International Journal of Innovation and Research in Educational Sciences
Volume 4, Issue 4, ISSN (Online): 2349–5219

Physical Examination of Natural Phenomena Game Theory, Probability Theory and Network Properties

Borbala Leitner

***Abstract* – In school education, the objects marked in the title do not appear as separated teaching units. The students usually resort probability calculations to the science of mathematics, the decision and game theory are less known among them, and they usually associate with incorrect analogies [1]. One possibility of developing a united picture of science is the student experiment and the observation. During the planned and controlled work, the understanding of learnes become more complex, which helps to find links easir between disciplines. Thanks to that young people will be open both the natural phenomena and the indicated field of science [2].**

***Keywords* – Experiment, Observation, Probability, Decision, Game Theory, Relations.**

I. Introduction

The description of the motion of suspended a body is idealized. When we are characterizing the movement, we need to use assumption and simplification options. The description is made with the help of physical laws. [3] The environmental burden that appears in social phenomena, the fact that individual may harm its natural and social level to increase own benefits can be easily described with the help of game theory [4].

II. Physical Experiment

Let's examine first the body that moves on the pendulum: It is assumed that the fixation is stable, the yarn is not extensible, the movement takes place in a single plane, the extent of the swing is limited, and most of the cases, we also ignore the effects of friction and air resistance [5]. After eliminating the listed factors, we observe how the hanged body moves or could move. In the kinematic description of the movement we recognize the physical quantity, which we consider decisive, the swinging time. We observe, we carry out experiments, measurements, and then conclude, then we use mathematics as help so we can describre exactly the movement of the suspended a body at any point in time [6].

During the dynamic description of the movement we explain that, why the pendulum moves just as we see it. Knowing the weight of the suspended body, and with the help of the resultant force the kinematic characteristics can also be determined. The body that moves periodically on the pendulum gets, every moment into a different position: passing through the equilibrium position, due to the maximum speed the kinetic energy can be facilely determined. In edge situations, the amount of potential energy is maximum. In intermediate locations, the sum of the energies that determine its state does not change [7].

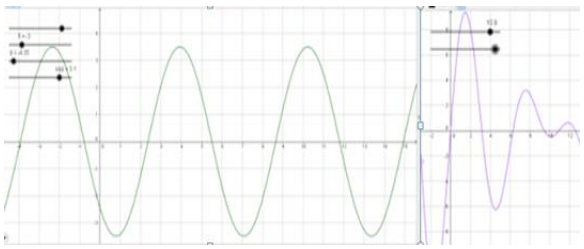

Fig. 1. A graph showing harmonic and dampening motion

We can see, that it is a significant part of the phenomena that occur in nature can also be described by the knowledge of this periodic change [8]. For instance the vibrations of the crystal lattice atoms, the elasticity of muscles that move our body, the thermal conductance of the solid material, or the condition of the body in the microwave oven. We cannot detect, the harmoniously functioning processes of the created world with the senses acquired at birth [9]. We see and feel the phenomena in society, and we experience, that human relationships and behaviors how far deviate from the order, what we are talking about on physics lessons. But we are all members of this seemingly disorganized society, and our science-conscious way of thinking can help, us to find physical laws in social relations as well. If we show that we can put a bigger mass on a thread than the "critical", or we can apply "real" yarn, which may have a size change due to the load [10]. Such movements cannot be described by the elementary level of mathematics, but computer graphics can help us. In addition they can be associated with such movements the interactions and processes in society.

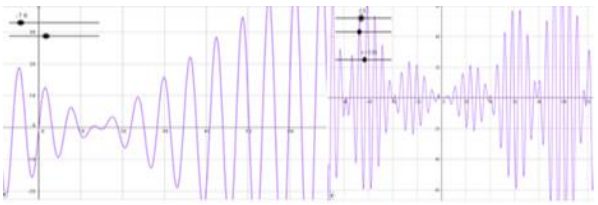

Fig. 2. The movement of the deformed pendulum

III. Social Processes

The examples which exist in society, can also be based on real, personal experiences of the students. When we analyze these, we can depict them as an analogy of the elongated pendulum so it can be called a social trap. A type of social traps appeared in 1968, in interpreting Garrett Hardin [11]. The papers that have been written about this agree, that the only possible condition for the survival og humanity to curb the wasting process of the forces of the nature. The braking is hard to implement: the damage is distributed among many people, the individual does not directly perceive them. The cost of planning strategies to protect nature exceeds the level of expenditure [12]. The

basic condition for avoiding the trap lies in its recognition. The recognitions, the first step in a process, its main element is the flow of information; the feedback about the possibility of damage; creating and maintaining coalitions between individuals and social groups; and the proper form of central regulation [13]. For students in science education, our task is to help to understand the natural and social environment, and to form and develop the conscious mindset. The parallels between the two areas are shown by the following examples.

IV. Presentation of the Experiments and Results

Science:

The experimental layout used in this example it was a stand, stretchy yarn, and some hanging weights. The task is to observe the movement of the swinging pendulum by the increasing loads. In the experiment, the observation of the movement is helped with electronic recording, its analysis can be conducted by electronic simulation.

Fig. 3. Movement of the hanged body by changing the load

The moving body carried out a specific type of movement [14]. As a function of the stretched yarn we expected, that we are confused and we will see irregular movements. However, the system is very interesting, by unpredictable manner, but moved within a closed interval defined with a given location coordinate. Movement was not explained by the change of parameters, it should also be as a factor, which we neglected during the analysis, due to its small size.

Game Theory:

The experiment was carried out with 74 pupils. By analyzing the basic situation, the students were autonomous in their decision in each situation. Starting position: You're on a study trip, and you can get to the designated meeting point by tram. You also want to buy food of your pocket money. You get into the passenger compartment of the tram, where on the ticket machine you can read the following:

First Version:

The ticket price is 300 HUF. We do not use a control system. Thanks to the honest customers that contributed to the cost of the trip. Do you buy a ticket for this trip?

Second Version:

The ticket price is 300 HUF. Every twentieth tram is checked, and those, who do not have a ticket, will be punish by the amount equal to the ticket price. Do you a buy ticket for this trip?

Third Version:

The ticket price is 300 HUF. Every tenth tram is checked, and those, who do not have a ticket, will be punish by the amount of twice the price of the ticket, and it is recorded in the register of offenses. Do you buy tickets for this trip?

Responses can be evaluated by descriptive statistics, or the interaction between students and traffic controllers can be analyzed using game theory. According to the game theory analysis, the student and the transport company are the players. The game is nothing but a change of ticket, or failure to do so. The profits earned during game it means that students' money remains in your pocket, the loss is the payment of money. The game is two-player and complete information, a which a possible solution can be given by searching the saddle point. Figure 4 together with drawing the saddle point, shows related to individual situations the probability of an optimal decision from a strategic point of view and the gain so obtained. The diagram illustrates the interaction of the learner, and the propensity to purchase tickets, and as a result of the purchased ticket displays the paid of payout function.

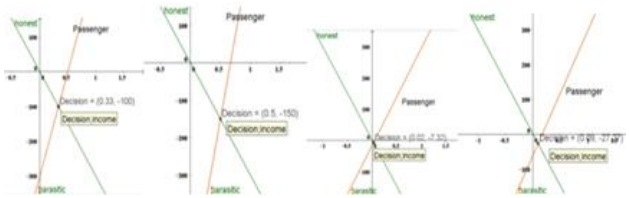

Fig. 4. Ticket purchase propensity according to the degree of punishment (a, b) in addition according to the frequency of flights checked (c, d)

Based on game theory analysis, the need of buy a ticket, considering only the conditions above less likely works [15]. Although the extent of the punishment increases, increases the willingness to shift tickets, the proportion of the frequency of the checked fittings, yet it is keeps it low. In the decisions of the students involved in the experiment appear even other items, which cannot be interpreted merely on the basis of game theory [16]. The willingness to buy a ticket, based on the declaration of the students in your experiment it cannot be explained with the help of game theory model. Thus parameters were included in the decision-making process, which are not the rate of punishment, rather it can be explained by the related infringement procedure.

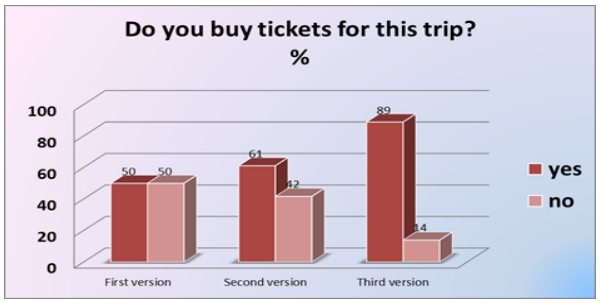

Fig. 5. The outcome of the game

Based on a comparative analysis of the two experiments we can get closer to the explanation of the behavior. During the comparison, following the disclosure of common features, the expected and the observed deviation of the results, we list the possible causes.

By analogy, we observe the following similar components:

Table 1. Parallels between game theory and experimental approach

The game theory approach Purpose: To develop social sensitivity	***The science approach*** Purpose: To develop natural-minded thinking
Let's start with the example of parasitic passengers. Suppose that there is absolutely no or minimal punishment, and there are few passengers who want to travel without payment:	Let's examine a periodic movement. Let us have a pendulum, where the yarn is not, or minimally extensible, and the weight of the plumment is small:
The maintainer of the transport does not spend much money on the controll, and punishment : Damages cannot be measured. The fuel and ticket prices are determined int he company's money.	The tension of the pendulum; Its elastic energy cannot be measured, During the transformation of the potential, and the kinetic energy transformation is decisive.
If the number of parasites increases, which could be described with either a continuous function ...	If the weight of the body hanged on the pendulum grows, which could be described with either a continuous function ...
a) Emergency, or b) A complete disorder occurs: In order to maintain heavier transport punishment shall be imposed,so you have to invest in the audit more money, so in cash flow the amount spent on the check, penalty-recovery,and it will be comparable magnitude as the previous two:	a) Emergency, or b) A complete disorder occurs: In order to maintain the movement Stiffer yarn should be used, Bbut so in the energy transformation process the elastic energy change is displayed ,and it will be comparable magnitude as the previous two:
If the number of parasites is constantly increasing, the traffic will be unmanageable at some point, then becomes unsustainable.	The pendulum is stretched, sustained deformation, then the motion is unverifiable and becomes uncertain.

In the experiment, the parameters did not include the impact of the air, the slip friction parameter of the suspension, and the dynamic effect of deformation considering the indefinable time and form. While the first factors are responsible for slowing motion- or changing the direction of motion, the dynamic effect causes unpredictability of the system. If any of these factors has a greater impact that the limit, the system breaks, falls or stops [17]. But due to the simultaneous effects in a given parameter range the fine balance of motion is granted.

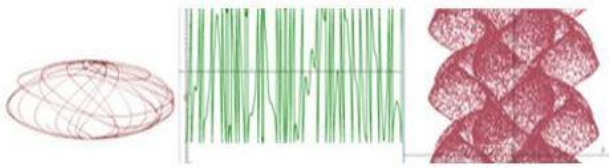

Fig. 6. Animated presentation of dynamic motion, position-time function and speed-position function

In social interaction the human behavior can be transformed by some parameters, like the human weakness: thanks to the interaction of the entire medium, it looks more stable than excepted.

V. Conclusion

Physical experiment and interaction with pupil jointly pointed out that, that the lack of preservation of the available natural resources-too much weight, too many parasites-upsets the balance and order of a system. If we extend the analogy to natural resources, we can understand that human activity, which is equivalent to the parasitic behavior for natural treasures may cause inpredictable consequences. As we have seen from the experiment, in a simple, and basically transparent, model, it happened that the outcome was different from the deterministically predicted result [18]. Nature, in comparison with man-made and prepared systems respond to errors better, because it is ensured by a network that is closely connected. Thanks to the interconnections of the existing network the survival chances of our environment are rising. Neverthless, because of the network's topology it should be awared, that despite the minor errors- too much weight, too many parasites-can not cause significant harm to nature, it is unprotected against coordinated, large-scale attacks- the example of forest fires. However on the basis of social interaction, it gives rise to optimism, that human behavior in relation to society or nature - shows signs which helps their dinamic survival.

VI. Summary

The science experiment, social interaction-related gaming and responsibility for natural treasures, contains many common features. Although education does not provide a specific time frame, it may be advantageous for our future, if we take advantage of opportunity of the quality development of young people's natural and social responsibility. In addition, we can point to young science areas, such as decision theory, game theory, chaos theory or network science. There are very good opportunities for all of these in physics education.

Acknowledgment

I thank my students for active help in research, to help in translation and professional advices I. Leitner.

For Gy. Szabó and P. Pollner for professional help and advice.

I would especially like to thank my helpful students for the enthusiastic job.

"This study was funded by the Content Pedagogy Research Program of the Hungarian Academy of Sciences."

References

[1] C. D' Aspremont & L. Gevers, „ Equity and the informational basis of collective choice," Review of Economic Sudies, 44, 199–209, 1977.

[2] B. Leitner, „ Experiences in teaching game theory in the high school," In: A. Király & T. Tel (eds.) (2015): Proceedings of the international conference Teaching physics innovatively (TPI-15). Budapest, 17–19 August, 2015. 211–216. Available: http://parrise.elte.hu/tpi-15/papers/Ch_05.pdf

[3] I. Nahalka & K. Radnoti, „ Rezgések mindenhol," Available: https://www.google.hu/search?biw=1366&bih=672&q=periodikus+mozg%C3%A1s+p%C3%A9lda&oq=periodikus+mozg%C3%A1sok&gs_l=psyab.1.1.0i71k1l4.0.0.0.19888.0.0.0.0.0.0.0.0..0.0....0...1..64.psy-ab..0.0.0.mr1qjJDB258#

[4] M. Szilágyi, „Talalkozas a jatekelmelettel," Available: http://beszelo.c3.hu/cikkek/talalkozas-a-jatekelmelettel

[5] A. Czifra & T. Goda, „ Mechanika III. Kinematika es Kinetika," Available:http://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0054_mechanika_iii_kinematika_kinetika/ch19.html

[6] L. Gulyas, „ Modellek, reprezentaciok es osszehasonlitasok a szamitogepes szimulaciokban," 2006 Available: http://hps.elte.hu/~gulya/Teaching/TarsSzim/ModRepCompInS.pdf

[7] A. Juhasz, T. Szegeczky, „Kinematikai feladatok grafikus ertelmezese es megoldasa," Available: http://www.ovegesegylet.hu/sites/default/files/kinematika.pdf

[8] I. Nahalka & I. Poor, „ Solving the problems and tasks in physics learning" The pedagogy of physics teaching, Eds. K. Radnoti & I. Nahalka, Nemzeti Tankönyvkiado, Budapest. 2002.

[9] L. Mero, „Who is Who World Society," Available: https://www.whoiswhoworldsociety.ch/kunden/direct/.../mero_laszlo.pdf

[10] M. & Z. Szilagyi, „A tool for simulated social experiments," Simulation. Vol. 74, 2000. 4–10.

[11] G. Hardin, „The tragedy of the Commons," Science 162, 1968. 1243–8.

[12] L. Mero, „Ways of thinking: The limits of rational thought and artificial intelligence," World Scientific, Singapore, 1990

[13] L. Mero, „ Games theory, logic, and human frailty," Springer Verlagt, New York, 1998.

[14] Eds. A Juhász & P. Jenei, „ A fizika tanitasa a kozepiskolaban," Available: http://ttomc.elte.hu/sites/default/files/kiadvany/fizika_tanitasa_a_kozepiskolaban.pdf.

[15] L. Filep, „ Game Theory," Textbook Publisher, Budapest, 1985 (in Hungarian)

[16] B. Leitner, „ Uncoordinated Collaboration Among Students" US-China Education Review B, 2017. Available: http://www.davidpublisher.com/index.php/Home/Journal/detail?journalid=49&jx=ucer-B&cont=allissues

[17] M. Schroeder, "Fractals, Chaos, Power Laws" Dover Publications, 2009.

[18] C. D'Aspremont, & L. Gevers,"Equity and the informational basis of collective choice" Review of Economic Sudies, 44, 199–209, 1977.

AUTHOR'S PROFILE

Borbala Leitner
Mathematics Physics Teacher, Innovation-profile master teacher, Measurement and evaluation expert, Affiliation(s): Szent Imre High School, Teacher, ELTE PhD student. Research field: Introduction to Game Theory and Network Science in the Secondary School.