Bourdeaudhuij I. and De Clercq D. (2007) *Back posture education in elementary schoolchildren: a 2 - year follow up study* 16(6): 841 - 850, European spine journal

[17] Pommier J., Guevel M.R. and Jourdan D. (2010) *Evaluation of health promotion in schools: a realistic evaluation approach using mixed methods* 10.1: 43, BMC Public Health