Harlen, W. The assessment of scientific literacy in the OECD/PISA project. *Studies in Science Education*, **36**, 79-104, 2001.

Hogan, K. Small groups' ecological reasoning while making an environmental management decision. *Journal of Research in Science Teaching*, **39**, [4], 341–368, 2002.

ITEA. *Standards for technological literacy: Content for the study of technology.* Reston, VA: International Technology Education Association, 2000.

Jarman, R.; Mcclune, B. *Developing scientific literacy. Using news media in the classroom*. Maidenhead: McGraw-Hill International, 2007.

Jiménez-Liso, M.R.; Hernández, L.; Lapetina, J. Dificultades y propuestas para utilizar las noticias científicas de la prensa en el aula de ciencias. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, **7**, [1], 107-126. 2010

Kolstø, S. Patterns in Students' Argumentation Confronted with a Risk-focused Socio-scientific Issue. *International Journal of Science Education*, **28**, [14], 1689-1716. 2006.

Korotayev A.; Malkov, A.; Khaltourina, D.. Introduction to Social Macrodynamics: Compact Macromodels of the World System Growth. Moscu: Editorial URSS. 2006.

Lewis, J.; Leach, J. Discussion of Socio-scientific Issues: The role of science knowledge. *International Journal of Science Education*; **28**, [11], 1267-1287. 2006

Lemke, J. Investigar para el futuro de la educación científica: Nuevas formas de aprender, nuevas formas de vivir. *Enseñanza de las Ciencias*; **24**, [1], 5-12. 2006

Linn, M. Promover la educación científica a través de las tecnologías de la información y comunicación (TIC). *Enseñanza de las Ciencias*; **20**, [3], 347-355. 2002.

Marco-Stiefel, B., Ibáñez, T. y Albero, A. *Diseño de Actividades para la Alfabetización Científica. Aplicaciones a la Educación Secundaria.* Madrid:Narcea Ediciones. 2000.

McCracken, G. Who is the Celebrity Endorser? Cultural Foundations of the Endorsement Process, *Journal of Consumer Research*, **16**, 310-321. 1989.

Membiela, P. Investigación-acción en el desarrollo de proyectos curriculares innovadores de Ciencias. *Enseñanza de las Ciencias*, **20**, [3], 443-450. 2002.

NRC. *National Science Education Standards*. Washington, DC: National Academic Press, 1996.

OEI. *Memoria de la programación 1999-2000*, Madrid: OEI. 121-134, 2001.

Oliveras, B., Márquez, C. y Sanmartí, N. The use of newspaper articles as a tool to develop critical thinking in science classes. *International Journal of Science Education*, **35**, [6], 885-905, 2013.

O'Sullivan, T.; Dutton, B.; Rayner, P. *Studying the Media: An Introduction.* London: Arnold, 1998.

Pitrelli, N., Manzoli, F. y Montolli, B. Science in advertising: uses and consumptions in the Italian press, *Public Understanding of Science*, **15**, 207-220, 2006.

Pozo, J.I.; Gómez-Crespo, M.A. *Aprender y Enseñar Ciencia.* Madrid: Morata, 1998.

Prieto, T.; España, E.; Martín, C. Algunas cuestiones relevantes en la enseñanza de las ciencias desde una perspectiva Ciencia, Tecnología y Sociedad. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*; **9**, [1], 71-77. 2011.

Pro, A.; Ezquerra, A. ¿Qué ciencia ve nuestra sociedad? *Alambique: Didáctica de las Ciencias Experimentales*, **43**, 37-48. 2005

Río, P. Publicidad y consumo, hacia un modelo educativo. *Infancia y Aprendizaje: Journal for the Study of Education and Development*, **35**, 139-174. 1986.

Sørensen, H., Clement, J. y Gabrielsen, G. Food labels – an exploratory study into label information and what consumers see and understand. *The International Review of Retail, Distribution and Consumer Research*, **22**, 101-114, 2012.

UNESCO. Science and Technology 2000+ Education for all. The Project 2000+ Declaration. París: UNESCO, 1994

UNESCO-ICSU. *Proyecto de programa en pro de la ciencia: Marco general de acción*. Conferencia Mundial sobre la Ciencia para el Siglo XXI: Un nuevo compromiso, Budapest (Hungría), 26 de junio-1 de julio de 1999.

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The Brazilian scientific literacy in the PISA
La alfabetización científica brasileña en el PISA

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Abstract

This study investigated the scientific literacy of Brazilian students through the data of the Programme for International Student Assessment - PISA. Starting from the importance and relevance of discussing the Brazilian scientific literacy it sought to answer to two questions: (a) where are the Brazilian students located in the international context in terms of scientific literacy of PISA?; (b) how do Brazilian students' contextual characteristics, such as their school administrative dependence and socio-economic status, impact their results in Science? For the study, in addition to the determination of descriptive statistics, the analyses were conducted by applying a linear regression model. The results of the 2006 PISA showed that Brazilian students not enrolled at a private school and who do not come from a high-income family have a considerable disadvantage in science. It also showed that the fact of their school being public is alone substantially enough to explain more than 20% of the variance of the average performance in science of Brazilian students and corroborates the results of numerous other studies in educational equality / inequality.

Key words: *international evaluation, scientific literacy, Brazil, PISA*

Resumen

Este estudio investigó la formación científica de los estudiantes brasileños a través de los datos del Programa para la Evaluación Internacional de Alumnos - PISA. Partiendo de la importancia y relevancia de discutir la alfabetización científica brasileña se trató de responder a dos preguntas: (a) cómo son los estudiantes brasileños ubicados en el contexto internacional en cuanto a la formación científica de PISA?; (b) las características contextuales de los estudiantes de Brasil, tales como la dependencia administrativa de su escuela y su estatus socioeconómico, impactan sus resultados en Ciencia? Para el estudio, además de la determinación de la estadística descriptiva, los análisis se llevaron a cabo mediante la aplicación de un modelo de regresión lineal. Los resultados del PISA 2006 mostraron que los estudiantes brasileños que no están inscritos en una escuela privada y que no provienen de una familia de altos ingresos tienen una desventaja considerable en Ciencia. También puso de manifiesto que el facto de ser alumno de la escuela pública es suficiente para explicar en más de 20% la varianza del rendimiento medio en ciencias de los estudiantes brasileños y corrobora el pozo encontrado por otros numerosos estudios en igualdad / desigualdad educacional.

Palabras clave: *evaluación internacional, alfabetización científica, Brasil, PISA*

INTRODUCTION

The Brazilian Association of Science (2008) states that the social, scientific and technological development of Brazil requires a major overhaul of the educational structure in the country. The need to improve basic education in Brazil and, in particular, science education, was a central theme of the document of the Brazilian Academy of Sciences - Science Education and elementary school: proposals for a system in crisis - published in 2008 (ABC, 2008). It is believed that in order to meet the demands of an increasingly complex society, permeated by science and technology, technically specialized knowledge is not enough. Above all, the development of skills to organize thinking, make decisions and deal with data, for example, are crucial to take part in the field of Science. Science and technology define the future of a society and its ability to create and adapt technologies developed from different backgrounds. Even with all the development of science and technology and, although Brazil contributes about 2.7% of the world's scientific production, research conducted in the education field points to a below average performance of Brazilian youth in tests that measure scientific skills and performance in mathematics.

Brazil occupies the 58th place among the most innovative countries in the world.[1]Recognizing science and technology as essential to the economic, cultural and social development of a country, the teaching of Science at all educational levels has growing in importance and has been the subject of numerous teaching transformation movements and can serve as an illustration for implementation and effects of educational reforms. In this paper, PISA - Programme for International Student Assessment - data is used to analyze the results of Brazilian students in Science. The study seeks to understand the school context, assuming that the results of large-scale assessments constitute instruments to understand the school curriculum (Forquin, 1995).

PISA is an international comparative assessment programme, developed and coordinated internationally by the Organization for Economic Cooperation and Development (OECD), applied to a sample of 15-year-old students. The programme takes place every three years, covering three areas of knowledge - reading, math and science - and each edition emphasizes one of these three areas. The assessment seeks to verify the extent to which schools in each participating country are preparing their young people to exercise their role as citizens in contemporary society. It is difficult to imagine a critical citizen who has limited scientific knowledge in a society where scientific knowledge and technological advancement are so important. Although the majority of the population makes use of and gets along with scientific and technological products, individuals do not reflect on the processes involved in the creation, production and distribution of those products. Thus, due to their lack of information they do not make independent decisions and are subordinated to the rules of the market and the media.This prevents the practice of critical and conscious citizenship (BRASIL, 1998). There is a need to prepare young people to be able to participate in some way, in the decisions made in this fieldsince, sooner or later, the choices end up affecting everyone's life. This participation should be based on scientific knowledge acquired at school and the relevant analysis of information received about the advances of science and technology.

The participation of Brazil in the OECD assessment, since its first edition in 2000, made it possible to overview the Brazilian scientific literacy in an internationally comparative perspective. Specifically, this study used the PISA 2006 data, due to the fact that in this edition science was evaluated in more detail. Besides the global scale, in the 2006 edition, it was possible to evaluate the participating countries performance also in specific scientific competencies. The emphasis on this area of knowledge was again the focus of the programme in 2015 and that makes the theme very new and recurrent. The results of that edition, however, were not released yet and are expected in December 2016.

The main goal here is to understand how scientifically prepared are the young Brazilians who participated in PISA 2006. For this, this study sought to answer the following research questions: (a) how are the Brazilian students ranked in the international context in terms of scientific literacy of PISA?; (b) Do Brazilian students' contextual characteristics, such as their school administrative dependence and socio-economic status, impact their results in Science? To continue the discussion and answer the mentioned research questions, the following text is organized into three sections following this brief introduction. In the sequence the methodological approach adopted here is presented, then the results and finally the conclusions.

METHODOLOGY

To answer the research questions, initially, the average performance of students in the science test was analyzed in order to identify Brazil's position on the scale of PISA compared to other participating countries. After that a linear regression model was implemented to analyze the impact of some independent variables in Brazilian students' science proficiency. In particular, the study sought to verify if the socio-economic profile of students and their schools' administrative dependence were able to explain the differences in Science Proficiency (Chart 1). The implemented model here can be expressed by the expression: $Proficiency = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + e$, where Proficiency is the country grade in Science, $_{X1, X2,}$ ... are the explicative variables of the model and $\beta_{0,} \beta_{1,} \beta_{2,}$ ... are the unknown parameters to be estimated.

Chart 1. Variables considered in the study, their definitions, values and notes.

Variable	Definition	Values	Notes
Proficiency in Science (Proficiency)	Indicates Proficiency in science. It is an independent estimation of the student performance in science.	Continuous	Variable built by the PISA Consortium through The Item Response Theory (IRT)
Student Socio-economic Status (SSS)	Indicates economic, social and cultural status of the students. It is composed from aspects like home possessions, highest occupational status and educational level of the parents	1=Very Low 2= Low 3=Medium 4=High	Variable built by the PISA Consortium through the IRT
School Administrative Dependence (SAD)	Indicates whether schools are private or public	1 = public 2 = private.	The variable was aggregated to the student base and then recoded

RESULTS AND DISCUSSION

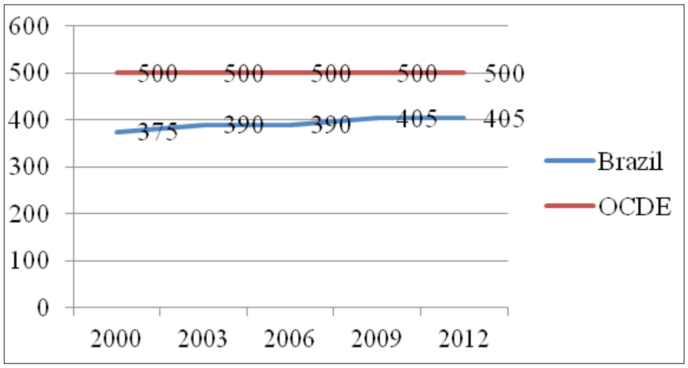
During most of the twentieth century, Brazil had quite unfavorable educational indicators, not only in comparison with European countries, but also compared to its neighbors in Latin America (Franco; Ortigão; Albernaz; Bonamino; Aguiar; Alves; Satyro, 2007). The results obtained by Brazilian students place the country at a disadvantage when compared to almost every country participating in PISA. The results of this performance evaluation in every knowledge domain are provided in a range in which the average of the OECD countries is standardized at 500, with a standard deviation of 100. This means that about two-thirds of the participant students obtained a score between 400 and 600 points.

Analysis of the overall results of PISA shows that the Brazilian performance in Science has improved since 2006 until 2012 from 390 to 405 score points (Graph 1), showing an annualized change of 2.3 score points (OCDE, 2013). Roughly half of this increase, according to OCDE (2013), can be accounted for by changes in the demographic and socio-economic composition of the student population. This mean is below the OECD mean and comparable with Argentina, Colombia, Jordan and Tunisia. Among Latin American countries, Brazil performs below Chile, Costa Rica, Uruguay and Mexico, but above Peru.

About 60% of students in Brazil are low performers in Science, which means that, at best, they can present scientific explanations that are obvious and explicitly highlighted. The percentage of students who exceed the baseline level of Proficiency in Science increased 7.3% between 2006 and 2012 (OCDE, 2013). Performance gains have been most notable among the lowest performing students (at the 10th and 25th percentile), similar to what is observed in mathematics and reading. Very few students (0.3%) in Brazil are top performers in science, which means that they can identify, explain and apply scientific knowledge and knowledge about science in a variety of life situations perceived as complex.

When comparing the mean obtained by Brazil (390) with the other countries participating in PISA 2006, it is obvious that the country's overall performance in Science is not good. Brazil was among the countries with lower performance, ranking 52.nd place among 57 countries administering the test, ahead only of Colombia (the 53.rd) when compared to its South American neighbors that have analogous socio-economic realities. Among the South American participating countries, only Chile and Uruguay have surpassed the barrier of 400 points, obtaining the 40.th and 43.rd positions, respectively. In first place is Finland with 563 points and last, Kyrgyzstan with 322.

1 Highlighted the president of the Brazilian Society for the Progress of Science (SBPC), Helena Nader, during the opening ceremony of the 65th annual meeting of the organization in the capital of Pernambuco/Brazil. Available in: http://memoria.ebc.com.br/agenciabrasil/noticia/2013-07-22/brasil-e-responsavel-por-27-da-producao-cientifica-mundial-destaca-presidente-da-sbpc.Accessed on 12/15/2015.



Graph 1. Evolution of Brazil and OCDE Science performance in all PISA editions.

The national report produced by the Instituto Nacional de Estatísticas Educacionais (INEP) to treat the PISA 2006 data (BRASIL, 2008) indicates that, based on socio-economic and cultural level indicators, it would be unreasonable to expect that the performance of Brazilian students be similar to the average of all OECD students, but that in Science it should be about 30 points higher (30% of a standard deviation) to be as expected for its average level. However, apart from socio-economic and cultural level indicators that substantially impact the results, by tradition, it is known that education in Brazil is unscientific. The education highlighted here is not the type that allows experimentation. As evidenced by Teixeira (1994) it is very abstract, focused on contents that are normally distant from students reality and minimally scientific, marked by a conservative education that allows no risk, no experiment or hypothesis testing; it is much more based on the notion of right and wrong and rooted in the conception of knowledge and use, the antithesis of what is recognized as the foundation of a quality science education.

PISA evaluated the students' competences in identifying scientific issues, in explaining phenomena scientifically and in using scientific evidence. On the competency of identifying scientific issues, Brazil reached an average of 398 points (Table 1). This is the competence in which Brazilian students show the higher skills. On the other hand, that same competence is where the OCDE students are less strong (498,79) but still with a difference that exceeds by one standard deviation the Brazilian students' mean. The greater competence of OECD students is to explain phenomena scientifically and it is very important that students understand scientific facts and theories enabling them to explain phenomena scientifically. However, they also need to be able to recognize what and how issues can be addressed in a scientific way in order to apply their abilities and scientific knowledge. About the fact of using scientific evidence, Brazilian students are particularly weak - 378.13 points.

Table 1: Average results of student s in different competencies in Science in PISA 2006 - Brazil and OECD

	Skills		
	Identifying scientific issues	Explaining phenomena scientifically	Using scientific evidence
Brazil	398.18	390.21	378.13
OECD	498.79	500.35	499.24

Source: PISA 2006 student and school database.

Currently, knowledge of and about science is more important than ever. The relevance of science to the life of any person is irrefutable and scientific knowledge is an essential tool for the achievement of individual and collective goals. This is especially important to the way Science is taught and learned. The tasks that students need to fulfill in PISA 2006 required scientific knowledge of two types: (a) knowledge *of* science, that can be divided into areas of content, such as: physical systems, living systems, earth and space systems; and (b) knowledge *about* science. Some countries have substantially higher performance in knowledge *about* science, ie knowledge of the purposes and the nature of scientific inquiry and scientific explanations, than in knowledge *of* science, knowledge of the natural world and how this is linked to different scientific subjects.

Although not reaching the average of OECD countries, Brazil managed to overcome the barrier of 400 points with respect to knowledge of Science, especially in the area of living systems. Based on the performance means of the OECD, results tend, albeit very subtly, to be better on the issues that require knowledge of science (Table 2).

Table 2: Average results of the students in the knowledge areas of PISA 2006 - Brazil and OECD

	Knowledge about Science	Knowledge of Science		
		Physical Systems	Living Systems	Earth and Space Systems
Brazil average	393.62	384.83	402.91	374.94
OECD average	499.85	500.02	501.81	499.53

Source: PISA 2006 student and school database.

The PISA national technical report (BRASIL, 2008) assures that performing better in *Knowledge of Science* suggests that the curriculum has emphasized the transmission of specific scientific knowledge. However, Brazil has better performance on issues related to knowledge about science (393.62) and the only exception is in the mean achieved in the area of living systems. This knowledge covers issues related to understanding the nature of scientific work and scientific thinking. In countries like Brazil where the literature points out and criticizes a curriculum that emphasizes only the transmission of knowledge, without promoting situations where this knowledge is mobilized (See Carnoy with Gove and Marshall, 2007), such a result is somehow surprising.

To facilitate interpretation of the results, PISA established in each domain of the evaluation areas various levels of performance, based on the classification points or proficiency associated with skills that students must have to achieve a corresponding score. According to the OECD itself (2007), the classification has two purposes: to catagorize student performance and to describe what they are capable of. The PISA Science scale has six levels of proficiency, from Level 1 to Level 6, but here, a Level 0 was included, which represents the students group that did not reach the first level of Proficiency proposed by the programme. The biggest percentages of Brazilian students, more than 60%, are concentrated in the lower range levels of the programme, levels 0 and 1 (Table 3).

Table 3. Distribution of students in the Science performance levels in PISA 2006-Brazil and OECD

	Proficiency levels in Science						
	Level 0 (Below 357.77)	Level 1 (From 357.77 to 420.07)	Level 2 (From 420.07 to 482.38)	Level 3 (From 482.38 to 544.68)	Level 4 (From 544.68 to 606.99)	Level 5 (From 606.99 to 669.3)	Level 6 (above 669.3)
Brazil	27.9	33.1	23.8	11.3	3.4	0.5	0
OECD	5.2	14.1	24.0	27.4	20.3	7.7	1.3

Source: PISA 2006 student and school database.

In large-scale assessments, such as PISA, it is anticipated that few students reach higher levels. It is expected that most of the students can reach levels two or three in the Proficiency scale, but such achievement is not reached by the participating Brazilian students in the Science PISA 2006. The reciprocal is true when attention is given to other areas evaluated by the programme in that same edition: reading and mathematics. The percentage of students under level one in reading is around 28% and over 46% in mathematics (OCDE, 2007). Students that are below the Proficiency level one are not able to perform the simplest tasks that PISA requests. This does not mean, of course, that they are completely unable to perform any task. Certainly, this result should be viewed with caution, especially when compared to the mean of OECD member countries. After all, since the

1960s the educational literature has reported the strong influence of socio-economic and cultural factors on the performance of students (Coleman, 1966; see also Marks, Cresswell and Ainley, 2007).

Despite the fact that the Brazilian parameters (BRASIL, 1998) assumes that training of citizens in elementary school require full mastery of reading, writing and arithmetic, and an understanding of: the material and social environment, political system, technology, arts and the values on which the society is based, PISA 2006 data show a significant portion of the Brazilian 15-year-old students not being able to correctly answer the questions considered easy to the majority of students participating in the programme. Currently the teaching of science has little emphasis within the basic education in Brazil, despite the strong presence of technology in people's lives and the central role that technological innovation has as an element of competitiveness between companies and nations. Scientific training should be a central component of education from the early years, alongside the training in the use of language and humanities subjects.

The Brazilian participating students in PISA 2006 were mostly from public schools, around 84% of the total. The percentage distribution of the Brazilian students of public schools through the performance levels decreases as the performance levels increase (Table 4). The distribution of the Brazilian private schools' students follows OCDE expectations to large-scale assessments. The majority of students enrolled in private schools evaluated by PISA 2006 could reach the levels 2 and 3 of Proficiency in the Science scale (62.1%). However, the same did not happen to students enrolled in Brazilian public schools where students appear concentrated in the two lower levels (0 and 1) of the scale (71.2%).

Table 4. Percentage of students in each performance level of Science according to their school administrative dependence - Brazil - PISA 2006.

Proficiency levels in Science	Administrative dependence	
	Public	Private
0	35.1	4.0
1	36.1	16.3
2	21.5	35.2
3	6.0	26.9
4	1.2	15.0
5	0.1	2.5
6	0	0.1

Source: PISA 2006 student and school database.

Brazil has greatly advanced in recent decades regarding the guarantee of educational rights, however, the universal access to school must give way to the effective right to a education of quality. Already in the mid seventies, Cunha (1975) showed the education of children of the working classes/public schools, the impact of the school access mechanisms and differentiated school performance in students of the low social segment. Based on his findings, which is fairly frequent in the literature (Patto, 1996; Soares, 2004; Franco; Ortigão; Albernaz; Bonamino; Aguiar; Alves; Satyro, 2007), here in, the distribution of students is analyzed for different socio-economic status through the PISA performance levels of 2006 (Table 5).

Table 5. Percentage distribution of the students by performance level in Science and socio-economic status - Brazil - PISA 2006.

Proficiency levels in Sciences	Socio-economic Status			
	Very Low	Low	Medium	High
0	38.3	26.5	20.9	7.0
1	36.8	35.1	29.7	15.2
2	20.0	25.5	28.6	32.2
3	4.3	10.9	14.5	24.3
4	0.6	1.9	5.7	17.7
5	0	0.1	0.6	3.4
6	0	0	0	0.2
Total	100	100	100	100

Source: PISA 2006 student and school database.

The socio-economic and cultural status is a substantially determining factor in the Brazilian students' distribution among the Proficiency levels of PISA 2006 and this is also supported in the literature by several other studies such as the classical Coleman Report (Coleman, 1966). The PISA 2006 results indicate that most of the "very low socio-economic status" students (38.3%) are at the level zero and these students are not able to reach the highest levels of the scale, levels 5 and 6. On the other hand, "high socio-economic status" students reach even the highest level of scale and more than half of them (56,5%) are allocated on the levels 2 and 3 of the PISA Scientific Literacy scale as expected by OCDE. Moved by the interest in the intensity or impact of the association between the dependent variable "proficiency" and the explanatory variables "administrative dependence" and "socio-economic status" a linear regression model was implemented.

Table 6. Regression model results (mean and standard deviation) for Brazilian participant students in PISA 2006.

Variables	Model 0	Model 1	Model 2
Proficiency in Science	390(89.3)	480.17(2.1)	506.4(2.7)
Public school		-111.9(2.3)	-81.0(2.7)
SSA Very Low **SSA Low**			-68.0(3.3) -47.4(3.5)
SSA Medium			-38.7(3.4)
R2		0.206	0.245

The science proficiency of the Brazilian students that attended a private school in the PISA 2006 was 480.2 (constant of model 1 – Table 6). Value for the mean would allocate Brazilian students at level two of the scale where students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving. Being a student of a public school, though, decreases the proficiency mean of a Brazilian student in Science PISA 2006 up to 111.9 points, taking them to an approximate Proficiency of 367.9 and fall of a performance level. Finally, with concern to model 1, the only fact of being a Brazilian student from a public school in PISA 2006 explains up to 20% of the whole variance in the Brazilian students Proficiency in Science ($R2 = 0.206$).

OECD (2004) indicates that Brazil is a country in which there is a stronger correlation between the socio-economic and cultural level of the student school conditions and school effectiveness. Therefore, the correlation between proficiency, student school administrative dependence and socio-economic status was tested (Model 2). As a result, the magnitude of the relationship between the variables became even stronger by including aspects of students socio-economic level. The total variance of the Brazilian students proficiency in science is explained by approximately 25% ($R2 = 0.245$) when considering students attending public schools and allocated on very low, low and medium socio-economic status compared to the mean represented here by private schools and high socio-economic status students. Brazilian private school and high socio-economic status students in PISA 2006 have a proficiency in science that reaches 506.4 points. Such performance places the students in the level 3 of PISA scale. A percentage of 56.7% of the students across the OECD can perform tasks at least at Level 3 but in Brazil it is only possible for students enrolled in private schools and with a high socio-economic status, which is only 4% of the Brazilian sample in PISA. At Level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge.

CONCLUSIONS

This study aimed to look a little deeper into the performance in science of the Brazilian students in the PISA, raise questions and make some reflections about the above mentioned results. In general, the results reproduce the usual findings of the literature that claims that the social, scientific and technological development of Brazil requires a major overhaul of the educational structure in the country (See Schwartzman, 2004; Carnoy with Gove and Marshall, 2007; Barros and Ferreira, 2009).

The results obtained by the Brazilian students place the country at a disadvantageous position compared to almost every country participating in PISA. Brazil was the 52nd country in scientific competence among the 57 participants in PISA 2006. By all means, the country is placed in the level 1 of the PISA performance scale, but there is still a significant margin of Brazilian students who cannot even achieve this, which is the lower level considered by the programme. It was not the goal here, however, to develop a comparative study between Brazil and the other countries participating in this programme. Recognizing and taking into consideration the socio-economic and cultural differences among the various participating countries was not done in this study. Although rudimentary, this study identified the effect on student performance of the socio-economic background and the school administrative dependence to which Brazilian students are exposed. Variables such as color, sex, grade failure, etc., are also known to be related to student performance variance and should also be investigated in a larger scope study.

The 2006 PISA data showed that students not enrolled in a private school and who do not come from high-income families have a considerable disadvantage in science. It also showed that the fact of being enrolled in a public school is alone substantially enough to explain the variance of the mean

performance in science of Brazilian students. Science education is important for citizens to help them face new challenges and new work opportunities as the modern world changes around them. This education is a significant step towards securing a better future for all (Cury, 2002). The right to education and quality education is one of those steps that have not lost importance nor lost its relevance.

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BIBLIOGRAPHY

ABC. Academia Brasileira de Ciências. *O ensino de ciências e a educação básica: propostas para superar a crise*. Rio de Janeiro, Brasil, 2008. 56p.

Barros, R.; Ferreira, F. *Measuring Inequality of Opportunities in Latin America and the Caribbean*. World Bank. Washington DC, USA, 2009. 165p.

Brasil. *Parâmetros Curriculares Nacionais: ciências: 5a a 8a séries*. MEC, Brasília, Brasil, 1998,138p.

______. *Resultados nacionais – Pisa 2006: Programa Internacional de Avaliação de Alunos (Pisa)*. INEP, Brasília, Brasil, 2008. Disponível em: < http://www.inep.gov.br/download/internacional/pisa /PISA2006.pdf >. Acesso em: 12 Abr. 2015.

Carnoy, M.; Gove, A.k; Marshall, J.h. *Cuba's Academic Advantage: Why Students in Cuba Do Better in School*. Stanford University Press, Stanford, California, 2007, 209p.

Coleman, J.S. *Report on equality of education opportunity*. US Government Printing Office for Department of Health, Education and Welfare, Washington, DC, United States, 1966, 575p.

Cunha, L.A. *Educação e desenvolvimento Social no Brasil*. F. Alves, Rio de Janeiro, Brasil, 1975, 293p.

Cury, C.R.J. Direito à educação: direito à igualdade, direito à diferença. *Cadernos de Pesquisa*, [116], 245-262, 2002.

Forquin, J.C. As abordagens sociológicas do currículo: orientações teóricas e perspectivas de pesquisa. *Educação e Realidade*, **21**, [1], 187-198, 1995.

Franco, C.; Ortigão, M.I.R.; Albernaz, A.; Bonamino, A.M.C.; Aguiar, G.S; Alves, F.; Satyro, N. Eficácia escolar en Brasil: investigando prácticas y políticas escolares moderadoras de desigualdades educacionales. In: CUETO, S. *Educación y brechas de equidad en América Latina*, Fondo de Investigaciones Educativas / PREAL, Tomo I, Santiago, Chile, 2007, p. 223-249.

Marks, G.N.; Cresswell, J.; Ainley, J. Explaining socio-economic inequalities in student achievement: the role of home and school factors. *Educational Research and Evaluation*, **12**, [2], 105-128, 2006.

OCDE. Organization for Economic Cooperation and Development. *Literacy skills for the world of tomorrow: further results from PISA 2000*. Organization for Economic Co-Operation and Development, Paris, France, 2004, 25p.

OCDE. Organization for Economic Co-operation and Development. *PISA 2006 Technical Report*. Organization for Economic Co-Operation and Development, Paris, France, 2007, 416p.

OCDE. Organization for Economic Co-operation and Development. *BRAZIL – Country Note – Results from PISA 2012*. Organization for Economic Co-Operation and Development, Paris, France, 2013, 12p.

Patto, M.H. *A produção do fracasso escolar: histórias de submissão e rebeldia*. 2.ed. Casa do Psicólogo, São Paulo, Brasil, 1996. 464p.

Schwartzman, S. The chalenges of education in Brazil. In: Brock, C.; Schwartzman, S. *The chalenges of education in Brazil*. Symposium books, Cambridge, UK, 2004, p. 9-40.

Soares, J.F. Quality and Equity in Brazilian Basic Education: facts and possibilities. In: Brock, C.; Schwartzman, S. *The chalenges of education in Brazil*. Symposium books, Cambridge, UK, 2004, p. 69-88.

Teixeira, A. *Educação não é privilégio*. Editora UFRJ, Rio de Janeiro, Brasil, 1994. 146p.

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Intelligent tutorial system for learning of basic and operational Math

Sistema tutorial inteligente para la enseñanza de las matemáticas básicas y operativas

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Abstract

The basic math are the first encounter of students with university mathematics, which will enable them to acquire the fundamentals to support more advanced courses, such as calculus, statistics, physics, chemistry, among others. Here the importance of the teacher to provide an adequate mathematical education is important. Thanks to information and communication technologies (ICT), many tools and teaching strategies involve the use of electronic and digital resources (m-learning, b-learning, e-learning, etc.) to enhance the learning processes. Intelligent Tutoring Systems (ITS) extend traditional content computerized learning systems by adding intelligence to improve the effectiveness of a learner's experience. The main objective of this paper is to present the intelligent tutorial system "Cyber-Math", which brings together the topics and theoretical concepts of basic mathematics, which allow the student to learn at their own pace, because it can be accessed at any time and place if there is access to the internet. This paper concludes that the intelligent tutorial systems can transform the traditional teaching – learning model to a flexible, agile and didactic model.

Key words: *artificial intelligence, education, mathematics, m learning, ICT.*

Resumen

Las matemáticas básicas y operativas es el primer encuentro de los estudiantes con las matemáticas de la universidad, la cual les permitirá adquirir los fundamentos básicos para abordar cursos más avanzados, tales como cálculo, estadística, física, química, entre otros, de aquí la importancia que tiene el docente de impartir una adecuada formación matemática. En la actualidad, gracias a las tecnologías de la información y la comunicación (TIC), existe una alta diversidad de técnicas y métodos de enseñanza de la matemática que involucra el uso de recursos electrónicos y digitales (m-learning, b–learning, e-learning, etc), facilitando el proceso enseñanza