BRITEC – Bringing Research Into the Classroom

Learning Scenario

1. Title

Urban Climate and Human Bioclimate activies and Lesson plan

Author(s)

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Area of research

Environmental protection issues

Subject(s)

Creative research activities

Physics: Introductory concepts for the study of physics, research and experimental methodology

Mathematics: Statistics and Probabilities, Graphs and Functions

Informatics: Use of office platforms, cloud computing and use of collaborative Open Source Platforms

Topic

The program was intended in the context of the subject of 'Creative research activities', a 2 hours weekly subject included in the Upper High School Curriculum

The "Research Creative Activities" foreseen in the current Upper High School Curriculum expand the content of the Research Works (Project), so that in addition to the scientific micro-researches they also include artistic, social character activities (volunteering, solidarity, interpersonal, etc.), environmental, cultural, activities related to modern and traditional media and information (print and digital media, creation of printed or electronic student magazine, actions related to internet student radio, etc.), as well as others, related to a variety of issues of school life and the environment.

Age of students

A' grade from 1st Vrilissia Upper High School, 23 students, 3 students in the management group, the rest separated in groups of 5. Age of students 16 years old

The same program was also run in the C grade from the 1st Vrilissia Junior High School, 21 students separated in groups of 5 or 6. Age of students 15 years old

2. Introduction

Contribution of the CS project to Science in general

The main points of the research process were students to be informed about concepts like (a) Climate change, (b) Urban climate, (c) Urban Heat Islet (UHI), (d) Urban population, and (e) Human biometeorology and then to focus on the School research work including scientific measurements, research on the topic, presentation and documentation of the results.

Aim of the activities plan and learning objectives

The aim of the Urban Climate and Human Bioclimate citizen Science project meet the targets of BRITEC program, namely:

Support the exchange between research institutions and schools. Both the Research center and the school gain experience in terms of working together for mutual benefits. Students develop skills, acquired knowledge and experience in the field of scientific research, while the NOA open new routes in involving citizens and raise awareness to pupils and the wider school community to become more active in supporting scientific research on global issues as the protection of the environment.

Co-create and pilot Citizen Science initiatives, skills and attitudes in schools, teachers and students.

Provide online training for teachers and recommendations for stakeholders, schools and local community into engaging schools and researchers into joint initiatives.

Beyond the above, the Urban Climate and Human Bioclimate program proposes to:

Facilitate learning and cultivate attitudes and approaches related to citizen science process that includes a number of characteristics present in Computational Thinking, such as logically ordering and analysing data and creating solutions using a series of ordered steps (or algorithms), and dispositions, such as the ability to confidently deal with complexity and open-ended problems. Students became researchers and producers by discovering information and by helping researchers to their research.

Support interdisciplinary teaching between STEM and research issues in the school. The project aims to create a community of practice for "citizen science" teachers inside the school,

on how to teach their subjects supporting each other and provide input and methodologies to their subjects' activities and teaching.

Co-create and implement integrated models inspired by research disciplines, increasing relevance while supporting the development of Computational Thinking related skills like solving problems, designing systems, and understanding human behaviour and the 21st century skills in students and school progress.

Soft, hard and technical skills development was also a goal for implementing the project

Hard and Technical Skills

Computer Technology skills in terms of Cloud, Open Source and MS Office Suite, Digital communication, Data Analysis (Data mining, Data presentation, Resource management, Data engineering, Data management, Use of data to explore a problem or make a decision), Design, Cloud computing

Soft Skills:

Communication Skills in terms of Clarity, Confidence, Respect, Empathy, Listening, Verbal and non-verbal communication, Written communication, Constructive feedback, Friendliness etc.

Team Work Skills in terms of Conflict management, Collaboration, Cooperation, Coordination, Idea exchange, Mediation, Negotiating

Adaptability Skills in terms of Curiosity, Self-management, Decision-making, Calmness, Optimism, Open-mindedness, Analysis, Self-confidence, Organization, Self-motivation.

Problem-Solving, analytical and creative thinking skills in terms of Analysis, Lateral thinking, Logical reasoning, Initiative, Persistence, Observation, Persuasion, Negotiation, Brainstorming, Decision making

Creativity in terms of developing innovative solutions by using Divergent thinking, Inspiration, Imagination, Reframing, Mind mapping, Insight, Innovation, Experimenting, Questioning, Design.

Work Ethic in terms of Integrity, Responsibility, Discipline, Initiative, Dependability, Commitment, Self-motivated, Professionalism, Teamwork, Time-management.

Time Management in terms of Goal setting, Prioritizing, Self-starter, Planning, Decision making, Focus, Delegation, Stress management, Organization.

Leadership especially for the group leaders that guided the other students to the goals and mission of the project, in terms of Project management, Empathy, Selflessness, Agility, Listening, Humility, Cultural intelligence, Authenticity, Versatility, Generosity, Trust and

Attention to Detail allowing them and the group to be both, thorough and accurate in their work.

Summary of activities

Number of activity	Name of activity
1	Record the meteorological conditions
2	Record of the subjective thermal sensation
3	Edit the data obtained and answer the research questions
4	Present the results

3. Detailed description of each activity (to be completed as many times as activities are implemented)

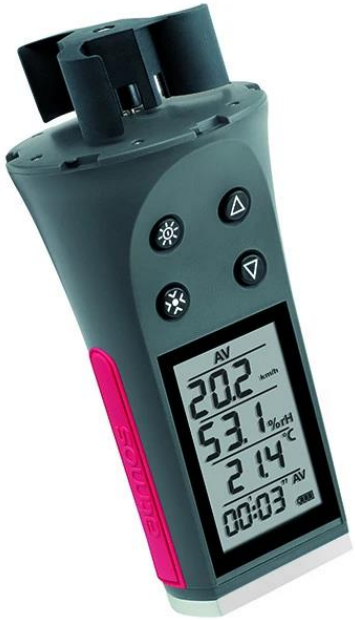
Activity 1: Record the meteorological conditions

First Part: Aim of the activity

Students record the meteorological conditions in seven (7) selected areas of the school and surrounding areas namely:

- school class,
- school yard under Shadow
- school yard under Sun
- street under Shadow
- street under Sun
- local parκ under Shadow
- local parκ under Sun

The *Pocket Weather Meter* for the measurements was provided by the Research Center.



Initially the meteorological conditions were kept in worksheet, see Annex 1.

Second Part: Suggested procedure

Preparation time	1 hour
Teaching time	1 teaching hour

Online teaching material	All support documents have been uploaded to the Google Drive (Google sheets, google docs, google presentations)
Offline teaching material	See Methodology / Protocol "Urban Climate and Human Bioclimate" and Annex 1,
Citizen science purpose of the activity (if any) *	Give a brief description (1 paragraph) of the meteorological conditions prevailing at the measurement points, emphasizing the differences that occur between the points. What are the characteristics of the points that lead to these differences? Urban Thermal Island 1. Create the temperature graph in relation to the time for the day November 18, 2019 for the area of Ampelokipi, Vrilissia and Spata on the same graph, using the CHARTS tools (Note: Adjust the scale of the vertical axis of temperatures so that the differences are more obvious). 2. Calculate the temperature differences between Ampelokipi, Vrilissia and Spata and then find the maximum differences using the MAX function. What time of day does it appear? 3. Calculate the average temperature difference between Ampelokipi and Spata during: a) night (from 17:00 to 07:00) and b) day (from 08:00 to 16: 00) using the AVERAGE function. When is the phenomenon of the Urban Thermal Island more intense? Are there lower temperatures in the urban area during the day than in other areas? How would you characterize this phenomenon? 4. Search for information about areas (Google Search, Google Earth, etc.) to briefly describe (1 paragraph) the characteristics of the areas (buildings, green spaces, etc.). What are the characteristics of the areas that contribute to the Urban Thermal Island phenomenon at night and to the opposite phenomenon during the day?
*** Guidance for teachers**	These are the main research questions that will promote the study. It is suggested for teachers and students to have a clear understanding of the Urban Thermal island based on based on bibliographic references and recent research papers. the activities, the type and the time of the activities are decided after close cooperation with the responsible researcher The scientific research carried at a school level could consists of: • Define purpose. • Construct hypothesis. • Test the hypothesis • collect data. • Analyze data.

- Draw conclusion.
- Communicate results.

(note: steps 2 and 3 is about a more statistically based study, outside the scope of students' abilities. However, the steps can be simplified after the collaboration of teaches – researchers, in order to meet student's abilities and knowledge)

Third Part: Advice on methodology

The program was intended in the context of the subject of 'Creative research activities', a 2 hours weekly subject included in the Upper High School Curriculum

The "Research Creative Activities" foreseen in the current Upper High School Curriculum expand the content of the Research Works (Project), so that in addition to the scientific micro-researches they also include artistic, social character activities (volunteering, solidarity, interpersonal, etc.), environmental, cultural, activities related to modern and traditional media and information (print and digital media, creation of printed or electronic student magazine, actions related to internet student radio, etc.), as well as others, related to a variety of issues of school life and the environment.

Indoors activities took place during the subject's teaching hours.

To complete outdoors activities we took the permission to use other teaching subjects' hours (total 1 school day)

Use of computer lab after the school

Fourth Part: Educational analysis

Project-Based Learning: students get fact-based tasks, problems to solve and they work in groups. This kind of learning usually transcends traditional subjects.

Collaborative Learning: a strong focus on group work.

Outdoor Education: learning outside of the school building in the "real" environment

STEM Learning: Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum

Peer Learning: students learn from peers and give each other feedback.

Cloud Based Learning: data, tools, software is all online and can be reached and modified from different devices.

Snack Learning: small and attractive bits of learning rather than pro-longed forms of study

Activity 2: Record of the subjective thermal sensation

First Part: Aim of the activity

Students record the subjective thermal sensation by each student in seven (7) selected areas of the school and surrounding areas namely:

The seven (7) selected measurement points.

- school class,
- school yard under Shadow
- school yard under Sun
- street under Shadow
- street under Sun
- local park under Shadow
- local park under Sun

Initially the subjective thermal sensation by each student were kept in a worksheet, see Annex 2.

Second Part: Suggested procedure

Preparation time	2 hour
Teaching time	1 teaching hour
Online teaching material	All support documents have been uploaded to the Google Drive (Google sheets, google docs, google presentations)
Offline teaching material	See Methodology / Protocol "Urban Climate and Human Bioclimate" and Annex 2,
Citizen science purpose of the activity (if any) *	• Outline questions or guidelines required for collecting data • Complete the activity, subjective thermal sensation and characteristics (columns I to T) of Groups 2 and 3, as in the case of Group 1, based on the thermal sensation questionnaires (see attached excel file) • Calculate the average subjective thermal sensation of Groups 2 and 3 in column U, using the AVERAGE function, as in the case of Group 1 (see attached excel file) • Give a brief description (1 paragraph) of the meteorological conditions prevailing at the measurement points, emphasizing the differences that occur between the points. What are the characteristics of the points that lead

	to these differences? • Give a brief description (1 paragraph) of the average subjective thermal sensation of the participants at each measuring point, emphasizing the differences that appear between the points. To what environmental factors are these differences likely to be due? • Give a brief description (1 paragraph) of the subjective thermal sensations of the participants at each measurement point, emphasizing the differences that occur between the participants. To what personal factors are these differences likely to be due?
*** Guidance for teachers**	The selected measurement points are very important for the experiment's output and must be selected and decides according to the • the depth of research • mobility of students • measuring instruments and • expected results

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Snack Learning: small and attractive bits of learning rather than pro-longed forms of study

Edutainment: playful learning. Learning while having fun.

Activity 3: Editing the data obtained and answer the research questions

First Part: Aim of the activity

Students in groups (every group is coordinated by one elected student)

Transfer the data obtained to a spreadsheet. Edit the data obtained using Data Sheets (Excel, Google Sheet, Libre office Calc). Analysis and discussion of results. Drawing conclusions.

The attached excel file (1st High School of Vrilissia - Biometeo Metrics - 18th November 2019.xls) was used to carry out the activity. The file was also transferred to a google sheet to facilitate collaboration between students and introduce them to the use of cloud computing.

Second Part: Suggested procedure

Preparation time	3 hours
Teaching time	2 teaching hours
Online teaching material	All support documents have been uploaded to the Google Drive (Google sheets, google docs, google presentations)
Offline teaching material	See attached excel file
Citizen science purpose of the activity (if any) *	Outline questions or guidelines required for collecting data Why use digital technologies to edit, store, process, transmit data and information How digital technologies contribute to the development of sciences How digital technologies are used by sciences and scientists

* Guidance for teachers	In a citigen science program teachers must be ready to explain the questions above and be fully informed of the physical object of the program. The simplest way to edit the data is to use free Open Source Collaborative tools and/or scientific applications offered by the research Institution.

Third Part: Advice on methodology

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Indoors activities took place during the subject's teaching hours.

To complete outdoors activities we took the permission to use other teaching subjects' hours (total 1 school day)

Use of computer lab after the school

Students have used cloud technologies to collaborate, communicate and integrate the project.

Fourth Part: Educational analysis

Cloud Based Learning: data, tools, software is all online and can be reached and modified from different devices.

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Activity 4: Present the results

First Part: Aim of the activity

Students in groups (every group is coordinated by one elected student)

Presentation of the results (see attached files)

The attached excel file (data processing BRITEC 1st Vrilissia Upper High School.xls) and the attached word file (britec_analysis_conlusion 1st Vrilissia Upper High School.doc) were used to present the conclusion and the results of the research and the activities carried out by the students.

Second Part: Suggested procedure

Preparation time	No preparation time needed,
Teaching time	2 teaching hours
Online teaching material	All support documents have been uploaded to the Google Drive (Google sheets, google docs, google presentations)
Offline teaching material	See attached excel and word files
Citizen science purpose of the activity (if any) *	Outline questions or guidelines required for collecting data Why use digital technologies to edit, store, process, transmit data and information How digital technologies contribute to the development of sciences How digital technologies are used by sciences and scientists

* Guidance for teachers	In a citizen science program teachers must be ready to explain the questions above and be fully informed of the physical object of the program. Data interpretation refers to the implementation of processes through which data is reviewed for the purpose of arriving at an informed conclusion. The interpretation of data assigns a meaning to the information analyzed and determines its signification and implications. Data analysis tends to be extremely subjective. People often simply summarize their results because they do not know how to interpret their findings. Summary, however, is not interpretation. Interpreting your findings is about seeing whether what you found confirms or does not confirm the findings of previous studies in your literature review. The presentation of the results should include the findings of your study and ONLY the findings of your study. The findings include: • Data presented in tables, charts, graphs, and other figures (may be placed among research text or on a separate page) • A contextual analysis of this data explaining its meaning in sentence form • Report on data collection, recruitment, and/or participants • Data that corresponds to the central research question(s) • Secondary findings (secondary outcomes, subgroup analyses, etc.)

Third Part: Advice on methodology

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Outdoor Education: learning outside of the school building in the “real” environment

STEM Learning: Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum

Peer Learning: students learn from peers and give each other feedback.

Digital Skills development (especially use of spreadsheets, text editors and presentations)

Snack Learning: small and attractive bits of learning rather than pro-longed forms of study

4. Assessment after implementation of the activities plan

Student´s learning

Discussion with students at the end of school year has shown that students believe that:

- The projects criteria were met successfully
- Acquired Proficiency in thinking like a researcher
- Understanding of the science, math and ICT tools needed to solve the problem
- Progress in working successfully in teams was achieved
- Development of student attitudes and confidence that lead to successful citizen science projects

Citizen Science experience

Lessons Learnt

The structure of the course has to be defined during the first meeting with teachers and researchers.
A presentation of the structured methodology has to be defined
The training of the teachers involved (by the researcher) is essential
The connection with the involved cognitive subjects, informatics, sciences must be clear
The experimental phase has to be conducted together with the researchers
Clear guidance and explanation of the scientific questions and research that students had to answer and accomplish.
It is expected that the students' outcome presentations will be exhibited to the school board and parents' associations, while local authorities will also be invited in the presentations. This is a strong motivation for students, as they have the chance to promote their research work and propose specific environmental measures that can potentially be applied in practice. In the same framework, the publication of the students' work in educational scientific conferences and journals will be considered.
In overall, the project is expected to increase the students' knowledge and awareness about urban climate and its importance in human bioclimatic conditions, especially under the climate change conditions that the planet is experiencing. The students will also practice in conducting research and in exploiting the resulting outcomes in the framework of serving society and their community.
Student's training involves:
1) One instructional lecture by the project's researchers, including the demonstration of the tools (weather meters, etc.) that will be used.
2) Practice in the methods and tools having the guidance of the teachers.

3) One demonstration on the daily operation of NOA/IERSD's ground-based weather stations, including the presentation of the different measure instruments.

We did not have high expectations after **the coronavirus crisis and the closure of schools** from March to June. Nevertheless, we believe that we have set goals that we have managed to achieve.

An effort has to be made before the start of the program to choose between students that are truly interested and motivated to participate and others that participate without any particular reason

The expectations were related to the development of knowledge and skills inextricably linked to the approach methodologies concerning the science of citizens such as:

Bring researchers and students together

The collection of data,

Sorting the data

Register the data

Processing and statistical analysis of data and

the recording of the results in a comprehensible form by non-experts

but also, with the development of similar knowledge and skills such as:

the use and utilization of CLMS systems like edmodo,

ways of remote communication,

utilization of cloud services

utilization of statistical analysis and processing analysis tools

use of office applications for data registration and presentation etc.

The citizen science initiatives/activities are suitable for cooperation between schools and scientists because it brought real researchers and students together under the same projects, sharing same questions, difficulties and expectations and because it was a great opportunity and experience for researchers to transmit knowledge at school level

Researchers offer motivation to the students

Teachers need support from the school environment, less bureaucratic conditions, team of teachers to support such programs, school must have a clear strategy to support such initiatives. Schools need support from the local and national educational authorities.

Clear institutional framework, flexibility in the curriculum to facilitate access to school hours.

Access to special equipment needed to implement science programs such as special sensors, special equipment, telescopes, access to original scientific data, electronic devices, science laboratories and last but not least, computer and network equipment and fast internet access.

Teachers need training.

Bring research, researchers and universities and research centers closer to schools

5. Bibliography

- http://www.urban-climate.org/
- https://www.urbanclimate.net/
- https://uwm.edu/biometeorology/commissions-and-study-groups/isb-climate-and-health-commission/
- http://www.umr-cnrm.fr/spip.php?rubrique134&lang=en
- https://sustainability.asu.edu/urban-climate/research/
- https://ghhin.org/resource-library/
- https://workspace.google.com
- https://www.eea.europa.eu/el/themes/climate/intro
- https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/priority-themes-eu-cities/climate-adaptation-cities_el

6. Annexes

Methodology / Protocol "Urban Climate and Human Bioclimate"

Introduction (speech):

(a) Climate change: An introduction to the new terminology ("climate crisis"), which more accurately describes the catastrophe that the planet is experiencing and emphasizes the seriousness of the issue.

(b) Urban climate: Description of structural, environmental, etc. characteristics of an urban area. The problem of widespread urbanization.

(c) Urban Thermal Island (UTI): The UTI as the most representative environmental problem due to the climate crisis, which is due to abusive human interventions in the local climate.

(d) Urban population: The combined effects of UTI and the most frequent, intense and longer - due to the climate crisis - heatwaves on city residents.

(e) Human biometeorology: Thermal comfort as one of the basic conditions for a good quality of life. The factors of the urban climate and the ways in which they affect the thermal balance of the human body and consequently the thermal sensation of a human being.

(f) Research work at school: (i) What are the characteristics of the local climate and thermal sensation in the school and the surrounding areas? (ii) Are there differences in thermal sensation between two people? (iii) What are the most crucial factors in creating these potential differences? (iv) There are areas that could be described as "hot / cold spots" (areas of increased hot / cold stress). (v) What are the characteristics of these areas that make them "hot / cold spots"? (vi) What measures could lead to the alleviation of hot / cold stress in these areas?

Students' research work:

The above research questions will be answered by the students themselves through the execution of the following research work:

Recording of meteorological conditions in seven (7) selected points of the school and the surrounding areas (Annex 1).
Recording of the subjective thermal sensation by each student at each of the seven (7) selected measuring points (Appendix 2).
Calculation of the objective temperature index PET (physiologically equivalent temperature) at the seven (7) selected measurement points according to the meteorological records using specialized software (RayMan).

Processing the data that will be generated using Microsoft Excel. Analysis and discussion of results. Drawing final conclusions.

The recordings (data collection) will be done by students for at least one (1) day within three months (eg. November, January, April) during the school year, in order to take into account the seasonality during the analysis of the results. The students of the high school will be given additional meteorological data for the measurement periods, coming from three automatic meteorological stations of the National Observatory of Athens (EAA) / meteo.gr: (i) Athens center (Gazi) - urban station, (ii) Vrilissia - suburban station, (iii) Pallini (Schools of Greek-German Education) - rural station. The purpose is to study the differences between the meteorological conditions of the three areas and in particular to examine the phenomenon of UTI. The calculation of the PET index (c) for each measurement period will take place by the responsible researcher. The processing of the data (d) will take place by the students in groups of 5-7 people. At the end of the school year each group will present their research work. The presentation will include the group's conclusions on the thermal sensation conditions in the school environment, as well as proposals for adaptation measures of the local climate in the context of a sustainable development plan and response to the climate crisis.

Annex 1

Recording of meteorological conditions

Date:

Measuring Area	Description	Local Time	Air Temperature (° C)	Relative humidity (%)	Wind Speed (m/s)	Cloud cover [1]
1	School class					
2	School yard (in the shade)					
3	School yard (in the sun)					
4	Street (in the shade)					
5	Street (in the sun)					
6	Park (in the shade)					
7	Park (in the sun)					

[1]

Scale	Conditions
0	*Completely clear sky*
1	1/8 of the sky is clouded
2	2/8 of the sky is clouded
3	3/8 of the sky is clouded
4	*Half* of the sky is clouded
5	5/8 of the sky is clouded
6	6/8 of the sky is clouded
7	7/8 of the sky is clouded
8	*Completely cloudy sky*

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Annex 2

Recording of the subjective thermal sensation

Personal Code:

{ Day of birth (e.g. 26)
First 2 letters of your favorite color (e.g. re)
Floor Number of the apartment you live in (e.g. 01) } e.g. -> 26re01

Sex: M / F Age: Body Structure: Small / Medium / Big

Skin tone: Very light / light / dark / very dark

Date:

Measuring Area	Activity [1]	Conditions of location [2]	Clothing [3]	Hat [4]	Thermal sensation [5]
1					
2					
3					
4					
5					
6					
7					

[1] Sitting / Standing up / Walking [2] Sun / Shadow / Partial Shadow

[3]

Scale	Description	Colour
0.3	Very light summer clothes (shorts + short-sleeved blouse)	Bright / Dark
0.5	Light summer clothes (long light pants + short-sleeved blouse)	Bright / Dark
0.8	Light clothes (long light pants + long-sleeved blouse)	Bright / Dark
1.0	Average autumn clothes (long thick pants + long-sleeved blouse) or long-sleeved tracksuit	Bright / Dark
1.5	Average autumn clothes (long thick pants + long-sleeved blouse) with cardigan or long-sleeved tracksuit with sweatshirt	Bright / Dark
2.0	Average winter clothes (long thick pants + sweater)	Bright / Dark
2.5	Average winter clothes (long thick pants + sweater) + heavy jacket or coat	Bright / Dark
3.0	Average winter clothes (long thick pants + sweater) + heavy jacket or coat + gloves + hat + scarf	Bright / Dark

[4] Yes / No

[5]

Scale	Sensation
− 4	Extreme Cold
− 3	Very Cold
− 2	Cold
− 1	Chill
0	Comfortable
+ 1	Little Hot
+ 2	Hot
+ 3	Very Hot
+ 4	Extreme Hot

Example of Completion:

I am in the 1st measuring area (school class), standing up[1,] in the shadow [2], wearing light dark clothes [3], without a hat [4] and feeling chill [5]

Measuring Area	Activity [1]	Conditions of location [2]	Clothing [3]	Hat [4]	Thermal Sensation [5]
1	Standing Up	Shadow	0.8 dark	No	− 1