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USE OF OPEN-SOURCE TECHNOLOGY TO TEACH BIOMECHANICS

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Abstract: The purposes of this study was: (1) develop a different methodology based on open-source technologies to promote quantitative movement analysis of sport skills as a regular tool in the biomechanics classroom, (2) analyze the expertise and development students' level during the work labs and finally, (3) access the students' engagement, motivational status and technology expertise performed in sports biomechanics. First we explore movement analysis with Dartfish software. A second software *Kinovea 0.8.15* was used to extract variables for the 2D kinematical analysis and the Excel 2010 was used for data mapping and the statistics treatment ($p \leq 0,05$). For the gait study results presented as an example, the statistically significant differences from the overcharge increase (+ 40% of body weight) were found on step time at 1,80 m/s (p=0,029), on the step leng at 1,25 m/s (p=0,001) and at 1,80 m/s (p=0,003), on the leng gait cycle at 1,25 m/s (p=0,011) and at 1,80 m/s (p=0,002), on the torso angle at 1,80 m/s (p=0,000) and on the hip joint angle motion at 1,25 m/s (p=0,000) and at 1,80 m/s (p=0,012). However, we conclude that overcharge (+ 40% body weight) reduce the step time and step lengthy, shorter gait cycle, increase torso frontal flexion (sagittal plane) and increase the hip joint flexion, mainly in the swing phase.The advantage of this type of classroom lab work with students, besides of having no costs, is an increase of their motivation, pushing the passing rates from 45% to 77% last year. The ability of understanding theory concepts has an exponential raise as every new concept has immediate application on the practical analysis performed with Kinovea At phase 4 we will establish the validity and reliability of all 3 softwares: Dartfish, Kinovea, and Tracker and compare sports and rehabilitation movements at 30 fps versus 60 fps
Key words: gait biomechanics, kinematics analysis, gait patterns, open source software, kinovea

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INTRODUCTION/ BACKGROUND

Computers, internet and new technologies have developed to a point where everybody viewing its use as a vital part of their lives (Alvarez & Olivera-Smith, 2013; Holladay et al., 2011). Indeed, the new technologies take us time and, in some circumstances, ours private lives, but give us new skills, different knowledge, worldwide information and, more important, the chance to share knowledge.

According to Yaman (2009), currently, the technology has turned out to be a need instead of a luxury. Presently, all professions and all professionals face the time were the new generations never understand life without technology (Alvarez & Olivera-Smith, 2013; Faro, 2009). Plenty of

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this technology is in the internet in an open-source base, or better, in a free download base. This new technologies are more and more predominant in our society and require new conditions and opportunities for teaching and learning processes (Alvarez and Olivera-Smith, 2013).

Perhaps, this link between this new, attracting and motivational technology and biomechanics could be an important step to take the biomechanics out of the laboratory and create a new free, educational, fascinate and alternative kinematics method for analysis the human movement in sports science, exercise & health and rehabilitation areas. To Becker et al. (2010), complementary innovations had to take place, such as in the area of business models, science research, people relations, society, countries organization and more, world point of view. In several studies developed on the physical education field show that students are highly motivated to perform the physical education class using technology (Ferreira, 2012; Edginton et al., 2011).

To Bartling and Friesik (2014) and Optaros (2007), open-source software is software components and solutions with available source code to be used, changed and distributed to other users following commonly agreed-upon rules. On the basis of open-source projects, new companies have been created and shaped to make money based on the success of open-source technologies. Most of these companies either distribute closed and open versions of specific software, offer support and maintenance services based on open-source software or provide consulting, training and systems integration services around open -source software.

Bartling and Friesik (2014) and Holladay et al. (2011), define three innovative elements of open-source software success: first, low cost distribution of the software through the Internet; second, collaborative development often connected to the development teams and, finally, transparent and free access to the source code and providing the basis for new services offerings such as support and maintenance. Based on these three elements, open-source is changing the way software is developed, acquired and used.

According Salmon and Wright (2014) and de la Vega et al. (2007), the use of the open-source technology to teach and learn biomechanics it is a real way to learn the physical principles applied to biomechanics and human movement studies. With this different lecture approach the students filmed the target movements, analyzed the variables selected, collected the data and they draw the conclusions from their hands-on experience always with the affordable equipment's (cameras, laptops …) and free software (kinovea, tracker …). The significant factor of linkage between students and technology appearance to be motivational, collaborative, highly engaged and behavior conducive, creating a significant improvement of knowledge transference, enthusiastic team-work dynamics, problem solving, critical thinking and improve the technology expertise (Smith, 2014; de la Vega et al., 2007).

OBJECTIVES

The purposes of this study was: (1) develop a different methodology based on open-source technologies to promote quantitative movement analysis of sport skills as a regular tool in the biomechanics classroom, (2) analyze the expertise and development students' level during the work labs and finally, (3) access the students' engagement, motivational status and technology expertise performed in sports biomechanics lecture.

METHODS

The study was conducted in 2 Universities (FCDEF UC and INUAF) in Portugal during 4 years and conducted in 3 phases. A total of 158 movements performed on the sagittal plane were filmed with digital video and analyzed using dartfish, kinovea and tracker software in the context of a classroom lab both at graduate and undergraduate levels to obtain kinematic variables.

1st phase, we analyzed the validity and the reliability of the students' classroom labs.

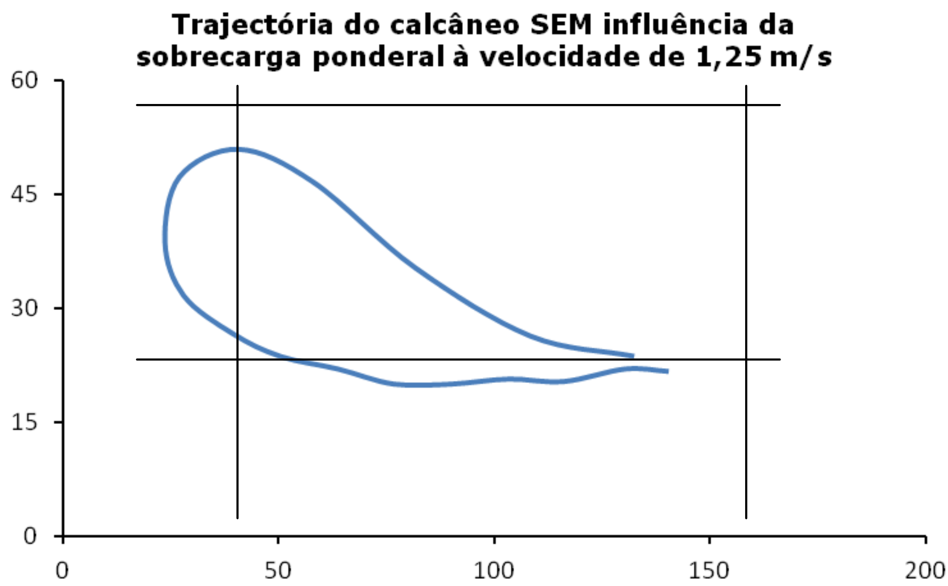
2nd phase, we studied the evolution since the first classroom lab to the Master Thesis using open-source software.

3rd phase, we explored the kinovea and tracker data to develop simulate models using software VIDLE for Python

RESULTS and DISCUSSION

Data will be presented showing the evolution of analyses done from phase one to phase three.

A study developed by Pedro (2013) using the open-source software (kinovea 0.8.15) as instrument have shown the data comparable with others data and reference studies. Figure 1 presents the trajectory of the foot with and without 40% overcharge at a velocity of1,25 m/s. As observed both present a similar path. Significative differences could be found for the x axes trajectory (p = 0,027; < 0,05) but not for the y axes (p = 0,227; > 0,05).



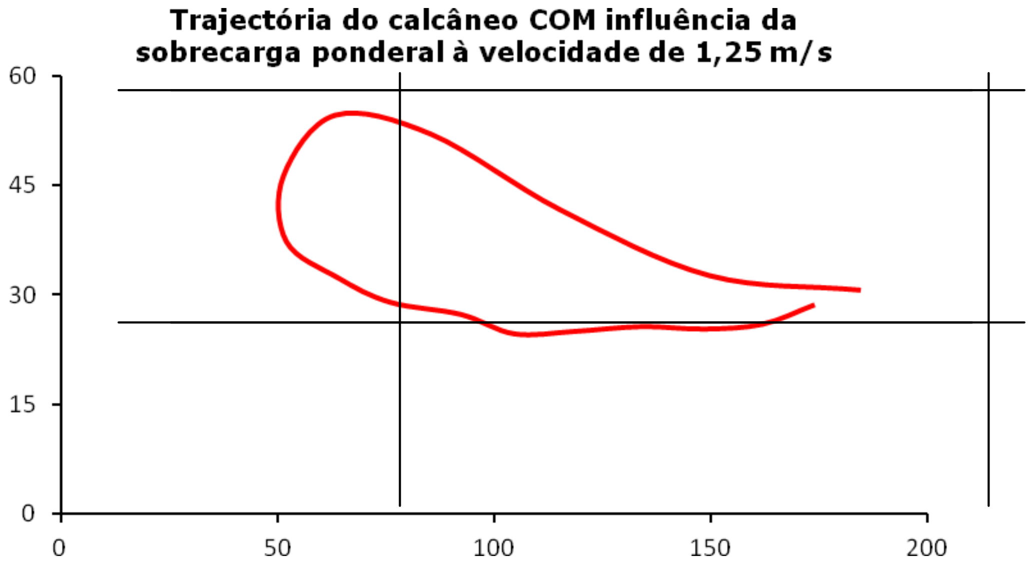


Figure 1: foot trajectory at the velocity 1,25 m/s

The angle values for the trunk at the velocity of 1,25 m/s present $\bar{X}$ = 88,71º ± 3,13 without overcharge of 40% body weight and $\bar{X}$ = 88,16º ± 2,75 With overcharge of 40% body weight (Fig. 2).

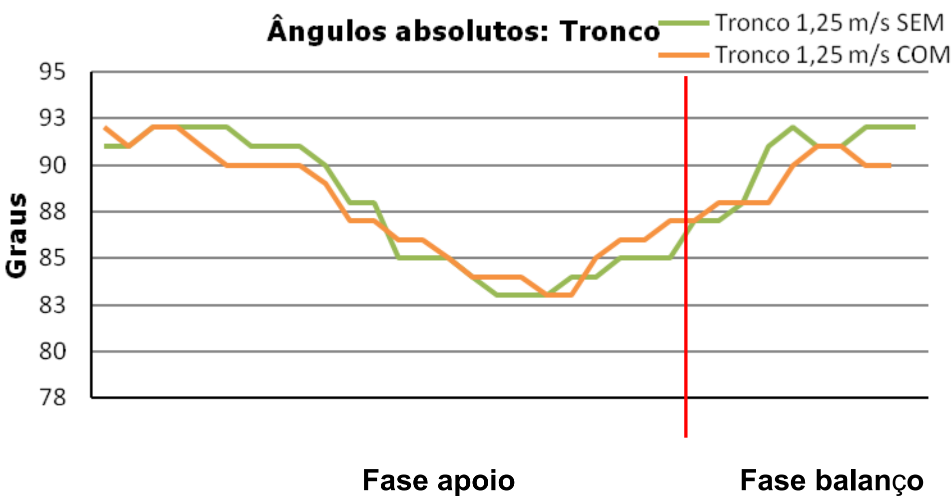


Figure 2: Absolute trunk angle at the velocities of 1,25 m/s overcharge of 40% body weight

Gait cadence are presented at table 1 comparing values obtained with this study and similar studies Ling et al. (2012), Cimolin et al. (2011), Demura and Demura (2010) and Silva (2009).

Table 2: Comparison of cadence data ($\overline{X}$ ± DP)

	Presente Estudo	Ling et al. (2012)	Cimolin et al. (2011)	Demura e Demura (2010)	Silva (2009)
Cadência CM (passos/min)	1,25 SEM=106 1,25 COM=109 1,80 SEM=124 1,80 COM=132	GC=76,7±13,4 GO=68,5±9,4	GC=111,8±4,8 GO=111,2±8,2	0%=116,0±4,7 20%=116,1±5,8 40%=114,4±5,6 60%=111,9±6,2	GC=116,8±5,4 GO=108,6±6,9

Movement times are presented at table 2 comparing values obtained with this study and similar studies Blaszczyk et al. (2011), Cimolin et al. (2011), Demura and Demura (2010) and Cunha (2009)

Table 2: Comparison of time data ($\overline{X}$ ± DP)

	Presente Estudo	Blaszczyk et al. (2011)	Cimolin et al. (2011)	Demura e Demura (2010)	Cunha (2009)
Tempo CM (s)	1,25 SEM=1,13±0,06 1,25 COM=1,10±0,03 1,80 SEM=0,97±0,02 1,80 COM=0,91±0,02	GC=1,16±0,11 GO=1,15±0,10	------------	0%=1,04 20%=1,04 40%=1,06 60%=1,08	GC=1,43±0,29 GO=1,28±0,20
Tempo apoio (s)	1,25 SEM=0,73 1,25 COM=0,72 1,80 SEM=0,61 1,80 COM=0,59	GC=0,77±0,09 GO=0,74±0,08	------------	0%=0,63±0,03 20%=0,64±0,04 40%=0,66±0,04 60%=0,68±0,05	------------
% Tempo apoio	1,25 SEM=64,7% 1,25 COM=65,5% 1,80 SEM=63,4% 1,80 COM=64,2%	GC=63% GO=67%	GC=61% GO=59%	0%=60,5% 20%=61,5% 40%=62,2% 60%=62,9%	GC=63% GO=65%
Tempo balanço (s)	1,25 SEM=0,40 1,25 COM=0,38 1,80 SEM=0,36 1,80 COM=0,32	GC=0,41±0,03 GO=0,38±0,02	------------	0%=0,41±0,01 20%=0,40±0,01 40%=0,40±0,01 60%=0,40±0,02	------------

% Tempo balanço	1,25 SEM=35,3% 1,25 COM=34,5% 1,80 SEM=36,6% 1,80 COM=35,8%	GC=37% GO=33%	GC=39% GO=41%	0%=39,5% 20%=38,5% 40%=37,8% 60%=37,1%	GC=36% GO=34%
Tempo duplo apoio (s)	1,25 SEM=0,27 1,25 COM=0,29 1,80 SEM=0,18 1,80 COM=0,19	GC=0,16±0,03 GO=0,19±0,04	------------	0%=0,11±0,01 20%=0,12±0,01 40%=0,14±0,01 60%=0,15±0,02	------------
% Tempo duplo apoio	1,25 SEM=23,9% 1,25 COM=26,0% 1,80 SEM=18,6% 1,80 COM=20,2%	GC=13% GO=17%	GC=23% GO=25%	------------	GC=11% GO=14%

Movement distances are presented at table 3comparing values obtained with this study and similar studies Silva (2009), Cimolin et al. (2011), Demura and Demura (2010) and Cunha (2009)

Table 2: Comparison of distance data *(* ± DP)

	Presente Estudo	Cimolin et al. (2011)	Demura e Demura (2010)	Cunha (2009)	Silva (2009)
Comprimento passo (m)	1,25 SEM=0,61±0,1 1,25 COM=0,59±0,1 1,80 SEM=0,73±0,2 1,80 COM=0,68±0,2	GC=0,88±0,2 GO=0,38±0,1	0%=0,66±0,1 20%=0,63±0,1 40%=0,62±0,1 60%=0,59±0,1	-------------	GC=0,64±0,1 GO=0,59±0,1
Comprimento CM (m)	1,25 SEM=1,22±0,1 1,25 COM=1,17±0,3 1,80 SEM=1,45±0,1 1,80 COM=1,37±0,2	-------------	-------------	GC=1,14±0,1 GO=1,02±0,2	GC=1,29±0,1 GO=1,18±0,1

CONCLUSIONS

The advantage of this type of classroom lab work with students, besides of having no costs, is an increase of their motivation, pushing the passing rates from 45% to 77% last year. The ability of understanding theory concepts has an exponential raise as every new concept has immediate application on the practical analysis performed with Kinovea. At phase 4 we will establish the validity and reliability of all 3 softwares: Dartfish, Kinovea, and Tracker and compare sports and rehabilitation movements at 30 fps versus 60 fps.

REFERENCES

Becker, S., Crandall, M., Fisher, K., Kinney, B., Landry, C. & Rocha, A. (2010), *Opportunity for All: How the American Public Benefits from Internet. U.S. Libraries.* Institute of Museum and Library Services. Washington, D.C.

Cimolin, V., Vismara, L., Galli, M., Zaina, F., Negrini, S. & Capodaglio, P. (2011), Effects of obesity and chronic low back pain on gait. *Journal of NeuroEngineering and Rehabilitation*, 8 (1), 55-63

Demura, T. & Demura, S. (2010), Relationship among Gait Parameters while Walking with Varying Loads. *Journal of Physiological Anthropology*, 29 (1), 29-34Faro, A & Chin, M (2011).

Edginton, C; Sobral, F.; Faro, A. (2009), Exploring the impacts of a contextually based, total immersion graduate program with a focus on teaching physical education with an emphasis on technology. *International Journal of Physical Education*, 48 (1): 18-26.

Faro, A. (2009), *Using Technology motivation in Physical Education: Is There One Best Way?* Unpublished research paper. University of Northern Iowa. Iowa.

Ferreira, A. (2012), *A Análise Digital de Vídeo e software exploratório no ensino da Física.* Master Thesis. Faculty of Science and Technology of Lisbon University. Lisbon. 153 pp.

Holladay, J., Glusman, A. & Soloway, S. (2011), *Internet Benefits: Consumer Surplus and Net Neutrality.* Institute for Policy Integrity, New York University School of Law. New York.

Yaman, (M. (2009), Perceptions of Students on the Application Distance Education in Physical Education Lessons. *The Turkish Online Journal of Physical Educational Technology*, 8 (1): 122-132.

Morton, F. (2006). *Consumer Benefit from Use of the Internet.* In A. Jaffe, J. Lerner & S. Stern, Innovation Policy and the Economy, Volume 6, Yale School of Management. Yale.

Optaros (2007), *Realize the Benefits of Open-source.* Open-source Catalogue. US Version. New York.

De la Vega, G., Aguilera, J., Puzzella, A. & Mallamaci, C. (2007), An alternative strategy to teach Biomechanics: The long jump. *Journal of Physics: Conference Series*, 90.

Alvarez, I. & Olivera-Smith, M. (2013), Learning in Social Networks: Rationale and Ideas for Its Implementation in Higher Education. *Education Science*, 3: 314-325.

Smith, T. (2014), Elementary Science Instruction: Examining a Virtual Environment for Evidence of Learning, Engagement, and 21st Century Competencies. *Education Science*, 4: 122-138.

Salmon, G. & Wright, P. (2014). Transforming Future Teaching through 'Carpe Diem' Learning Design. *Education Science*, 4: 52-63.

Fecher, B. & Friesike, S. (2014), Open Science: One Term, Five Schools of Thought. In Bartling, Sonke; Friesike, Sascha, editors – *Opening Science: The Evolving Guide on How the Internet is Changing Research, Collaboration and Scholarly Publishing*. Springer Open, London. p. 17-48.

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