STEM Molecular and Cellular Neuroscience Didactics for Human Health in High School

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Abstract

Neurons are specialized cells, the biophysics basic units of the nervous system with the main function to communicate and the synapses are the key of relationship between neuronal cells. Neuroscientists are researching how neuron can interacted which others to generate signals also in pathological conditions and how can organize storage and delete information in complex biochemical and physiological mechanisms.

The mission of this project was to develop innovative didactic research about teaching and learning Molecular and Cellular Neuroscience with Interdisciplinary STEM methods. Different didactics neuroscience activities were realized to activate reasoned enquire approaches. Working as biologist didactic researcher - principal investigator in scientific international community, were realized innovative learning by doing strategies about Brain science topics for inclusive health education in curricular didactic actions. Surfing and searching in scientific selected international data base was also possible to guide students in analyzing historical aspects and modern biological concepts about human brain, scientific literacy about elements of biochemistry and cellular physiology for neurodegenerative disease. Brain science research for innovative STEM High School Research; cooperative learning actions with new strategies to promote dynamic knowledge about young people Health Education introducing Systems Neuroscience. Elements of Brain Science Evolution were promoted motivating students in ICT work and educating to correct communication and interpretation of modern neuroscience discoveries.

Two key concepts were important in this neuroscience project: neuronal plasticity and neuronal connectivity, analyzing with dynamic strategies the important role of Glutammate receptor proteins (NMDA and AMPA). In this educational path were useful STEM didactics approaches to realize together protagonist - students Health Education itinerary with "contamination" between different disciplines, linking innovative bioscience concepts, strategic cooperative teaching practices to realize constructive Neuroscience Orienting Education.

Keywords: *interdisciplinary education, Neuroscience communication, Neurodegenerative disease, STEM didactics strategies, Neuroplasticity, Biologist - didactics researcher;*

Introduction

The main function of a neuron is the communication: it is also used to feel, to transform all the messages coming from the inside to elaborate these messages and to promote the action; besides neuron can converter electrical energy or chemical energy into mechanic energy. Didactic of Neuron and for Synapse is important to educate High school students to understand modern Brain science in interdisciplinary way promoting innovative role of Educational Neuroscience beginning from Biophysics concepts. This STEM didactic research project has created elements of interdisciplinary educational process about Neuroscience bases with elements of experimental neuroeletrophysiology history beginning from

SCIENTIFIC QUESTIONS FOR STUDENTS

*What are the function of neurons and which is the difference between excitable and not excitable cells with example?
*What is synapse in human nervous system and how was realized discover by scientists?
*In which way do you think is possible to represent concepts of synapse also with a model?

Innovative research about strategic didactic activities for learning biological neuroscience of synapse also with innovative STEM elements from *International* 2017 *Neuroscience Meeting*. In teaching modern Neuroscience topics in High School is very important to link school research activities with science world, learning innovative developments and limits of modern Brain science. Biologist didactic–researchers have analyzed international synapse researches to construct STEM activities to

improve neuroscience learning. The core of Neuroscience studies can be presented to High School classes in innovative way, also understanding different aspects of interdisciplinary neuroscientists' methods to investigate the brain. Modern didactic and communication for synapse working as didactic researcher - teacher with protagonist students as "active scientific community" were realized to present also modern concepts about *Neuroplasticity* with scientific STEM disciplines (biophysics, biochemistry, neuroelectrophysiology, ICT, cellular biology) in learning neuronal science using also international selected articles of scientists about this topics. From lecture of simple neuroscience highly effective communication to complex neuroscience articles, also consulting with students www.brainfacts.org – Society of Neuroscience, Washington.

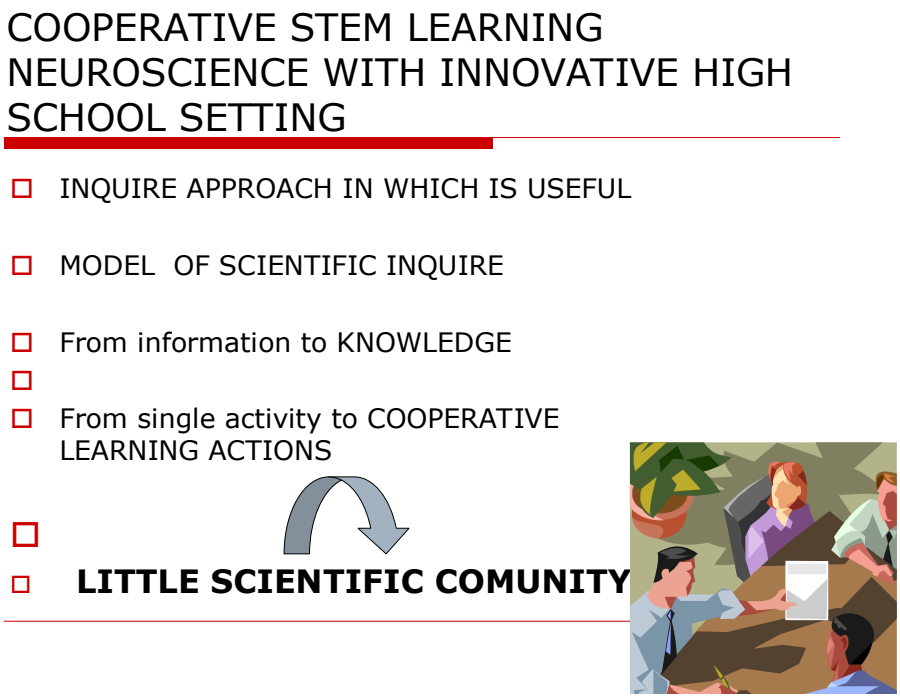

Fig. 1 -Modern High School setting with innovative Neuroscience Didactics

Material and Methods

New idea in this didactic itinerary: to link High school' world with Research' world in Educational Neuroscience Itinerary with modern inspiring role of science research. "*Principal investigator*" with group *researcher - students* for Science Education Community in High School. During didactic itinerary was important Teaching and Learning in multidisciplinary way with Creativity and Flexibility, analyzing also history and evolution of experimental *neuroelectrophysiology techniques* useful for Biomedicine about Neuronal cell. The innovative STEM didactic itinerary was a part of large creative project realized to educate High school students in understanding evolution of modern biomedicine techniques with limits, difficulties, new applications. From historical biophysic elements to modern molecular biology and neurophysiology techniques, guiding students in team work to understand scientific data in cellular membrane of excitable cells as neuronal cells. In teaching modern science topics was very important to learn innovative developments and limits of modern science techniques as in academic innovative itinerary. Modern class setting: educational didactic path to work with critical thinking and with historical approach to understand Systems Neuroscience into little scientific community as student- researchers.

Different phases were realized in this STEM project working High School' students that have created "*Bioglossary for Neuroscience with interactive images*", interpretation and representation action potential simulation creating possibility to determinate change of ionic concentrations after stimulus on the neuronal membranes. Each group of students have drawed with computer graphic model of neuronal cell and on the membrane the strutture of different proteins channels, reading articles and representing new concepts about synapse from some international scientific researches. Different curricular actions of students in cooperative learning Neuroscience were realized with enquire method:

1.	To tell history neuroelectrophysiology techniques
2.	To draw glossary in cooperative learning and to construct synapse model of neuron
3.	To represent interactive action potential simulation and protein channels activities
4.	To analyze, to reflect and represent about 2017 “synapse science” discovers
5.	To analyze in active way oxidative stress condition on microglial cells: neurodegenerative disease
6.	To comunicate as researchers in classes - miniworkhop

Tab.1 – Different actions of cooperative “Learning Neuroscience Activities”

From this activity to “*Tell a neurotransmitters activity*” in which was realized by little group of students interactive works with ICT skills, innovative scientific posters about principal neurotransmitters. In “ *Neuronal cells communication*” phase were realized didactic learning strategies teaching modern Brain studies about Biochemistry and Cellular neurobiology of neurodegenerative disease as Alzheimer’ to improve impact of actually knowledge about this topic in Health Education.

Results

Didactic products (ICT rielaborations, Synapse Interactive model and others) were realized in all activities working with inquiry-based learning as in community of scientists. This research project has created conditions in which innovation is the core of new didactics strategies in student’s groups to increase the levels of motivation, to activate collaboration in teaching, learning and planning processes. From the principal concepts of Neuroscience to modern Neuroinformatics didactic activities in surfing Brain Bioinformatic Bank, students have integrated different knowledge to realize correct communication and interpretation of Brain Science. Students have read also innovative scientific articles about modern synapse’s discoveries (2017), analyzing in little groups some aspects of the Application SYNGO,” *Synapse Consortium – Synapse Gene Ontology”*, a collection of information about genes in different species, proteins, experimentals, 3D images about synapse brain regions.

Discussion

Each group of students has drawed with computer graphic neuronal cells and on the membrane the structures of different proteins channels also reading and representing new synapse concepts. In “*Neuronal cells communication”* phase questions of biology researcher - teacher about “neuronal conversation” with international modern researches. From this activity to “*Tell Neurotransmitters”* on which was realized interactive work to neuroinformatic didactic surfing in Bioinformatic bank. Didactic learning strategies about modern brain studies in the classes also about biochemistry and physiology elements of neurodegenerative Alzheimer’s disease. Others STEM didactics activities were realized about innovative *Optogenetics* that links genetics, pharmacology and optical control with the possibility to manipulate receptors with photoinactivation, the possibility to describe proteins conformations mobility and introducing new functions into proteins also positive and allosteric modulation of glutamate receptors. From the basic concepts about chemical synapses, the function of neurotransmitters in neuronal communication to promote an interdisciplinary analyse with proteins receptors important for Brain plasticity: *Glutamate receptors* (NMDA and AMDA). In terminal High School classes is possible to work with students about Glutamate Protein Receptors implicated in memory mechanisms and neurodegenerative diseases for little groups in *ICT surfing activities* using *Data Protein Bank* (*PDB*), searching proteomic information about chemical structures (aminoacid numbers, per cent of alfa beta sheets, year of discoveries, receptors weight), the role of these proteins in normal plasticity during modulation of neuronal communication, potentiation or depression .

WHAT IS PLASTICITY FOR STUDENTS? Plasticity is a key concepts in modern science . Plasticity is the brain ability to reorganize itself by new connections between neurons THROUGHOUT LIFE
WHAT IS NEUROPLASTICITY CAUSED BY? 1. PHYSIOLOGICAL CAUSES (learning, automatic behaviour; reactions to positive damaging stimuli) 2. PATHOLOGICAL FACTORS (after a brain damage are consolidated circuits and brain areas replaced by parallel circuit: re-educational path)

Tab. 2- Neuroplasticity concepts for High School students

Conclusion

In this educational synapse path realized in High school classes, teacher - researcher write itinerary of didactic project in which students are protagonists. It was possible to guide students with motivating strategies to work as researchers also analyzing biochemical and physiological innovative dates, relationship between molecules of neuronal communication, learning by doing also about pathological mechanisms of Alzheimer' disease (AD). For better Learning Neuroscience was important to create new didactics STEM path with multidisciplinary Brain Science, analyzing normal and pathological condition and reflecting about importance of equilibrium of individual life style on cognitive functions. It was important for success of project to prepare flexibly actions for students of different classes, to programme active interdisciplinary lessons with protagonist students, to solidify learning with cooperative STEM class group-work. In this way should be taught elements of neuroscience in High School, with interdisciplinary approaches and with STEM enquire methods. From the basic concepts about neuronal physiology and chemical synapses to role of different neurotransmitters in neuronal communication, an interdisciplinary analyse of proteins receptors important for plasticity of the Brain: *Glutamate receptors* (NMDA and AMDA). Glutamate Protein Receptors implicated in memory mechanisms and neurodegenerative diseases to understand the role of these proteins in normal plasticity during modulation of neuronal communication, potentiation or depression to improve in modern way Health Education about Brain.

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