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Brain Talking: Classroom Activity to Engage Students in Deep and Meaningful Learning

Abour H. Cherif, Ph.D. (Corresponding author)
President Emeritus, American Association of University Administrators (AAUA)
Associate editor, Journal of Higher Education Management.
Chicago, Illinois, 60661, U.S.A
Tel: 847-220-0895 E-mail: acherif@aaua.org; abourcherif@att.net

Dianne Jedlicka, Ph.D
The School of Art Institute of Chicago. Chicago, Illinois 60603, U.S.A
Tel: 815-474-4829 E-mail: djedlicka@saic.edu; djedlicka@colum.edu

Sujata Verma, Ph.D
Ivy Tech Community College of Indiana, Fort Wayne, Indiana, 4685, U.S.A.
Tel: 260-417-0361 E-mail: sujataraniverma@gmail.com

Khalid Uddin, MBBS. MPH.
Harold Washington College, Chicago, Illinois 60661, U.S.A.
Tel: 321-553-5890 E-mail: kuddin@ccc.edu

Farahnaz Movahedzadeh, Ph.D
Harold Washington College, Chicago, Illinois 60661, U.S.A.
Tel: 321-553-5890 E-mail: fmovahedzadeh@ccc.edu

Abstract

One of the best ways to take care of ourselves is to take care of our own brain. To do so, we need to individually learn both how our brain functions and how to know it is healthy and functional, at an optimal level, throughout our life span. After all, using Mariettle DiChristina's (the chief editor of the Scientific American) words, our gelatin-like brain contains all that makes us who we are, including our hopes and dreams (2016, p. 6). We do know that brain aging starts early (Sandres, 2016). In the hopes of increasing brain health and learning about the human brain, we designed role play learning activities and sets of related assignments for students to learn about brain structure, function, and how such learning can enhance our understanding of how to protect our brain from various mental disorders/health problems and to optimize its function and in turn the quality of our own lives. If we want to stay fit, feel better, look younger, and live a healthy, longer life with sharp memory and high mental function, then the pathway to achieve all these is through meaningful understanding of our brain through purposefully well designed learning tasks. We have designed a scenario through which students are actively engaged in a purposeful redesign of the human brain through a role-play pedagogical learning approach. Students adapt or change different parts of the brain and compete for permission to alter the structure and the function of a given part for a purposeful reason. Throughout the processes, students conduct research, work individually and in collaboration with others in groups. Students form and present informative and research-based supportive arguments in open forums. Through this role-play, teachers and instructors provide initial resources for the students, and then continue to provide effective feedback to support student learning and extend it to higher levels. Role-play has been shown to increase interaction and engagement by placing students in an active role in the classroom as they act out behaviors, concerns, and actions associated with a character. Students who act out assumed roles have also been shown to gain new perspectives and grow a deeper understanding of what it would be like to be that character in real life (Cherif and Somervill, 1995). The hope is that by learning about the brain in early school years, not only do we stay mentally sharp but also we are able to continue to have new learning experiences and live life to the fullest throughout our entire life span.

Keywords: Brain, Role play, Active learning, Student's engagement, Effective instruction, Brain disorders, Healthy life-span.

1. Scenario

For learning purposes, Integrated Biological Assembly (GIBA) is a fictitious organization created for this role play activity. The members of the Global Integrated Biological Assembly (GIBA) have decided in the last annual meeting in Geneva that the biological affairs and conditions of our world has reached a critical condition that requires all life forms must make changes in their unique structural and functional design to reduce the current global problems. However, this is a risky matter because no one has intentionally done this before and therefore the members of the assembly voted after a lengthy discussion and debate to go with a less risky approach. They decided to only allow two groups, the human species and the bacteria to make intentional changes in their unique structural and or functional design. Human species were given approval to increase the capacity of one part of their brain, but left the decision to humans to choose which part. Unlike humans, bacteria have been given the right to alter their molecular structure (genetic structure) in any way they see fit. While we understand why human species has been selected, simply because most of the significant alterations on the planet earth have human fingerprints and root causes, we don't know the main reason for giving unrestricted freedom to bacteria. We can only speculate that may be because bacteria are the first living form to inhibit this planet earth and remained the only life on this planet for more than two billion years; or because they are the most abundant and in many ways the dominant life form on the earth; or because of their ability to live in every type of conditions and climates; or because all other life forms depend on them for their existence, etc. In this scenario, we are part of the human species, and thus we focus on the human brain and which part can be justifiably modified to increase its capacity and why and how.

You have been entrusted with this remarkably unique opportunity on behalf of humanity. Your decision and contribution will impact not only the human species, but also all living forms through their environmental and interspecies interactions, and in turn, the survival of the global world as a whole. Indeed, your contribution might even be significant in accomplishing the dream of colonizing other planets and making humans as a multi-planetary species.

The pedagogical approach for this selected scenario, on the human brain, is for students to actively engage in this purposeful redesign of the human brain through a role-play learning approach. Role-play has been shown to increase interaction and engagement by placing students in an active role in the classroom as they act out behaviors, concerns, and actions associated with a character. Students who act out assumed roles have also been shown to gain new perspectives and grow a deeper understanding of what it would be like to be that character in real life (Cherif, Jedlicka, Movahedzadeh, & Phillips, 2012; Shaw, 2004; Cherif and Somervill, 1995).

2. The Human Brain

If you want to stay fit, feel better, look younger, and live a healthy, longer life with sharp memory and high mental function, then the pathway to achieve all these is through meaningful understanding of your brain. While every part in the human body is important and critical in its own intrinsic way of survival, the brain and the heart stand out among all.

The brain itself is comparable, metaphorically, to a biological computer. However, anatomically and physiologically the human brain is more advanced than any computer built or will ever be built, regardless of the potential of the great speed, ability to encode, retain, retrieve, and process information. The brain and the spinal cord comprise the central nervous system, or CNS, while the remainder of the nervous system comprises the peripheral nervous system or PNS. After receiving sensory input from various sensors in the body, the CNS can react and respond accordingly to daily need and survival.

Unlike the multifunctional human brain, the heart, a part of cardiovascular system, has a single function – to pump the blood into the blood vessels so that it reaches the trillions of tissue cells of the body including those in the brain. In doing so, it is considered as the center of the body's closed network of blood vessels. The heart's importance cannot be understated; it is essential for survival as it circulates the necessary oxygen and nutrients while transporting metabolic waste away from all parts of the body. It works in conjunction with the pulmonary system to maintain appropriate levels of oxygen and carbon dioxide in blood (Cherif, et. al, 2008). The typical adult would have about 4 to 5 liters of blood constantly circulating the entire volume in the course of a minute, beating, on average, 75 times (Restak, et. al, 2014).

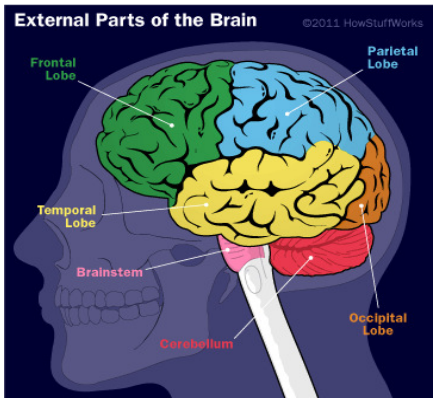
But back to the main subject, the brain appears as a largely unimpressive jellylike pinkish gray mass. The newborn human brain is about the size of a small tangerine with trillions of pathways (Roberts, 2017). By adulthood, it's only about the size of two fists in a wrinkled ball, weighing in at 1600 grams (3.4 pounds) in an average man, and about

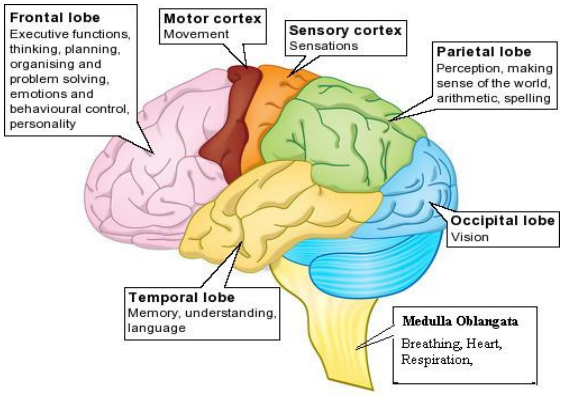
1450 grams in an average woman, but in equal proportions against body mass; in other words, males and females have equivalent brain size. However, while intact, the human brain is just 2% of the body weight and consumes almost 20% of the body's needed energy (Walsh, 2016; Al. Arabi, A. Cherif, A., Jedlicka D., and Aron, R., 2005).

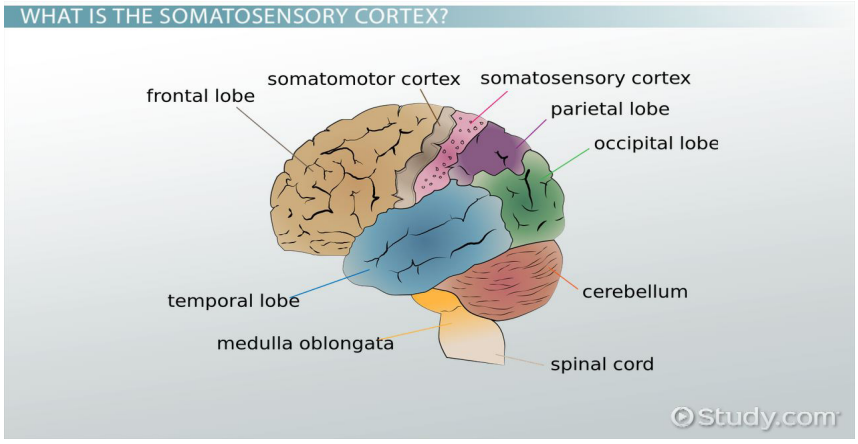
Our brains are about 60 percent fat in mass, which is why medical doctors are urging us to eat Omega-3 fatty acids. They "promote the brain's ability to regulate mood-related signals, are a crucial constituent of brain cell membranes, are needed for normal nervous system function, mood regulation, and attention and memory functions (Pratt and Matthews, 2004). The brain is composed of around 100 billion neurons and up to 50 trillion neuroglia. Bone, membranes, and cerebrospinal fluid protect the brain, which sits above the spinal cord (Resrak, et. al, 2014, p. 236).

The brain controls and coordinates virtually every function in the human body. It automates breathing, allows us to solve equations, register sensations and houses our memory, intellect, emotions, behavior, sleep, and wakefulness. It allows us to be aware of ourselves and our environment, develop and create new thoughts and ideas, and communicate with others (Resrak, et. al, 2014, p.236). Terry Burnham and Jay Phelan (2000) compared machines such as microwaves or cars against the human brain. The brain appears to have its own agenda sometimes. Despite our best efforts, we break our diets or have instant likes or dislikes for some things. We can have dreams that are not of our own conscious construct, and if we go against the brain's wishes, it usually gets its way.

Figure 1: Main Structure of Human Brain







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www.study.com

Burnham and Phelan (2000) best illustrate this struggle with the brain. They use very relatable conflicts we may have as a product of evolution. Once we understand our brain design, "it is no longer surprising that we experience tensions in our marriages, that our waistlines are bigger than we'd like, and that Big Macs are tastier than brown rice." They further say that "to understand ourselves and our world, we need to look not only to Sigmund Freud but rather to Charles Darwin" (Burnham and Phelan, 2000, p. 4).

In their book *Mean Genes*, Burnham and Phelan (2000) explain how we can understand our animal nature, especially desires that causes trouble or lead to unhappiness. We can then harness this gained knowledge to tame our primal instincts. This is where formal education can play an important role in ultimately taming our primal instincts while educating ourselves about the brain. And the sooner we expose our students to learn about their own brain, including its structure, function, and how we can use this understanding to enhance and maintain the brain healthy, the better. As Sweeney (2016) shows in *Complete Guide to Brain Health*, while we might not be able to prevent all problems associated with, for example, aging, we can take steps now improve overall brain health. This is very important especially since the new discoveries have shown that "the brain continues to develop way beyond adolescence; it continues to have the ability to change and form new synapses throughout life. It's our challenge to keep it changing and growing as we age," (NG, 2015, p. 362). Therefore, when it comes to slowing down the aging process, studies show that staying "mentally active is equally as important as physical fitness, a healthy diet, and stress reduction" (NG, 2015, p. 361). After all, as Zimmer (2014) explained, the secret to understanding many diseases "may be hiding in the brain's genes, as they shut down or switch on abnormally" (p. 43).

Finally, as Norbert Myslinski, an associate professor at the University of Maryland, Baltimore, and the 2016 Science Educator of the Year explained, neuroscience and brain education is not just for scientists and the people with brain disorders. It is needed and can be used to help teachers become better teachers, parents become better parents, and students become better students. But he added, it is important to start neuroscience education early – in high school, and may be even earlier (Depenbrock, 2016). With this in mind, we design this set of learning activities to help students become well-informed about their brain and in turn about themselves. We agree with Fergus Walsh (2016), from the BBC in saying that, "Just as the *Human Genome Project* transformed knowledge of biology and genetics, a similar revolution is underway in scientific understanding of the brain. The international *Human Connectome Project (HCP)* aims to unravel how the brain is wired and the function of neural networks by map the entire network of the human brain." We, as educators, we want to be, not only part of it, but also to contribute to it through the availability of real and relevant learning materials, our innovated instructions, and the will for educating our students. After all, as the chief editor of the *Scientific American* journal, Mariettle DiChristina (2016) eloquently put it, our brain contains all that makes us who we are including our hopes and dreams (p. 6). It is one of our biggest assets for becoming human beings.

3. Pedagogical Approach: Role-play Learning Activity

3.1 Role-Play as An Effective Teaching Tool:

There is no doubt that effective teaching through engaging students in the learning processes helps students to think critically, communicate effectively, learn self-discipline, develop an understanding of oneself and others, and cultivate the perpetuation of self-education (Shaw 2004; Freiberg and Driscoll 2000; Cherif and Somervill 1995; Cherif and Adams 1993). Role playing is one of these effective teaching and learning techniques that encourages such participation. It provides the learners with the opportunity to develop a shared vocabulary which is essential for successful communication and for "acting out" conflicts, collecting information about social issues, learning to take on the roles of others, and improving students' social skills and informative behavioral attitudes. As a teaching strategy and learning approach, role playing offers students an unique way to resolve interpersonal and social dilemmas as well as help teachers in achieving the intended learning objectives (Joyce et.al. 2009; Ross et al. 2008; Cherif and Somervill 1995). Role playing also provides an opportunity for students to engage in active learning which involves the critical analysis of new ideas by linking them to already known concepts or principles; something that could lead to better understanding as well as long-term retention of concepts (Cherif, et. al, 2012; Houghton 2004). Additionally, it gives students the opportunity to develop and combine important skills such as forming logic based arguments, scientific research, aforementioned interpersonal cooperation skills, and evidence-based conclusions.

An essential part of success and a key trait in learning and leading through understanding are the capacity to listen, take heed, and act (Chopra, 2016), therefore, role play as a platform for developing the skills of productive

listing is an excellent pedagogy. It provides the opportunity for discussions that have chance of being productive, which in turn help students see how valuable real, productive listening can be helpful in developing the habit of listening not only in the classrooms but also in society and in life. Listening is important, especially in today's globally interconnect world. As Chopra (2016) recently wrote "success is achieved through consciousness" and stresses the importance of listening as both a means of learning, understanding, and connecting with people as well as a tool for leading effectively. Furthermore, role play provides a good platform for students to develop shared vocabulary which is essential for better intentional conversation and effective communication.

3.2 Class Room Procedure

In this activity, groups of students assume the roles of the representatives and the bioengineering guardians of one of the eight major areas of the human brain: *Frontal Lobe, Parietal Lobe, Temporal Lope, Occipital Lobe, Cerebellum, Motor Cortex, Sensory Cortex, and Brainstem*. If needed, additional key categories can be included, such as the limbic system, hypothalamus, the components of the mesencephalon, striatum, or even the spinal cord. More advanced biology classes, for example, may substitute the lobes for "cerebrum" and include more specific areas such as the hypophyseal portal system and the aforementioned mesencephalon structures. One more group of students can assume the role of the media which has become an essential component of our everyday life at all levels (Table 1). Students of each identified group work together to develop convincing arguments and debate that the part of the human brain that they are responsible for is the most important part and should be awarded the enhancement that decided to be given to the human species by the Global Integrated Biological Assembly (GIBA).

During the process, students learn and reinforce their understanding of the unique relationship between the anatomical structure and the physiological function of the human brain and the effect each component has on humans as self-aware individuals and as collective social creatures. In addition, role playing activities such as this as they act out behaviors, concerns, and actions associated with a character they gain new perspectives and grow a deeper understanding of what it would be like to be that character in real life.

1. Ask each student in the class to conduct research about the human brain including its structure, function, development, and factors that could affect its development and function. Give the students one week to complete this assignment and to write at least 2-3 pages on their research. Include references and preferably illustrations and analogies.
2. After one week, have students complete their research and submitted their written assignments. Give each student a copy of the scenario and ask him/her to read it individually.
3. Divide the class into nine groups (Table 1). Each group should consist of a leader and 2-3 members. Depending on class and group size, each student may have to play more than one role.
4. Write down the following main parts of the human brain individually on 2x2 in cards: Brain stem, Cerebellum, Frontal Lobe, Occipital Lobe, Parietal Lobe, Temporal Lobe, Motor Cortex, and Sensory Cortex. On one more index card write Media Group.
5. Fold the cards and place them in a box. Then ask one student from each group to come and take one index card.
6. Inform the groups that each group will be assigned to adapt and argue for their assigned brain component. The role of media group is to accurately report the event, raise important related questions that might not be asked by the debated groups, and inform the public.
7. Ask the members of each group to meet and divide the roles between themselves by selecting a leader for the group as well as to devise a plan, roles, and strategy of how they will prepare themselves to perform on the debate, and plan to win by convincing the debate committee members to rule in their favor in the final outcomes of the debate.
8. The media group will need to work together to devise a plan, roles, and strategy of how they will objectively cover the debate, prepare questions that they will ask the groups, and how they will inform the public with the outcome of the debate.
9. Form a debate committee consisting of the instructor, 1-2 volunteer instructors, if available. (If there are no volunteer instructors, then select two high achieving and well-respected students from your class.)
10. Give the groups two to three weeks to prepare for their class presentation and the roles that they are assigned to play.

Table 1
Proposed teams, what they represent, and few functions of human brain parts

	Interest Groups	Team Numbers	Few Roles or Functions
1	Brain stem	3-4 members (students)	Breathing, heart rate, arousal, consciousness, sleep and wake cycle, and temperature.
2	Cerebellum	3-4 members (students)	Balance and coordination, skilled motor activity.
3	Frontal Lobe	3-4 members (students)	Thinking memory, behavioral and movement, emotional control, self-awareness, motivation, judgment, problem solving, talking, initiation.
4	Motor Cortex	3-4 members (students)	Movement: It generates neural impulses that control the execution of movement.
5	Occipital Lobe	3-4 members (students)	Sight and vision: It is the visual processing center of the mammalian brain which receives input from the retina of the eye.
6	Parietal Lobe	3-4 members (students)	Language and sense of touch, awareness of spatial relationships, academic function such as reading, etc.
7	Sensory Cortex	3-4 members (students)	Receiving all the sensory input information from the body (sight, sound, touch, taste, and smell) for processing.
8	Temporal Lobe	3-4 members (students)	Hearing, language, learning, processing information, understanding, memory, and feelings
9	Media Group	3-members (students)	Follow and report the debates and inform the public. In doing so, they question the members of the groups, rise questions that have not been rise by the debate committee, etc.
10	Debate Committee	2-3 members (teachers or selective students)	Manage the debate by listening to arguments, raising questions, decide the outcomes of the debate, based on evidence-based and sound logic and arguments decision.

3.3 For the presentation, each group must:

- Each group must introduce the part of the brain that they are advocating for, by describing its structure and significance and why the increase of the capacity of that part would benefit humanity. They also must be able to justify why the members of their group are qualified to support the argument.
- Provide an explanation that is confident and convinces the members of the debate committee and classmates. Also explain how the proposed plan for increasing capacity will be implemented to maximize the brain efficiency and protection from new potential infections and brain disorders. Include vocabularies terms from biology and physiology understandable language.
- Prepare a well-researched student handout as well as an illustrated poster.
- Integrate the use of technology such as PowerPoint, animations, and interactive activities into the presentation.
- Include in their research and presentation at least 2 different types of foods (ex., fruits, vegetable, etc.) and show how they are important in protecting and promoting a healthy brain. For example, research has shown that consuming blueberries could help slow and even reverse many of degenerative diseases associated with an aging brain such as Alzheimer's disease and dementia (Pratt and Matthews 2014). Research has also shown that cultures which have high omaga-3 consumption in fish have far less depression and a host of other mental health problems than diets low or lacking in omaga-3 fatty acids.
- Must pay attention and respectfully listen to the arguments presented by the speakers of different teams. Chopra (2016) explains success which is achieved through consciousness, cannot be achieved when you aren't aware of what the others are saying or providing. Therefore, the skills acquired in awareness, which listening is one of them, are crucial for success.
- Must present their plan and strategy, show how they work, and thereby convince everyone that their plan and strategy are the best for achieving the purpose, to help humanity, and all the life forms.

3.4 **During the Presentation:**

a. The groups will take turns presenting their case to the members of the debate committee, the rest of the classmates, and invited guests (if there are any).
b. The leader of each group will present the proposed plan and the strategy of his/her group, then call on the members of his/her group to talk about how the plan and strategy provide justification.
c. The members of the debate committee can ask up to three questions after a given group finishes its presentation.
d. When all the groups finish their presentations, the debate committee can ask more questions to all the groups. The students including members of the media group can also ask questions which the members of the debate committee must consider in their final judgment. The members of each group, including the media group, must also take notice of all the questions that were asked.
e. The chairperson of the debate committee will wait until the next class meeting to share their final decision and the reasons behind making it with the members of the groups.

3.5 **After the Presentation:**

a. Before the chairperson of the debate committee reads and defends its final decision, each group will be given three to five minutes to address the debate committee one more time. In these short final remarks, the groups must have written statements that can be read to support their case. The written statements do not have to be shared with the other groups beforehand. This is a very important stage in the activity and is related to the "Creative Domain" of McCormack and Yager's (1989) taxonomy for science education as we will see in the coming assessment section.
b. After all the groups present their final remarks, the chairperson of the debate committee will read, explain, and defend the committee's final decision. After that, the chair of the committee will encourage the groups who are not satisfied with the committee's decision to write and submit an appeal within 3 days, but make no promises of whether the appeal will be accepted and or acted upon.

You may wish to direct your students to Michael Sweeney (2016) book "*Complete Guide to Brain Health*", David Perlmutter's (2015) book "Brain Making", and or "National Geographic" magazine, February 2014 issue, or any of the references in the appendix 2, to read as part of your class discussion.

4. Student Level of Involvement in the Learning Activity

In any learning activity, it is important that teachers know their own students' cognitive abilities and academic readiness and decide the level of challenges and involvement they want them to be engaged in (Cherif, Rose, and Gialamas 2016). This is simply because, as seen in table 2, there are seven factors that make up, for example, a typical role-playing situation: the problem to be solved, the characters to be played, the roles to be followed, essential information to be gathered, the procedures for the play to be adapted, and the outcome to be learned (Cherif & Somervill, 1994; 1995). Because of this, teachers and educators need to make a decision about which level they would want their students to be involved in the role-play. The decision usually is based on age of the students, as well as their cognitive abilities, the level of knowledge and information they already have on the subject matter being investigated, etc.

Table 2
Student Level of Involvement in the Learning Activity
(Adapted from Cherif and Somervill 1995)

Student's Level of Involvement	Problem to be solved	Characters to be played	Roles to be followed	Essential info to be gathered	Procedures for the play to be adapted	Conclusion to be Reached (outcome to be learned)
Level I	Given	Given	Given	Given	Given	Given
Level II	Given	Given	Given	Given	Given	
Level III	Given	Given	Given	Given		
Level IV	Given	Given	Given			
Level V	Given	Given				
Level VI	Given					
Level VII						

As previously explained, (e.g., Cherif, Movahedzadeh, Michel, Aron, and Jedlicka, 2011; Cherif & Somervill, 1995; 1994), to ensure that the learning is effective and the learning experience is productive, teachers and instructors need to emphasize the learning values of a given activity to their students. To make the teaching approach of the given learning activity more productive, teachers should lead students toward greater levels of involvement in the process by including them in planning the seven factors that make up a typical role-playing situation. In this brain activity, the problem to be solved and the characters to be played have to be provided to the students. The roles to be followed, the essential information to be gathered, the procedures for the play to be adapted, and the conclusion to be reached (outcome to be learned) **are part of the learning activity and the students' responsibilities** with guidance from the instructor when needed.

5. **Assessment:**

As we have previously applied and explained in any role-play learning activity, the post-activity discussion is very important for students' cognitive and social development because it encourages understanding of the social and personal dynamics involved in reaching a conclusion (e.g., Cherif, et al 2011; 2009; Cherif & Somervill, 1995; 1994). The teacher and students should explore how and why each group reached its decision, and whether this situation could have been approached in other ways (Joyce & Weil, 1986). We suggest the use of McCormack and Yager's (1989) taxonomy for science education as a framework for assessing students' performance and understanding, and the effectiveness of the activity. Some of us have used this framework successfully in the past (e.g., Cherif, Verma & Somervill, 1998; Cherif & Somervill, 1995; 1994). Some examples of assessment criteria are shown in table 3.

Note: Many assessment questions could fall into more than one domain of McCormack and Yager's (1989) taxonomy, depending upon how the questions are formed.

Furthermore,

> *McCormack and Yager's (1989) taxonomy for science education as a framework for assessment which could be accomplished as both formative (conducted during instruction) and summative assessment (which conducted at the end to measure what is learned), is a good framework for students' achievement, and for assessing students' performance and understanding, as well as for the effectiveness of the activity. The Table 3 below summarizes the McCormack and Yager's (1989) taxonomy for science education. We have found this to be very effective in enabling both teacher and student to explore how and why each group reached their decision, and whether this whole situation could have been approached in other ways (Joyce and Weil, 1986). Furthermore, Tables 4, 5, and 6 in the appendix section have been used successfully as tools to record information and to monitor the level of cognitive involvement of the members of a given group during role play learning activities. For example, using table 4, instructors can record the type of questions being asked by the members of a given group as well as the relevancy of the questions to the subject matter and to the point being addressed. In addition, using table 5, instructors can record the number of questions being asked by the members of a given group to the other groups. Instructors can use table 6 to record the type of questions or conditional statements and their values for assessment purposes (Cherif, et. al., 2009).*

Table 3
Summary of McCormack and Yager's (1989) Taxonomy for Science Education as a Framework for Assessment

	Domain	Description	Type of Questions That Can be Looked At.
I	Knowledge Domain	Students acquire knowledge of the subject, an understanding of relationships between the bodies of knowledge, and give reasons for their approach to solving the problem.	What concepts did students learn and how well did they understand them? How well did the students integrate knowledge from different subject areas? To what extent did students demonstrate the understanding of multiple relationships of various bodies of knowledge? Were the students able to disprove or verify some of the supporting theories used in the role-playing activity? What kind of explanations did students offer for the relationship they observed and understood?
II	Process Domain -	Students learn how to collect, organize, and analyze data; develop strategies for building rational arguments and thoughts; state problems and generate valid conclusions; participate in team-work; interpret meaning from the project.	How did members of a given group compile data and information? Was there cooperation in putting the information together? How efficient was each group in presenting and communicating the collected data and information? Was their delivery of statements and arguments smooth and coherent? How well did the students use knowledge meaningfully? Did all members participate in the activity?
III	Creative Domain	Students apply creative thinking to the project; cultivate the ability to recognize, evaluate, and use data and information provided by the other parts of the role play; learn to modify a given design as needed.	In what new ways did students use objects and ideas generated during the enactment of the role-playing to enlarge their understanding? How imaginative were students in identifying relevant problems, solutions, and conceptualizing new ideas?
IV	Attitudinal Domain	Students learn to listen closely and comprehend the other parts of the role playing. They also learn cooperation in a group performance and self-evaluation.	How persuasive were group members in articulating their positions to change the attitudes of the others? How effectively did each group function? Did students' sensitivity and respect for others develop during the process? Did members of a given party demonstrate skills and abilities to resolve conflicts with others constructively? How might each group have functioned more effectively?
V	Application and Connection Domain	Students learn to generate alternative approaches, problem-solving strategies, and solutions.	Did they come up with practical and workable solutions? To what extent did the students utilize their personal experiences and collective group understanding in making decisions related to the activity? How well did the students integrate knowledge from different disciplines in problem-solving strategies? How well did the students learn to negotiate constructive solutions to conflicts?

Table 4
Individual group questions analysis and account.
(Cited from Cherif, et.al, 2009, p. 350)

	Type of Question or Conditional Statements	Extremely Relevant	Relevant	Less Relevant	Not Relevant	Total of Questions
1.	Why					
2.	How					
3.	What do you think if...?					
4.	Which					
5.	What					
6.	When					
7.	Where					
8.	Is/Are					
Total of questions and or wondering statements						

Table 5
Tracking the number of question asked by each group of other groups
(Adapted from Cherif, Michel, Movahedzadeh, Aron, Adams, and Jedlicka, 2009, p.351)

	Frontal Lobe	Parietal Lobe	Temporal Lope	Occipital Lobe	Cerebellum	Motor Cortex	Sensory Cortex	Brainstem	*Media Group*
Frontal Lobe	X								
Parietal Lobe		X							
Temporal Lope			X						
Occipital Lobe				X					
Cerebellum					X				
Motor Cortex						X			
Sensory Cortex							X		
Brainstem								X	
Media Group									X
Total of Questions									

Table 6
Type of Questions or conditional statements and their values for assessment purposes
(Cited from Cherif, Movahedzadeh, Michel, Aron, and Jedlicka, 2011, p.20)

Type of Question		Why How	What do you think if	Which	What, Where, When	Is Are	Total
Extremely Relevant	# of Questions						
	Value per question	5	4	3	2	1	
	Total Values						
Relevant	# of Questions						
	Value per question	4	3	2	1	0.5	
	Total Values						
Less Relevant	# of Questions						
	Value per question	3	2	1	0.5	0	
	Total Values						
Not Relevant	# of Questions						
	Value per question	1	1	0.5	0	0	
	Total Values						
Total							

6. A Post-test Homework Assignment:

Ask the students to work individually to answer the following questions.

1. What have you learned from the activity both academically and at a personal understanding?
2. If you had to do this all over again, what would you change or do differently and why?
3. Knowing what you already know, how would you argue against the perspective of your own group?
4. Based on what you have learned, if you have the choice to select which brain part to represent and advocate, which part would you select and why?
5. What is the research about the relationship between mitochondria and brain function indicate?
6. Bacteria in the human gut weigh as much as the brain (Perlmutter 2015). What is the connection between microbiome and brain in humans?
7. Since we are what we eat, what is the relationship between brain and food?
8. How the understanding of the brain and how it works help you to better yourself, for example on exercising good and desirable habits and boosting your well-being?
9. If we want to cultivate harmony, balance, and flow, we need to not only understand our brain and how it functions, but also to use this understanding in a meaningful way to better ourselves. How do you take this understanding into life?
10. Show how and why certain mental brain functions decline and what we can do to prevent or slow this decline?
11. Based on what you have learned, can our brain be re-trained? And if yes, how? If no, why not?
12. Based on your research, why do you think most people believe that it is so hard to establish healthy habits?
13. How can we increase and expand our brain power and capacity to meet everyday challenges and enhance the quality of human life?
14. If you have the means, will and the power to rebuild your brain, what type of brain would you want to live with the rest of your life? Explain.

15. Essential Fatty Acids (EFAs), as their name suggests, are ~~an~~ essential nutrients. Three types of EFAs are known, the Omega-3s, Omega-6s, and Omega-9s. However, unlike Omega-6 fatty acids and Omega-9 fatty acids which are more stable and available in our diets, the Omega-3 fatty acids are the most fragile and most lacking EFAs in our American diet. EFAs are needed for healthy cell function, brain development, nerve coverings, hormones, bile acids, and prostaglandins, to name a few. With many other things, the deficiency if EFAs is associated with many illnesses including cardiovascular disease, brain and behavioral dysfunctional, strokes, to name a few (Murray, 205; Wood, 1999). The good news is that Omega-3s is available and not expensive for people to get and use. However, as Wood (1999) has strongly advised us to "purchase any oil that contains EFAs in small quantities, purchase only Omega-3 oils that list their date of manufacture and a "best if used by" date stamped on the container. Purchase oils bottled in opaque, black, inert plastic bottles" (p. 118).
    a. Why do you think Wood provided us with this urgent advice to follow when buying Omega-3 oils?
    b. Conduct a research study to compare Omega-6s, Omega-9s, and Omega-3s fatty acids.
    c. How does Omega-3 oils help human brain to function better?
16. The statement below was written about 15 years ago concerning a type of glial cell that are located throughout the brain and spinal cord and with longevity of up to lifetime of an organism. They are known as microglia and account for 10-15 percent of all cells found within the human brain. One of their role in the human brain is to act as macrophage cells, the first and main form of active immune defense in the central nervous system (CNS). However, microglia are not only present in humans and other vertebrates, but are also found in nervous systems of various non-vertebrate organisms (Biber, Owens, and Boddeke, 2014). Read the statement below, and then conduct neurobiological research to read more to find out:
    a. Describe the structure of a microglia cell and how its structure is related to its function.
    b. What the literature is saying about additional role(s) of microglias?
    c. What additional information can you add, correct, and or update in the information stated below.
    Mounting evidence shows that the brain has an extensive defense network that functions like a private immune system. The key soldiers are microglias, cells of the activated only when brain cells are harmed or threatened. Once aroused, microglias secrete some of the same chemicals that immune-system cells use to destroy invaders – chemicals so potent that they also destroy nearby healthy cells. This has aroused suspicion that zealous microglias may contribute to certain brain disorders, such as Alzheimer's and Parkinson's diseases. If so, figuring out how to control microglias activity might one day yield new cures?

    (Carleton, 2001, P. 195)
17. It has been reported that we become more benevolent and more altruistic as we get older. Because of this, more than half of all donations to charity are made by those over 60; and it's not just because those people have more money. The Magnetic Resonance Imaging (MRI) scans of the brains of older people have shown that the older adults become more altruistic and less self-centered as they age (AARP Bulletin, 2016). The advantage of the using MRI instead of, for example a CT or X-ray equipment in studying brain, is that MRI provides a strong contrast of soft healthy and diseased tissues that most under medical equipment cannot. Anatomically speaking what does the MRI scans of the brains show to let medical doctors to come to a conclusion such as this?
18. Is it ethical to provide drugs or any other harmful materials to your friends when you know that it could affect the short or long run functions of the brain and, in turn, the individual's quality of life? Explain.
19. What might happen to human population if humans neglect to invest resources and energy to learn more about the human brain and how to protect it?
20. Since brain damage, misuse, abuse, etc. have not only health and emotional consequences, but also behavioral, economic and social ones, should a policy of "Brain Protection Right" be established in the society? Such as, for example, free diagnostic and medical care for anything related to brain and brain illness. Explain.
21. It has been recorded that iodine deficiency disorders, which is the most common cause of preventable brain damage, affect three-quarters of a billion people in the world (Blake, 2008). Conduct research to find out:
    a. What types of brain damage are caused by iodine deficiency?
    b. How does the iodine deficiency cause brain damage?
    c. Which type of diets that are good for preventing iodine deficiency?
22. Give each student a lateral view diagram of human brain, colored pencils or felt pens, and a copy of the table 7. Then ask each student to use the description in the column 2 to identify each part a lateral view diagram of human brain.

23. It has been said that learning over your lifetime will make you more likely to be mentally healthy in old age. Do you agree or disagree with this statement? Explain.
24. It has been said that learning molds the brain structurally, growing new connections between brain cells. Do you agree or disagree with this statement? Explain using physiology.
25. What have you encountered in your research about the relationship between stress and the shrinking of the brain cells?
26. While some aspects of brain aging are under genetic control, based on your research what can you do to prolong your health and keep your mind sharp?
27. While almost all of us know that diet has a profound effect on weight, risk for heart diseases, cancer, and many other serious diseases, many of us don't associate food with brain and boosting metal abilities. Identify three type of foods that are considered to be mental boosters and chemically explain why and how.
28. A recent study by Cambridge University team found that even though we still need to know relatively more about how extra weight affects the brain, the brains of overweight people look "10 years older" than those of leaner peers (BBS 2016). Conduct a research to find out on what data did the research team based their finding on.

Table 7
Brain Structure: Study, analysis, and Match

Significant Information		Structure Name		Matching Letter with Numbers
1	Area involved in activating muscles in the body.	A	Auditory area	
2	Area involved in articulating words when speaking.	B	Broca's area	
3	Area involved in producing sensations such as pain, touch, and pressure.	C	Cerebellum	
4	Area involved in receiving and interpreting sensory information from the eyes.	D	Fissure of Rolando	
5	Area involved in receiving and interpreting sensory information from the ears.	E	Fissure of Sylvius	
6	Area that separates the frontal lobe from the temporal lobe.	F	Medulla oblongata	
7	Area that separates the frontal lobe from the parietal lobe.	G	Motor area	
8	Area that coordinates muscles to produce skilled movement	H	Pons	
9	Area that plays a role in synchronizing sight, sound, and muscle movement, such as dancing with a partner.	I	Sensory area	
10	Area that is considered the most vital part of the entire brain for keeping us alive. It controls heart actions, respiration, and blood vessel diameter; and contains reflex centers for swallowing, vomiting, coughing, sneezing, and hiccupping.	J	Spinal cord	
11	An extension of the brain giving rise to 32 pairs of spinal nerves.	K	Visual area	
12		L		

Source: Modified from Fleming, 1985, pp. 14-15

29. If you know what you need to do in your later life, what should you do in your younger life? After searching this question, use table 8 bellow to answer this question.
30. If you have to write a hand-written letter to your own brain, what would you write, how, and why? Please write 1-2 pages of a personal letter to your brain. Then give this letter to a close friend or trusted family member to read it to you loud. After finishing listening to your own letter, share the what, why,

and how behind writing this letter to your own brain to your friend and or close family member. Finally, write 1-2 paragraph reflecting on the experience of the writing and listening of this letter to your own brain and what have you learned from this experience.

31. Using what you have learned about the brain, what type of myths about human brain you have encountered?
32. Using what you have learned about the brain and the fact that your brain is not static, but adapts to external stimuli or changes in behaviors how you might use this knowledge to:
    a. re-train your brain to improve your personal and professional life as student, member of a given family, and the community?
    b. help making your brain faster, smarter, and better?

Table 8
If You Know What You Need to Do in Your Later life,
What Should You Do In Your Younger Life

		What Should You Do In Your Younger Life	In Your Adult Life
1	Sharpen your perceptions		Get more pleasure out of life by enhancing sight, learning, taste and other senses.
2	Improve your memory		Remember names and faces better and reduce those annoying "what was I doing again?" moments
3	Improve longevity		Help your brain work better and last longer
4	Build new mental connections		The more you exercise you brain the better it can work!
5	Improve your physical conditions		Including balance and fine motor skills that are closely linked to brain function.
6	Sharpen your existing skills		To give yourself an edge, improve your performance at work and home, and get all the pleasure you can out of all the activities you love.
7	Protect your health		With the right kinds of stimulation, you may be able to delay the onset of many of those troubling symptoms of aging.

33. Given the fact that people have already walked on the moon, lived in orbit on the space station, there are continuous rapid advances in the science and technology, and every day we know more about the other planets, and the solar system and beyond, it is only a matter of time that space travel will become a common thing at least for those who can afford it. Using what you have learned about the brain and the fact that your brain is not static, but adapts to external stimuli or changes in behaviors , did you encounter in your research how might whether or not the cosmic radiation has any effect on the human brain? If yes, what type?
34. In the class, read the letter cited below, by Barry Maletzky who sent it letter to the editor of the Scientific American journal, reflected on article he read titled "*Making Al More Human*," published on June 2017). After finishing read the letter divide the class into a small groups of 2-3 students and ask them to write one page reflecting on Barry Maletzky wrote. Also let them know that the "*Making Al More Human*," is available in the school and public libraries if they wish to read. Give the students one week to complete the assignment. The next week as the groups to read their reflection in the class and then start an open discussion in the class.

Barry Maletzky wrote that:

> *Assumptions about fabricating an artificial brain ignore what little we know about how the human brain thinks, feels, and acts, and we cannot view it as a slower version of a computer. The brain is a soft, squishy organ, which has evolved over millions of years, and its synaptic connections are not electronic but electrochemical (hence out sluggish ability to solve equations, compared with a computer's speed). Scientists working on Al are aware of this disparity and are trying to build ever more humanlike central nervous systems, such as computers that "learn" through trial and error. But these machines can only duplicate certain brainlike functions. I wonder why so much attention (and consequent funding) is spent trying to mimic the human brain instead of, for example, researching practical medical advances. We make hundreds of thousands of brains every day; they are called babies. (Scientific American, October 2017, p. 8).*

35. Human brain which repoected only 2% of total body weight contains 20% of the body's cholesterol. Conduct research to find out:
    - Where does the brain cholesterol come from?
    - Where is the brain cholestrol located the most?
    - What is the main function and purpose of the cholostrol in the brain?
    - How the human brain mangnage and or protect itself from statin medications like Lipitor which many people take to lower their cholesterol levels?
36. You are a post doc who just completed his/her doctoral degree in neutoscience and ~~deit~~ diet. You are lucky that your application for post-doc to Dr. Georgia Ede, MD, a Harvard-trained psychiatrist and nutrition consultant practicing at Smith College lab, has been conditionally accepted. The condition is that to read 3-4 of her articles that deal with brain, diet, and health and to provide informative, objective, analysis and critique of her work. Since Dr. Ede has written so many articles, it will be difficult to know which ones to select, you have been lucky again. One of the senior post docs in the lab suggested to start with the following three of her articles. She also suggestd to you to visit Dr. Ede' website "DiagnosisDiet.com.

    Read the three articles by Georgia Ede, (2017a, b.,c), and write three to four pages as you have been asked to be submitted to Dr. Ede. Again, your paper must be informative, objective, analytical and critice of Dr. Ede's work.

37. For many years, scientists have routinely used rats as a main model for brain research. Recently however, scientists have shifted to using lab mouse simply because better imaging equipment and fuller understanding of a mouse's genetic profile (Chiba, 2015; Coghlan, 2014). However, there are some voices that see the use of mouse brains to understand human brain and human brain diseases is not the best approach. Those scientists argued that in order to understand what makes us who we are, we really need to focus on and study the human brain. Breaking through has been recently achieved by scientists in Seattle who were able to create "three-dimensional computer reconstructions of living human brain cells by studying tissue that is usually discarded during surgery. The virtual cells, unveiled Wednesday by The Allen Institute for Brain Science, capture not only the shape and anatomy of living cells, but also the electrical signals they produce" (Hamilton, 2017, ¶. 1-2). Conduct a research to find out why whole mouse brains has been used to study and understand human brain diseases? Why some scientists don't think this approach is not a good one to understand human brain and human brain diseases? How the scientists at The Allen Institute for Brain Science were able to achieve this significant breakthrough in the way to study human brain?

7. Final Remarks:

Without a doubt, the brain is one of the most significant identifier that distinguishes us from many other life forms on Planet Earth. It has been said that the healthier the brain the better the memory, which is the most powerful tool in everyday life. And the better the memory, the more information we can have at our immediate disposal and be better thinkers (Vishton 2016). Keeping our brain anatomically and physiologically healthy and active enables, for example, memory to continue to link our past life experience to the future which in turn gives us the power to plan, to reason, to perceive, and to understand ourselves and the world around us. Keeping our brain healthy and functional is an essential element for good living and life. It is our job to learn how to

effectively protect our brain. Yet, as Dr. David Perlmutter (2015) clearly described in his latest book *Brain Making*, despite our advancements in science against viruses and bacteria and successfully lowering mortality rates in cancer and heart disease, there have been relatively few advancements in brain related diseases and disorders (p. 3-4).

Today, the neurological disorders are growing at a startling rate – from ADHD and debilitating mood, anxiety to depression, from bipolar disorder and schizophrenia to multiple sclerosis and dementia. Dr. Perlmutter (2015, p. 4) further elucidates this in mentioning that brain disease, death, and incidence of dementia have dramatically increased over the past two decades in the world's wealthiest nations. Citing a 2013 British report, Perlmutter stresses that there is a 66 and 92 percent increase in brain disease related death in men and women, respectively. The concern in the younger ages is also noteworthy, as risk reduction in injury or death has decreased in most major categories, with the notable exception of brain related problems.

But the advances in science and technology have made this medical revolution an astonishing reality with news on how to understand and treat not only behavioral and mood disorders but also chronic headaches, multiple sclerosis, Parkinson's autism, Alzheimer's, and many more conditions. However, science, technology, and advances in medical files cannot do it alone. We, as individuals, communities, and society need to also learn and understand how our own brain function and how we can help and protect our own brain. For example, as Perlmutter (2015) has shown, that the health of our brain is, to an extraordinary degree, dictated by the state of our individual microbiome – the vast population of organisms that live in our body and outnumber our total cells ten to one. It is because of this we have designed and implemented this learning activity, to help future generations to comprehensively learn about their brain and how to protect and keep it healthy not only for themselves and their communities, but also for humanity.

As teachers, mentors, and educators, we always need to keep in mind that learning activities and teaching approaches should always aim to capture the student's interest and spark motivation for learning and knowledge creation among students. To achieve this we need to create learning opportunities and then give students these opportunities to be involved in the planning, implementation, and assessment of a given learning activity **(Cherif and Somervill, 1994; 1995)**. **To make the teaching approach of a given learning activity more productive, we need to ask students** to research and prepare a plan of a pathways for understanding their brain and brain health which needs to be presented in the classroom and voted on by teachers and the students. In this assignment, students need to include for example a "how to" guide to optimal whole brain health including healthy senses, coordination and balance, words and language, to name a few. The students need to show how to stay sharp, improve memory, and boost creativity that leads to a healthy present and future for their brain (Sweeney, 2016).

In Brain Talking activity, the problem to be solved and the characters to be played are given to the students. The essential information to be gathered, the procedures for the play to be adapted, and the conclusion to be reached (outcome to be learned) **are part of the learning activity and are the students' responsibilities (**with guidance from the instructor). But what we (teachers, instructors, and educators) need to keep in mind, is that, when we teach students about their own human brain from early ages, we ensure that all students regardless of cultural and socioeconomic background are granted equitable opportunities to learn how to understand and protect their own brain and in turn succeed in the classroom and beyond.

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Appendix 1: Additional Resources:

The following are a few articles and reports that could be suggested to the students before starting their research.

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