70 - PHYSICAL ACTIVITY AS A STRATEGY FOR CONSTRUCTING SUBSUMPTIONS IN SCIENCE EDUCATION

ELENISE SAUER
BRUNA LEAL
MARIA HELENE CANTERI
UTFPR, Ponta Grossa, Paraná, Brasil
sauer@utfpr.edu.br

doi:10.16887/88.a1.70

Introduction

Practical activities are the activities which the students are protagonists of the actions that can contribute to the construction of knowledge. These actions, according to Andrade; Massabni (2011) can be developed through experimentation, laboratory class, handling materials, environment study, research and field classes, which are essential for teaching science in the elementary school.

In a period that encompasses more than twenty-five years of teaching practice, linked to activities in the laboratory, it was observed that actions taken by students in these practical activities are precursors and used to construct the subsumptions for the construction of the knowledge. Subsumptions are defined by Moreira (2012) as previous knowledge specifically relevant to a new learning, not necessarily a concept.

In addition to the experience of the practical activities result effectively as subsumptions precursors, when these subsumptions have not yet been established in the cognitive structure, serve as facilitators of new connections, associated with the daily life, or to a previous formal learning, which allow the development of more elaborate concepts for a given theme.

In this way, the meaningful learning is established, a theory proposed by David Ausubel (2000), which the subsumptions are considered "anchors", promoting the interaction between prior knowledge and new knowledge, interacting in a substantive way and not arbitrarily. When this occurs, these new knowledge obtained by the subject acquires a meaning, whereas the previous knowledge acquire new meanings and greater stability in their cognitive structure (MOREIRA, 2012).

Relevant practical activities and contextualized with the environment in which the students are inserted can play an important role in the formation of these structures, such as the practice of physical exercise, extremely present in the daily life of students in elemntary school. Therefore, it is understood the relevance of proposals and research about these activities as a contribution to the teaching-learning process.

In this context, the aim of this article is to present a practical activity developed from physical exercise, as a strategy for constucting subsumptions, associated with the cinematic content in science education, an alternative to static learning environment of the classroom, that instigate the search for examples closer to the student context, in alternative to classic examples and approachs presented in specialized literature.

Methodology

The practical activity was developed with students in the ninth grade of elementary school, in science education, from a public school located in the southern region of Brazil.

The methodology outlined for planning the educational goals consisted to propose for the students to follow seven steps, adapted from Lopes (2015), as shown in Figure 1.

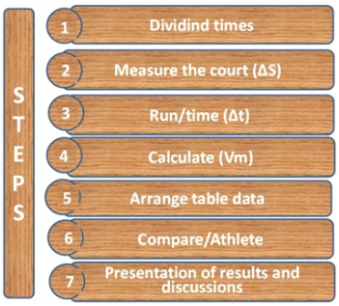

Figure 1 – Steps of development of the practical activity.
Source: Adapted from Lopes (2015).

First step - consisted to distribute the 35 students in teams, under random criteria, with a maximum of five componentes. Each group chose a leader to coordinate the team in the development of the activity. After that, it was distributed a A4 sheet for notes and highlighted the use of the international system of units (SI), meter (m) was used as a unit of measurement and second (s) as unit of time.

Second step - consisted to guide the data collection of the first variable for the space, the space variation (ΔS), i.e., in measure the court length with the help of a tape measure, as shown in Figure 2.

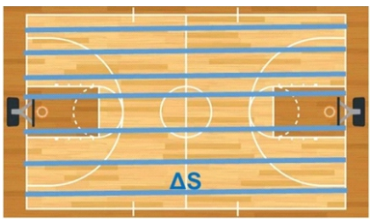

Figure 2 - Schematic drawing of the sports court used in the practical activity.
Source: Authors.

Third step - the students were told to go through the delimited space, running in a straight line, in two replicates, respecting their physical limits. They were also told that the goal was not the competition, but the collection of data. Thus, under the coordination of the team leader, each student ran the race, while another member was responsible to measure the time taken to perform the action and the variation of time (Δt), with the stopwatch. Another team member was listed as the responsible in annotating the results obtained.

Fourth step - the students calculated the scalar average speed (AS), as the ratio between the change in space and time variation (AS = ΔS/Δt), sitting on the court or in the bleachers and grouped in accordance with their teams.

Fifth step - students were advised to arrange the data in tables.

Sixth step - students were encouraged to compare the obtained results with results obtained by an athlete of the racing sport.

Seventh step - students held an oral presentation of the results, up to 10 minutes per team, followed by discussions involving all students in the class.

Results and Discussion

In the development of practical activity, some questions were raised by the students and the teacher answered the call in each team, always in the direction of mediation the knowledge, to encourage students to get to the answers.

The common questions to the teams were about the use of values to the variables ΔS and Δt, necessary for the resolution of the scalar average speed calculation (AS). In this case, the teacher presented the relation AS = ΔS/Δt, printed on A4 sheet, and drove into dialogic conersation to establish conceptual correlations to the numerical newly obtained for them.

Another step that generated common difficulty to teams, was the organization of data in the form of tables. In this step was required a greater intervention of the teacher in some teams to suggest how to allocate rows and columns for sorting of the results obtained.

The results obtained by the students, as the variables to perform the calculations and the results of scalar average speed, corresponding to 1 to 7 teams, were rearranged to allow better visualization and mediation of discussions, and are presented in Table 1.

Table 1 - Average speed results obtained from students' physical activity in teams 1 to 7.

Team1/student	**1a1**	**1a2**	**2b1**	**1b2**	**1c1**	**1c2**	**1d1**	**1d2**	**1e1**	**1e2**
ΔS (m)						17.66				
Δt (s)	5.88	3.88	5.30	5.48	5.75	5.18	4.68	4.97	4.63	5.32
AS= ΔS/ Δt (m/s)	3.00	4.55	3.33	3.22	3.07	3.40	3.77	3.55	3.81	3.31
ASS (m/s)		3.78		3.28		3.24		3.66		3.56
SD		1.10		0.08		0.23		0.16		0.35
RSD (%)		29.03		2.38		7.21		4.25		9.93
Team2/student	**2a1**	**2a2**	**2b1**	**2b2**	**2c1**	**2c2**	**2d1**	**2d2**	**2e1**	**2e2**
ΔS (m)						17.81				
Δt (s)	4.64	10.31	3.63	14.87	4.57	14.10	4.37	10.13	4.44	11.59
AS= ΔS/ Δt (m/s)	3.83	1.72	4.72	1.19	4.07	1.26	3.89	1.75	4.01	1.53
ASS (m/s)		2.78		2.96		2.67		2.82		2.77
SD		1.49		2.50		1.99		1.51		1.75
RSD (%)		53.77		84.47		74.56		53.66		63.31
Team3/student	**3a1**	**3a2**	**3b1**	**3b2**	**3c1**	**3c2**	**3d1**	**3d2**	**3e1**	**3e2**
ΔS (m)						18.00				
Δt (s)	3.51	3.49	4.00	3.00	4.00	5.00	2.60	2.66	8.00	7.98
AS= ΔS/ Δt (m/s)	5.12	5.15	4.50	6.00	4.50	3.60	6.92	6.76	2.25	2.26
ASS (m/s)		5.14		5.25		4.05		6.84		2.26
SD		0.02		1.06		0.64		0.11		0.01
RSD (%)		0.41		20.20		15.71		1.65		0.31
Team4/student	**4a1**	**4a2**	**4b1**	**4b2**	**4c1**	**4c2**	**4d1**	**4d2**	**4e1**	**4e2**
ΔS (m)						17.40				
Δt (s)	11.01	11.39	5.76	5.32	5.97	6.45	4.01	4.60	4.10	4.00
AS= ΔS/ Δt (m/s)	1.58	1.52	3.02	3.27	2.91	2.70	4.33	3.78	4.35	4.55
ASS (m/s)		1.55		3.15		2.81		4.06		4.45
SD		0.04		0.18		0.15		0.39		0.14
RSD (%)		2.74		5.62		5.47		9.59		3.18
Team5/student	**5a1**	**5a2**	**5b1**	**5b2**	**5c1**	**5c2**	**5d1**	**5d2**	**5e1**	**5e2**
ΔS (m)						17.81				
Δt (s)	4.50	4.24	4.15	4.55	4.57	3.42	3.24	3.95	3.14	3.77
AS= ΔS/ Δt (m/s)	3.96	4.20	4.29	3.91	3.21	5.50	4.68	4.51	5.67	4.72
ASS (m/s)		4.08		4.1		4.36		4.60		5.20
SD		0.17		0.27		1.62		0.12		0.67
RSD (%)		4.16		6.55		37.18		2.62		12.93
Team6/student	**6a1**	**6a2**	**6b1**	**6b2**	**6c1**	**6c2**	**6d1**	**6d2**	**6e1**	**6e2**
ΔS (m)						18.00				
Δt (s)	4.23	4.11	3.57	3.64	3.32	3.84	3.80	4.31	4.33	4.57
AS= ΔS/ Δt (m/s)	4.20	4.37	5.00	4.94	5.42	4.68	4.73	4.17	4.15	3.90
ASS (m/s)		4.29		4.97		5.05		4.45		4.03
SD		0.12		0.04		0.52		0.40		0.18
RSD (%)		2.81		0.85		10.36		8.90		4.39
Team7/student	**7a1**	**7a2**	**7b1**	**7b2**	**7c1**	**7c2**	**7d1**	**7d2**	**7e1**	**7e2**
ΔS (m)						18.00				
Δt (s)	3.71	3.36	3.52	3.25	4.02	4.12	3.91	3.78	3.72	3.61
AS= ΔS/ Δt (m/s)	4.85	5.85	4.67	4.73	4.47	4.36	4.60	4.76	4.84	5.00
ASS (m/s)		5.35		4.70		4.42		4.68		4.92
SD		0.71		0.04		0.08		0.11		0.11
RSD (%)		13.22		0.90		1.76		2.42		2.30

Standard Deviation (SD). Relative Standard Deviation (RSD). Average Student Speed (ASS).Source: Authors (adapted from students).

In the presentation and discussion of the results obtained (Table 1), there is a significant variation in the ΔS data collection, since the minimum value of 17.40m to a maximum of 18.00m. This result was used to mediate the discussion of operational errors in the handling of the tape measure and the actions used to minimize errors of measurement.

The discussion about the comparison of the results of the average speed (AS) was instigated and mediated from the values obtained between the replicates and among team members. Thus, about the results of the replicates, it is possible to point out that the values of the relative standard deviation (RSD) ranged respectively in 29.03%, 20.20%, 9.59, 37.18%, 10.36% and 13.22% for teams 1, 3, 4, 5, 6 and 7.

However, the values of RSD of average speed (AS) obtained by team 2, are far superior to other teams, in 84.47%, justified by its members in the implementation of data collection in different conditions, running and walking in space set, with "the aim of highlight a difference in the final result ". This action revealed the involvement of these students, attitude that has enriched the discussion of the data obtained.

The results of average speed (ASS) obtained by students were compared with the results of an icon of the sport, Usain Bolt, was mentioned and accepted unanimously during the activity. As a result, the value of the average speed Usain Bolt (UBAS) equal to 10.5m/s was used for comparison, calculated from results obtained by the athlete during the World Athletics Championships, held in Berlin, in 2009, where he ran 100m in 9.5s, and broke the record in the 100m run shallow, becoming the fastest man in the world (LOPES, 2015).

The presentation and discussion of the comparison between the average speed (ASS) obtained in physical activity for students, in the teams 1 to 7, and the average speed obtained by Usain Bolt (UBAS) in 2009 (Table 2) was mediated to reflect about the dimension of the value obtained at difference Usain Bolt (UBD) and average speed by students (UBAS – ASS). This

analysis points out that the biggest difference Usain Bolt (UBD) was 8.95m/s in team 4 and the smallest difference was obtained on team 3.

Table 2 - Comparison between the average speed (ASS) obtained in the students' physical activity. in teams 1 to 7 and Average speed obtained by Usain Bolt (UBAS) in 2009.

Team1/student	1a	1b	1c	1d	1e
ASS (m/s)	3.78	3.28	3.24	3.66	3.56
UBD (m/s)	6.72	7.22	7.26	6.84	6.94
Team2/student	2a	2b	2c	2d	2e
ASS (m/s)	2.78	2.96	2.67	2.82	2.77
UBD (m/s)	7.72	7.54	7.83	7.68	7.73
Team3/student	3a	3b	3c	3d	3e
ASS (m/s)	5.14	5.25	4.05	6.84	2.26
UBD (m/s)	5.36	5.25	6.45	**3.66**	8.24
Team4/student	4a	4b	4c	4d	4e
ASS (m/s)	1.55	3.15	2.81	4.06	4.45
UBD (m/s)	**8.95**	7.35	7.69	6.44	6.05
Team5/student	5a	5b	5c	5d	5e
ASS (m/s)	4.08	4.1	4.36	4.60	5.20
UBD (m/s)	6.42	6.40	6.14	5.90	5.30
Team6/student	6a	6b	6c	6d	6e
ASS (m/s)	4.29	4.97	5.05	4.45	4.03
UBD (m/s)	6.21	5.53	5.45	6.05	6.47
Team7/student	7a	7b	7c	7d	7e
ASS (m/s)	5.35	4.70	4.42	4.68	4.92
UBD (m/s)	5.15	5.80	6.08	5.82	5.58

Usain Bolt Difference (UBD) = (UBAS – ASS).
Source: Authors (adapted from Students).

1 Elenise Sauer, Av Monteiro Lobato, s/n - Km 04 CEP 84016-210 - Ponta Grossa, Paraná, Brasil. Telefone Geral +55 (42) 3220-4800, sauer @utfpr.edu.br

The development of the activity allowed the compilation of a considerable volume of data for the variables So, S, ΔS, Δt and AS, obtained from the reality experienced by the students (Table 1) and allows the adaptation of variables to represent the data in accordance with the reality during the activity, as the average speed of the student (ASS), average speed obtained by Usain Bolt (UBAS) in 2009 and difference Usain Bolt (DBU).

This development of the representation of new variables is an exercise that adds meaning and enables the student to approach the genesis of scientific content presented in specialized literature.

The observation in the course of the activity allowed the analysis of students who engage in parallel conversations, feature constant restlessness and little involvement in the activity of teaching in the classroom, however, in this activity they reproduced these behaviors in the new educational environment, the school sports court. However, on resumption to the contentes and in solving problems in subsequent classes, these students were the first to manifest itself in order to respond to the questions.

This expression is interpreted as an approximation of the non-formal contente for the student, obtained by experience in practical activity the scientific knowledge represented by the formal content of knowledge presented in the books, in order to carry meaning to the school contente, regardless of whether the dimension is personal, social and cultural, as Kato; Kawasaki (2011).

On the whole, it was easy for students to solve problems in the interpretation of their statements, and its association to the variables So, S, ΔS, Δt. The relation ΔS/Δt allowed composition of the value of the average speed (AS), in a manifest correlation between the content of science and the actions carried out in the own sport environment, which enabled data collection from their actions.

The results confirm the importance of providing problematization situations, as well as mediation in pedagogical practice that approximate the world of the student to the sciences, demythologizing the inaccessibility of scientific production in the classroom, according to notes from Kosminsky; Giordan (2001). Above all, the value of the diversity of strategies and resources that don't put the textbook as the primary resource used by teachers and, often, as a single resource capable of performing student approach with the world, reality still present in teaching science, as Sepini; Maciel (2014).

According to the presented contexto, means that the activity developed presents potential in the constitution of meanings and in the construction of subsumptions for the learning in science education. Infers that, the activity developed can contribute further to the process of teaching and learning in science of these students, similar to the results obtained by Mintzes; Wandersee (2015 p. 84), where learning was correlated to the subsumptions defended on the meaningful learning theory by Ausubel and Novak.

It is also important to note that activities involving the experience with physical models bring a positive effect on the resolution of problems, according to results of the study carried out by Manches; O'Malley; Benford (2010), which demonstrated significant advantage of the use of physical resources in solving numerical questions, in relation to the virtual activities, due to the possibility of creating strategies to get the final answer.

Final Considerations

The development of the practical activity provided approach to genesis of scientific knowledge, with the production of a considerable volume of data from the role of students, in the exercise of their analysis, comparisons and discussions. To the same extent that allowed the representation of new variables with meaning, as the average speed of the student (ASS), average speed obtained by Usain Bolt (UBAS) in 2009 and Usain Bolt (DBU).

On the whole, contributed to students to interpret statements and associate to the variables So, S, ΔS, Δt, and ΔS/Δt, for calculating the average speed (AS), in a correlation between the content of science and the actions carried out in the own sport environment , which enabled data collection from their actions.

It is considered, according to the results of the evaluated and presented context, that the activity developed presents potential in the constitution of meaning and in the formation of subsumptions that contribute for learning in science education.

References

ANDRADE, M. L. F; MASSABNI, V. G. O desenvolvimento de atividades práticas na escola: Um desafio para professores de Ciências. Ciência & Educação, v.17, n.4, p. 835-854, 2011.

AUSUBEL, D.P. The acquisition and retention of knowledge. Dordrecht: Kluwer Academic

Publishers. 2000.

KATO, D. S; KAWASAKI, C. S. As concepções de contextualização do ensino em documentos curriculares oficiais e de professores de ciências. Ciência & Educação (Bauru), Bauru, v.7, n.1, p. 35-50, 2011.

KOSMINSKY, L.; GIORDAN, M. Visões de Ciências e sobre o Cientista entre estudantes do ensino médio. Química Nova na Escola. N. 15, maio, 2002.

LOPES, S. Investigar e conhecer. Ciências da Natureza. Ed. Saraiva. 1ed, São Paulo. 2015.

MANCHES, A. A.; O'MALLEY C. B.; BENFORD S.C. The role of physical representations in solving number problems: A comparison of young children's use of physical and virtual materials. Computers & Education. 54. p. 622–640, 2010.

MINTZES, J.J.; WANDERSEE, J. H. Research in Science Teaching and Learning: A Human Constructivist View. Chaper 3. Academic Press. p. 59-90. 2005.

MOREIRA, M. A. Al Final Qué Es Aprendizaje Significativo? Revista Qurriculum, v.25; marzo, p. 29-56; 2012. ISSN: 1130-5371.

SEPINI, R. P.; MACIEL, M. D. Mudanças conceituais apresentadas por estudantes de graduação após intervenção didática com enfoque na natureza da ciência e tecnologia. Uni-pluri (Medellin), v. 14, p. 753-759, 2014.

PHYSICAL ACTIVITY AS A STRATEGY FOR CONSTRUCTING SUBSUMPTIONS IN SCIENCE EDUCATION

The purpose of this article is to present a practical activity, developed from a physical activity, as a strategy for constructing subsumptions for the cinematic content, in science education, as na alternative to static learning environment in the classroom and the classic examples presented in most of the specialized literature. The methodology consisted of guiding students to collect data from your physical activity, performed in the court of the school. The data of the variables of space variation (ΔS) and time variation (Δt), were obtained in two replicated per student, in seven teams with five components, and used for the calculation of the average scalar speed. The development of practical activity provided approach to genesis of scientific knowledge, in the production of a considerable volume of data from the role of students, in the exercise of your analysis, comparisons, discussion and reflection. To the same extent allowed the representation of new variables that add meaning, as the average speed of the student (.ASS), average speed obtained by Usain Bolt (UBAS) in 2009, and Usain Bolt (DBU). On the whole, contributed also for students to interpret, and the associated to the variables studied, in a manifest correlation between the content of science and the actions carried out in the own sport environment, in the Constitution of meaning, and in the formation of subsunçores learning in science education.

Keywords: physical activity, subsumptions, science education.

L'ACTIVITÉ PHYSIQUE COMME STRATÉGIE DE FORMATION DE SUBSOMPTIONS EN LA ACTIVITÉ PRATIQUE DANS L'ENSEIGNEMENT DE SCIENCES

L'objectif de cet article est de présenter une activité pratique développée à partir d'une activité physique comme stratégie pour la formation de "concepts pertinents préexistants" (sous-unités ou subsumptions) pour le contenu cinématique dans l'enseignement de la science, alternative à l'environnement d'apprentissage statique de la classe, et a les exemples classiques presentés en majorité de la littérature spécialisée. La méthodologie a consisté à guider les élèves à recueillir des données, a partir de son activité physique réalisée dans un terrain de sports de l'école. Les données de variables de la variaton de l´espace (ΔS) et la variation du temps (Δt) ont été obtenus par deux replicates par chaque étudiant, dans sept équipes avec cinq éléments, et utilisés pour le calcul de la vitesse scalaire moyenne. Le développement de l'activité pratique a conduit jusqu´a l'approche à la genèse des connaissances scientifiques, à la production d'une quantité considérable de données à travers de la participation des étudiants dans l'exercice de ses analyses, des comparaisons, des discussions et des réflexions. De la même manière, cette activité a permis la représentation de nouvelles variables qui ajoutent du sens, comme la vitesse moyenne des étudiants (ASS), la vitesse moyenne obtenue par Usain Bolt (UBAS) en 2009, la différence Usain Bolt (DBU). Dans l'ensemble, a également contribué aussi pour qui les étudiants interprètent les questions avec association à les variables étudiées, dans une corrélation manifeste entre le contenu de la science et les actions réalisées dans l'environnement pertinent du sport, dans la constitution des significations et dans la formation de subsomptions pour l'apprentissage dans l'enseignement des sciences.

Mots-clés: activité physique, subsomptions, éducation scientifique.

ACTIVIDAD FÍSICA COMO ESTRATEGIA PARA LA FORMACIÓN DE SUBSUMIDORES EN ACTIVIDAD PRÁCTICA EN LA ENSEÑANZA DE CIENCIAS

El objetivo de este artículo es presentar una actividad práctica desarrollada a partir de una actividad física como estrategia para la formación de subsumidores para el contenido de cinemática en la enseñanza de ciencias, alternativa al contexto de enseñanza estática del aula y a los ejemplos clásicos presentados en la mayoría de literatura especializada. La metodología consistió en orientar a los estudiantes para la recolección de datos, a partir de su actividad física realizada en la cancha de deportes de la escuela. Los datos de las variables de variación del espacio (ΔS) y de variación del tiempo (Δt), fueron obtenidos en dos replicadas por estudiante, en siete equipos con cinco componentes, y utilizados para el cálculo de la velocidad media. El desarrollo de la actividad práctica propició acercamiento a la génesis del conocimiento científico, en la producción de un volumen considerable de datos a partir del protagonismo de los estudiantes, en el ejercicio de su análisis, comparaciones, discusiones, así como en la representación de nuevas variables que agregan significado, como la velocidad media del estudiante (VmE), velocidad media obtenida por UsainBolt (VmUB) en 2009, diferencia UsainBolt (DBU). En el conjunto, contribuyó también para que los estudiantes interpretaran enunciados, y los asociaran a las variables estudiadas, en una correlación manifiesta entre el contenido de ciencias y las acciones realizadas en el contexto propio del deporte, en la constitución de significados y en la formación de subsumidores para el aprendizaje en la enseñanza de ciencias.

Palabras clave: actividad física, subsumidores, enseñanza de ciencias

ATIVIDADE FÍSICA COMO ESTRATÉGIA PARA FORMAÇÃO DE SUBSUNÇORES NO ENSINO DE CIÊNCIAS

O objetivo deste artigo é apresentar uma atividade prática, desenvolvida a partir de uma atividade física, como estratégia para formação de subsunçores para o conteúdo de cinemática, no ensino de ciências, alternativa ao ambiente de ensino estático de sala de aula, e aos exemplos clássicos apresentados na maioria da literatura especializada. A metodologia consistiu em orientar os estudantes para coleta de dados, a partir de sua atividade física realizada na quadra de esportes da escola. Os dados das variáveis de variação do espaço (ΔS) e de variação do tempo (Δt), foram obtidos em duas replicatas por estudante, em sete equipes com cinco componentes, e utilizados para o cálculo da velocidade escalar média. O desenvolvimento da atividade prática propiciou aproximação à gênese do conhecimento científico, na produção de um volume considerável de dados a partir do protagonismo dos estudantes, no exercício de sua análise, comparações, discussões e reflexões. Na mesma medida em permitiu a representação de novas variáveis que agregam significado, como a velocidade média do estudante (ASS), velocidade média obtida por Usain Bolt (UBAS) em 2009, e diferença Usain Bolt (DBU). No conjunto, contribuiu também para que os estudantes interpretassem enunciados, e os associassem às variáveis estudadas, numa correlação manifesta entre o conteúdo de ciências e as ações realizadas no ambiente próprio do esporte, na constituição de significados, e na formação de subsunçores para a aprendizagem no ensino de ciências.

Palavras chave: atividade física, subsunçores, ensino de ciências.