



Lecture Plan — Create and Act

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Version & Date:	V1, 17/6/016	Approved by:	

Acknowledgment:

The format of this Lesson Plan is following the CREATIONS Demonstrators' template that was developed from the CREATIONS Project (www.creations-project.eu). The template was developed from the National and Kapodistrian University of Athens team, Menelaos Sotiriou and Prof. Zacharoula Smyrniou.



Funded by the
Erasmus+ Programme
of the European Union

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1 Introduction

1.1 Topic

Create and Act. This topic include the following:

- Creativity in STEM: Art and Science
- Science and Art Events
- Learning Science Through Theater (Case study)
- Warm ups and tips on how to start working together for an art/science event
- Develop your own short Theater Performance

1.2 Type of Activity

- 1) *Theory lecture type: Lecture*
- 2) *Case study: Learning Science Through Theatre*
- 3) *Project work: Warm ups and developing a science theatre performance and stage it*

1.3 Duration

- 1) *Theory lecture type: 1.5 hour*
- 2) *Case study: 1.5 hour*
- 3) *Project work: 6 hours*

NOTE: *It has to be noted that this Lesson Plan could last one day but the most suitable duration is 3-5 days so to give the opportunity to the participants to develop team spirit and collaborate in a more creative way. The theoretical part could be around one day and then the rest of the 3 or 4 days will be spend in the developing of the art/science activity.*

1.4 Setting (formal / informal learning)

It could be both formal and informal, depend on the target group and the setting (eg. a classroom, a theatre, a museum)

1.5 Effective Learning Environment

- Communities of practice
- Arts-based
- Dialogic Space / argumentation
- Visits to research centres (virtual/physical)
- Communication of scientific ideas to audience

2 Rational of the Activity / Educational Approach

2.1 Challenge

The main challenge of this activity is the involvement of the participants to develop their own performances or art activities. During the last decades a lot of effort has been dedicated to present the audience, performances developed from professionals (mainly artists) based on scientific fields. The last years efforts have been dedicated to involve the audience (students, researchers, young people) to develop their own art activity with the belief that this could motivate, encourage them to be involved and engaged and to understand better the respective scientific field.

When it come to educational purposes, traditionally the body has not been used in education. Every involvement of the body had been consistently excluded from the educational practice, the process of learning and the interaction among students. The notion of Embodied Learning was not known and therefore not acceptable by the educational community such as the teachers and the students. Consequently it was difficult to understand that the body does not solely constitute a means of knowledge, or a mediator, but it also reflects the student's interaction with the environment. (Smyrniou Z., Sotiriou M., Georgakopoulou E., Papadopoulou E., 2016). As a result, until now, students are not usually given the chance to learn scientific concepts through expressing them with their body and by the interaction of their body and the environment.

2.2 Added Value

Through the principles of embodied learning, basic principles of epistemological knowledge and pedagogical theories can be combined, so that the student can utilize his body as a source of knowledge and feel alive and active during the learning process. As a result, the seemingly absent student's body can be activated and used as a communication channel between students. (Arvola, Orlandre & Per-Olof Wickram's In Alsop, 2011). Through embodied learning, each time the human motor-sensory system is involved with his body movements, the stimuli he perceives can be converted into a more stable and powerful memory and cognitive representations (Abrahamson, Gutiérrez, Charoenying, Negrete, & Bumbacher, 2012).

Embodied learning has been linked with the field of Science (Smyrniou & Kynigos, 2012). According to Hutto et al. (2015), embodied learning enhanced the understanding and acquisition of skills in physics, technology, engineering and mathematics. Gallagher & Lindgren (2015) investigated the advantages of physical representation of transfer (Chun Hung, Hsiu-Hao Hsu, Nian-Shing Chen, 2015) and found that its representation facilitates the learning outcomes more than just reading the transfer. Furthermore, Lozano and Tversky (2006) argue that gestures can facilitate learning, as they are considered as embodied knowledge. Finally, Novack & Goldin-Meadow (2015) argue that even the gestures can be incorporated into educational activities, especially in courses with symbols, such as Mathematics, Physics and Chemistry. Thus, pupils

directly connect their movement, gesture and communication with scientific concepts which they perceive, as embedded in the educational activities (Kynigos, Smyrniou & Roussou, 2010).

If we take as an example the Learning Science Through Theater (LSTT: www.lstt2.weebly.com) initiative, the scientific concepts are represented with highly original, imaginative and innovative ways. The embodied learning helps in most cases to describe the concepts in another way, more descriptive. During the dramatization of the students' scenarios, the result was robust when there was a connection between the embodied representation (in its entirety, including the factor of emotion), the scientific concept and verbal description. And it was excellent, if there was extra music or choreography as a representational or embodied system.

It is also worth mentioning that where there was implemented an interdisciplinary and multidisciplinary approach, the scientific concepts were strengthened, as they were in a rich context where, apart from the Art and Science, Literature, Philosophy, Culture (for example this season, or season that Scientist lived) and Society were involved (for example a scientific theatre performance that made reference to the refugee issue, involving harmoniously all previous fields). In this context, science won from the embrace with the Art. Science became a vehicle for scientific, social and other messages and challenges. In addition, science acquired emotion and vitality through multiple representations (embodied, verbal, etc.).

Furthermore, in accordance with the constructivist principles, the body is used both inside and outside classroom for experiential learning and is not treated as a place of learning. The principles of Embodied Learning provide answers to questions related to the ways knowledge is constructed by students as they leave behind them the academic model of perceiving knowledge and treat each student as a whole, while they view everyone's body as a tool for knowledge construction and as a knowledge carrier (Smyrniou Z., Sotiriou M., Georgakopoulou E., Papadopoulou E.) Moreover, constructionist learning involves students drawing their own conclusions through creative experimentation and the making of social objects.

Regarding the argumentation approach, by engaging students in argumentation processes provides them with a better insight into the nature of scientific enquiry and the ways in which scientists work. This enculturation in the scientific discourse (Driver, et al., 2000; Duschl & Osborne, 2002; Osborne, 2010) can subsequently lead to epistemic improvement in pupils' knowledge (Smyrniou, et al., 2015). The argumentation process in this case might be the exchange of ideas and dialogue when the script of the theatrical performance is developed.

The specific Lesson Plan is building on innovative approaches and methodologies that are followed in science education and communication. The Create and Act Lesson will build mainly in methods taken from several initiatives and mainly from already tested activities within the CREAT-IT (www.creatit-project.eu) and CREATIONS Project (<http://creations-project.eu/>) and mainly on the framework and the features that these project propose and elaborate. CREATIONS is proposing activities with school students and teachers as well as researchers and communicators in formal, informal and non formal settings. This lesson is a

basic lesson to follow these methods and try to transfer these methods to young people in general. It will try to involve and engage young people (from 12-25 years old) in the development of their creative project/activity. An initiative where the participants are asked to create their own performance in a collaborative way. So for this Lesson young teams coming from several countries will collaborate to produce their own short theatrical play based on a scientific field/phenomenon. The activity will be based on the 4Ps of engagement in creative science education and communication (Craft, 2011):

- **pluralities:** opportunities for students and teachers to experiment with many different places, activities, personal identities, and people
- **possibilities:** opportunities for possibility thinking, transitioning from what is to what might be, in open possibility spaces
- **participation:** opportunities for students and teachers to take action, make themselves visible on their own terms, and act as agents of change
- **playfulness:** opportunities for students and teachers to learn, create and self-create in emotionally rich, learning environments.

So, via these processes the tutors aim to contribute to developing creative young people (scientists, teachers, artists, general youth public). Embedded within this is the vitally important notion that young people are creating wisely and humanely, and that cyclical developments occur between their creativity and their identity. As they generate new ideas; this in turn generates change in them as 'makers'; they are also developing or 'becoming' themselves. Slowly, small changes accumulate to contribute to 'journeys of becoming'. These individual journeys accumulate together, embedded within an ethical awareness of the impact of creative actions on the group. Through this process small-scale creative changes or 'quiet revolutions' can take place for the group as a whole.

It has to be noted that the European Commission's Responsible Research and Innovation framework promotes a transparent, interactive process where innovators need to be mutually responsive. The Create and Act approach is based on the fact that ideas generated through individual, collaborative and communal activities have a potent capacity to contribute to engagement and change. The layer of communal engagement is particularly important in terms of the societal level of the Responsible Research and Innovation, and the idea that innovators need to be mutually responsive within and beyond their communities. The idea of communal engagement (Chappell, 2008) acknowledges that when working creatively people exist in groups with shared identities which shape their ideas and thinking and which may be challenged by the thinking of other groups. This raises ethical questions which need consideration if these challenges are to be overcome (Craft, Claxton and Gardner, 2008) and people are to be genuinely engaged in scientific debates and questions via education.

Of vital importance to nurturing empowerment and agency, dialogue, individual, collaborative and communal activities for change and ethics and trusteeship are two more principles which finally resonate with Responsible Research and Innovation. The first is the importance of rigorous Discipline knowledge. This means science discipline knowledge but it is also embedded in the idea that there are different ways of knowing in the world, alongside those prioritised within the scientific realm which scientists and must engage with in order to generate conversations between their ideas and those of the 'public' in order that a shared dialogue can be ongoing rather than a one way conversation. The second is the promotion of the idea of professional wisdom. At its heart, this approach values the idea that teaching professionals bring a



wealth of often intuitive teaching and discipline knowledge and expertise; they cannot be viewed as 'information deliverers'. It is their professional wisdom that can make the science learning process creative and can engage children and young people in a meaningful ways.



3 Learning Objectives

3.1 Domain specific objectives

The main aim of this Lesson is to give the opportunity to **high university students, teachers, young researchers, communicators to stage a short play and dramatize scientific concepts and knowledge from any science field that consider appropriate to their knowledge.**

The Create and Act domain specific objectives are to:

- Get participants interested in science and research through theatrical play
- Teach participants how to develop a theatrical script, relevant to a scientific topic
- Initiate the development of a theatrical performance from participants, regarding a scientific topic
- Present the method to initiate contact between the participants and other professionals (for example directors and musicians)
- Present how to engage the general public into relevant initiatives and events
- Build National-wide networks
- Present how to be open to the local communities and involve all the stakeholders.

Towards attaining these objectives, peripheral aims are formed addressing participants' needs to:

- develop abilities necessary to do scientific inquiry
- develop understandings about scientific inquiry
- identify questions and concepts that guide scientific investigations
- design and conduct theatrical scripts relevant to scientific concepts and issues
- use technology to improve investigations, communications and the development of theatrical performances and videos
- formulate and revise scientific scripts exploiting creativity and imagination
- recognize, analyze and imagine alternative explanations and models
- communicate a scientific argument or issue in a creative way
- develop lifelong learning skills
- develop attitudes befitting a scientific ethos

- link with science and society in a personal context

3.2 General skills objectives

In the context of the Create and Act Lesson Plan, participants' general skills objectives are:

- Active participation in the negotiation of scientific concepts
- Develop creative and critical skills
- Understanding of scientific concepts and phenomena
- Scientific interconnection of science with aspects of art (participants will create a multi-disciplinary artistic performance -Science Theater- which demonstrates and deepens understanding, supporting discipline knowledge in both the science and arts educational disciplines).
- Develop spirit of cooperation and teamwork
- Connect the science spaces (classrooms, museums) with professionals, parents and local communities

More Specifically:

- Participants will learn and build knowledge about scientific concepts
- Participants will become acquainted with the concept of learning science creatively through Science Theater and other art activities. They should be aware of what science theater is and how it will help them deepen their science knowledge and express themselves creatively. They should also be specific about key concepts they will be focusing on.
- Participants will gain knowledge and experience with group-work in which various groups will create a script, scenography, costumes, music and a video composition. The script should include key concepts connected to the scientific theme. Scientific models and figures can be of great inspiration to scenography, costumes and music.
- The participants should be able to describe fundamental concepts concerning their chosen topic. Participants will learn to realize common impulses between discipline knowledge in both science and arts by performing a multi-disciplinary artistic performance which demonstrates and deepens scientific and emotional understanding. Throughout the initiative, pupils will learn to make their own decisions during inquiry processes, make their own connections between questions, planning and evaluating evidence, and reflect on outcomes.



4 Activity characteristics and students' needs

4.1 Describe the aim of the activity

The Lesson Plan's main aim is to give the opportunity to participants to stage a play and dramatize scientific concepts and knowledge from the material based in any science field. In this way, participants learn science in a creative way.

Participants select a science theme that would like to develop as a theatrical performance. In this way, it is given the opportunity to participants to inquire about scientific concepts and issues of their interest and express their findings in creative ways, such as the development of theatrical scripts, costumes, scenery, choreography, etc.

The Lesson Plan aims at the enhancement of the participants' cognitive involvement, their representation of scientific content using their cognitive processes, the participants' sensorimotor involvement using their bodies or gestures, their emotional involvement, the social interaction and communication between them, the use of past experiences and the creation of new ones based on sociopolitical and historical framework and on beliefs and behaviors, their brain, body and emotion coordination and finally the holistic use of their personality and their motives.

4.2 Describe the student that need to be addressed

This Lesson Plan includes the development of authentic theatrical scenarios which are performed by the students and are in accordance with their interests and cognitive load. Students develop research questions, identify, investigate and experiment on various scenarios and scripts and construct knowledge. The topic for the development of the theatrical play is selected by the students. This freedom of the topic selection is a challenging factor for students in order to get immersed in active investigations of scientific issues, and be engaged in collaborative discourse and creation. As a result, students manage to constructively build on each other's ideas, enhance their learning of scientific concepts, co-create and perform theatrical plays. The co-creation engages them in meaningful activities in authentic environments and the theatrical performance helps them learn and express scientific concepts using their body, their gestures, etc. Embodied Learning leads students to the most successful representation of scientific concepts, enables the connection of student to modern forms of Art while even the unconscious movements performed by the students may be indicative of the degree of appropriation and embodiment of scientific concepts. During the implementation of the Lesson Plan, students seem to be able to understand the key features of each notion, using scientific terminology and simple vocabulary at the same time, to reliably describe notions and to use their past experience so as to describe scientific knowledge. Additionally, successful rendering of meaning is also possible both through verbal and through non-verbal communication.



Furthermore, collaborative learning is supported through Embodied Learning, which facilitated communication among students.

Finally, the guidance provided by professionals, not only manages to relate science with art, but also ensures a high-quality production of scientific theatrical play.



5 Learning activities & environments

5.1 Target group

Age	12 - ...
Sex	Male/Female
Group vs single activity	Group Activity
Is supervision required?	Yes
Pupils'/Participants' ability	Mixed (The Lesson Plan allows space for pupils of various abilities to participate)
Participants' prior knowledge	<i>There is no really need of any prior knowledge. The Participants should have a background in any scientific field or willing to know about it.</i>

5.2 Resources

Materials	<i>paper, pen, colours,</i>
Equipment	<i>projector, camera, video camera, some simple music equipment will be helpful but not required., speakers, microphones (in case the room of performance is large, lights in case the performance will take place in an auditorium.</i>
Technology	<i>Basic laptop software, internet connection will be very helpful</i>
Location	<i>classroom, outdoor space, science museum, theatre, ...</i>

Health and Safety implications	<i>none</i>
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5.3 Keywords

Key concepts	Art and Science
Science keywords	All the science fields
Arts keywords	Theatre performance, direction, scenery, costumes, choreography, music, video editing

IBSE Activity	Student / Participant	Teacher / Communicator / Young Researcher	Potential arts activity
<p>Phase 1: QUESTION: students investigate a scientifically oriented question</p>	<p>Build interest in scientific issues and their explanations/social impact. engage with open-ended inquiries related to their lives. use the web and watch videos to explore the selected scientific topic/issue</p>	<p>The teacher tries to attract the students' attention by eliciting students' relevant questions or pinpoint unexplored areas to the topic under negotiation.</p>	<p>Optional: Preparatory drama, visual arts and music workshop\class</p>
<p>Phase 2: EVIDENCE students give priority to evidence</p>	<p>Students investigate on the science theatre design and implementation. They are divided into groups: Script/directing group: Investigate characters and generate ideas for dialogues/actions. Actor group: Investigate characters and work on performance in collaboration with script/directing group. Music group: Generate musical ideas which correspond to the script. Dance group: After consulting with script/directing, actor and music</p>	<p>The teacher identifies possible misconceptions.</p>	



	<p>groups, generate choreography ideas to incorporate in the play.</p> <p>Set/costumes group: Generate ideas after consulting script group and collect materials.</p> <p>Video group: Generate ideas after consulting script group and collect or create video clips.)</p>		
<p>Phase 3: ANALYSE students analyse evidence</p>	<p>Students engage in analysing data (organizing data, finding patterns, assessing data quality), interpreting data, making inferences, modeling, etc.).</p>	<p>Acts as a facilitator of the process</p>	<p><u>Script/directing group</u></p> <p>Investigate characters and generate ideas for dialogues/actions.</p> <p><u>Actor group</u></p> <p>Investigate characters and work on performance in collaboration with script/directing group.</p>



			<p><u>Music group</u></p> <p>Generate musical ideas which correspond to the script.</p> <p><u>Dance group</u></p> <p>After consulting with script/directing, actor and music groups, generate choreography ideas to incorporate in the play.</p> <p><u>Set/costumes group</u></p> <p>Generate ideas after consulting script group and collect materials.</p> <p><u>Video group</u></p> <p>Generate ideas after consulting script group and collect or create video clips.</p>
<p>Phase 4: EXPLAIN</p> <p>students formulate an explanation based on evidence</p>	<p>Students evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.</p>	<p>Acts as a facilitator of the process</p>	<p>Provide creative theatrical scenarios / scripts to strengthen their explanations</p>



<p>Phase 5: CONNECT</p> <p>students connect explanations to scientific knowledge</p>	<p>Explore the topic spherically and find connections with other disciplines (eg arts, theatre, music, technology).</p> <p>Exploration of new areas according to students' interests</p>	<p>Allows room and enhances connectivism with other disciplines, such as arts, theatre and music. Teacher also communicates with professionals (director, musician and pedagogist)</p>	<p>Creativity in identifying connectivism and providing possible solutions</p>
<p>Phase 6: COMMUNICATE</p> <p>students communicate and justify explanation</p>	<p>Students communicate with professionals (director and musician) in order to get help about their scientific scripts, the direction and the music.</p> <p>Students communicate their inquiry findings by implementing a science theatre performance</p>		<p>Rehearsals of theatrical performances and final 2-day science theatre event</p>
<p>Phase 7: REFLECT</p> <p>students reflect on the inquiry process and their learning</p>	<p>Discuss specific issues (stage design, music composition, group dialogue, ethical decision-making regarding inclusion of all students in the</p>	<p>Teacher balances the outcomes of the creative educational process with the assessment features of the</p>	





	creative process, etc.)	curriculum	
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6 Additional Information

Additional information with resources, guidelines, scripts from other performances, videos from students' performances could be found in the following links:

The CREAT-IT Project web portal: <http://www.opendiscoveryspace.eu/community/culture-creativity-curiosity-413201>

Learning Science Through Theatre web community:

<http://www.opendiscoveryspace.eu/community/learning-science-through-theater-841279>

Facebook Page of the Learning Science Through Theatre:

<https://www.facebook.com/learningsciencethroughtheater/>

Website of the initiative Learning Science Through Theatre (in Greek at the moment):

<http://lstt2.weebly.com/>

The CREATIONS web portal: <http://www.opendiscoveryspace.eu/creations>

The Global Science Opera website: <http://globalscienceopera.com/>

Videos from past students' performances (only in Greek at the moment):

https://www.youtube.com/playlist?list=PL6s6-1JKu8YWITHHrfgk_i6bSaceX002





7 Teacher's notes

All the needed background with pedagogical frameworks, guidelines, instructions, examples etc. Could be found in the Learning Science Through Theatre web community:

<http://www.opendiscoveryspace.eu/community/learning-science-through-theater-841279>



8 References

- Abrahamson, D., Gutiérrez, J., Charoenying, T., Negrete, A., & Bumbacher, E. (2012). Fostering hooks and shifts: Tutorial tactics for guided mathematical discovery. *Technology, Knowledge and Learning*, 17(1/2), 61–86.
- Alsop, S. (2011). The body bites back!. *Cultural Studies of Science Education*, 6, 611-623.
- Chun Hung, I., Hsiu-Hao Hsu, Nian-Shing Chen, Kinshuk. (2015). Communicating through body, embodiment strategies. *Educational Technology Research and Development*. doi: 10.1007/s11423-015-9386-5
- Craft, A. (2011). *Creativity and Education Futures. Changing Childhood and Youth in a Digital Age*.
- Duschl, R., & Osborne, J. (2002). Supporting and promoting argumentation discourse. *Studies in Science Education*, 38, 39–72.
- Gallagher, S., & Lindgren, R. (2015). Enactive metaphors: learning through full-body engagement. *Educational Psychology Review*.
- Hutto, D. D., Mc Givern, P., & Kirchoff, M. D. (2015). Exploring the enactive roots of STEM education. *Educational Psychology Review*.
- Kynigos, C., Smyrniou, Z., & Roussou, M. (2010, June). Exploring rules and underlying concepts while engaged with collaborative full-body games. In *Proceedings of the 9th International Conference on Interaction Design and Children* (pp. 222-225). ACM.
- Lozano, S. C., & Tversky, B. (2006). Communicative gestures facilitate problem solving for both communicators and recipients. *Journal of Memory and Language*, 55(1), 47-63.
- Maximiliane F. Schumm & Franz X. Bogner (2016) Measuring adolescent science motivation, *International Journal of Science Education*, 38:3, 434-449, DOI: 10.1080/09500693.2016.1147659
- Novack, M., & Goldin-Meadow, S. (2015). Learning from gesture: how our hands change our minds. *Educational Psychology Review*, 27(3), 405-412.
- Osborne, J. (2010). Osborne, J., *Arguing to learn in science: The role of collaborative, critical discourse*. *Science*, 328(5977), 463-466
- Smyrniou Z., Sotiriou M., Georgakopoulou E., Papadopoulou E. (2016), *Connecting Embodied Learning in educational practice to the realisation of science educational scenarios through performing arts*
- Smyrniou, Z., Petropoulou, E., Sotiriou, M. (2015). "Applying Argumentation Approach in STEM Education: A Case Study of the European Student Parliaments Project in Greece." *American Journal of Educational Research*, 3(12), 1618-1628.
- Smyrniou, Z., Kynigos, C. (2012). Interactive Movement and Talk in Generating Meanings from Science, *IEEE Technical Committee on Learning Technology, Special Theme "Technology-Augmented Physical Educational Spaces"* Hernández Leo, D. (Ed). *Bulletin of the Technical Committee on Learning Technology*, 14, (4), 17-20. Retrieved October 2012, available online at <http://www.ieeetclt.org/content/bulletin-14-4>.