STE(A)M IT

AN INTERDISCIPLINARY STEM APPROACH

LEARNING PRODUCTS: PEDAGOGICAL DESIGN, ASSESSMENT, STAKEHOLDER DIALOGUE

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LEARNING PRODUCTS AND PEDAGOGICAL DESIGN

- Learning product (physical or digital): Artefact created by students during a learning activity; usually students are supported by tools, templates or scaffolds
- Examples of learning products (physical or digital): Drawings; concept maps; hypotheses; experimental designs; data collected in datasheets; graphs; tables; models, videos created by students, etc.
- A sequence of learning activities may be reconstructed as a sequence of learning products, where each learning product of a former learning activity is needed as necessary input for processing an upcoming learning activities
- Learning products present a key point for all state-of-the-art learning approaches
- They determine the duration of learning activities and class arrangement (if learning activities are to be undertaken by individual students, groups of students or if these are whole-class activities)

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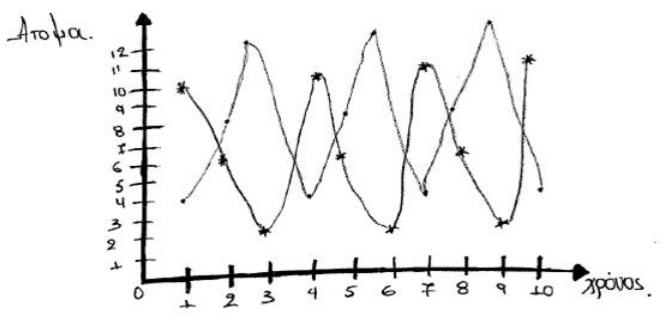
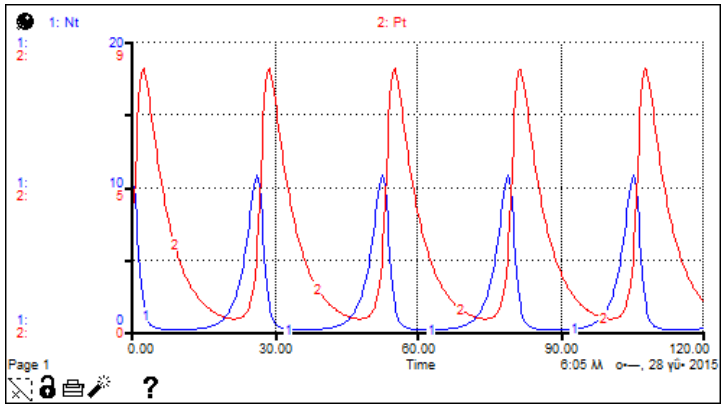
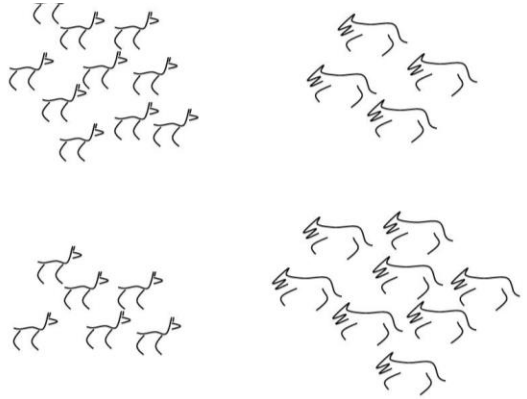
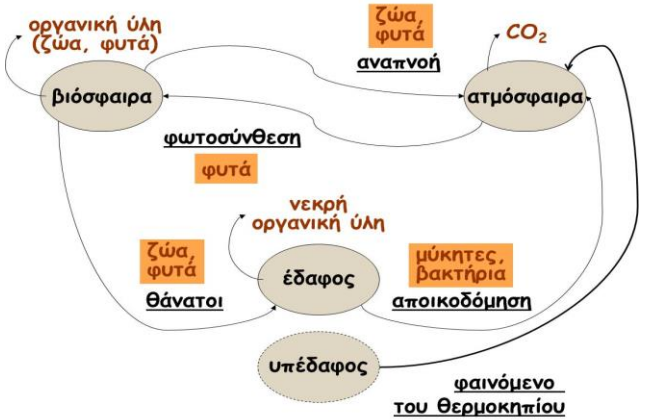


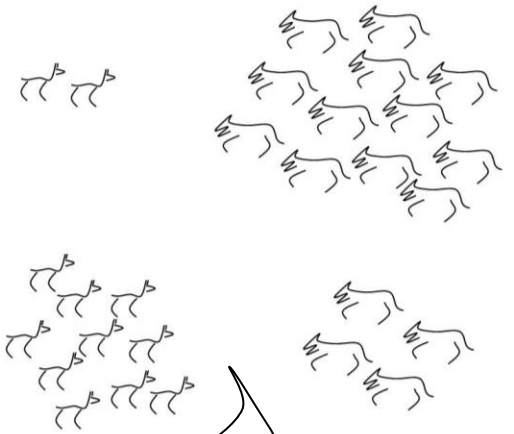


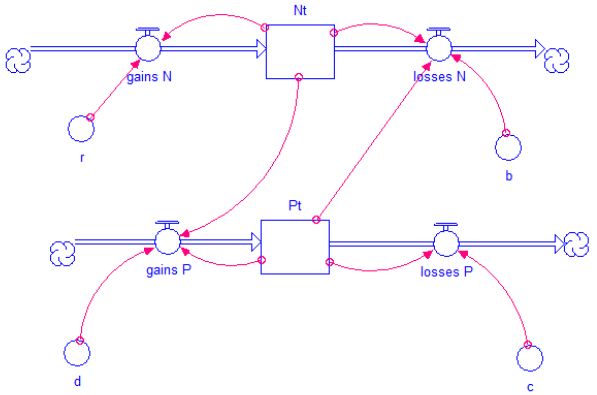
	Population size of foxes	Population size of rabbits
1	4	10
2	8	6
3	12	2
4	4	10
5	8	6
6	12	2
7	4	10
8	8	6
9	12	2
10	4	10

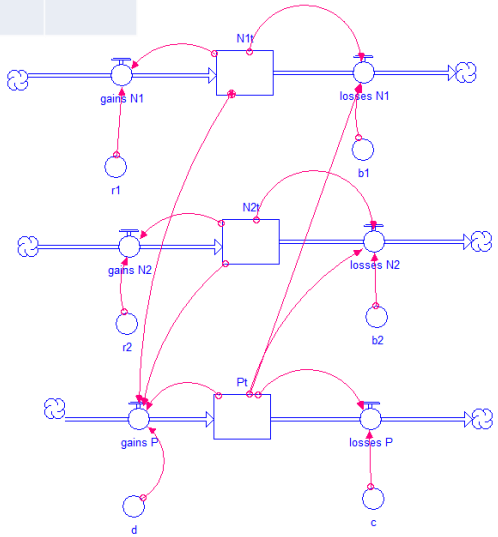


	Κτηνοτρόφοι	Κυνηγετικοί σύλλογοι	Περιβαλλοντικές οργανώσεις	Ταμείο Θήρας
Ερείσματα (γνώσεις, πεποιθήσεις και συμπεριφορές των κοινωνικών ομάδων που ενδέχεται να προωθήσουν τη συναίνεση)			Μέσα αποτροπής ζημιών	
Μειονεκτήματα (γνώσεις, πεποιθήσεις και συμπεριφορές των κοινωνικών ομάδων που ενδέχεται να αποτρέψουν την επίτευξη συναίνεσης)				Γνώση
Ευκαιρίες (υφιστάμενες ή αναμενόμενες συγκλίσεις, συνέργειες **μεταξύ** των κοινωνικών ομάδων)			«Η τροποποίηση του νόμου δεν θα καθιστά την αλεπού θήραμα για κυνήγι...»	
Απειλές (υφιστάμενες ή αναμενόμενες αντιπαραθέσεις, διενέξεις **μεταξύ** των κοινωνικών ομάδων)	Δηλητηριασμένα δολώματα	Δευτερογενής δηλητηρίαση κυνηγετικών σκύλων		









EXAMPLES OF LEARNING PRODUCTS

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LEARNING PRODUCTS AND ASSESSMENT

- Learning products reflect knowledge and skills which are necessary for their creation: If students do not possess this knowledge and these skills, they would not be able to create these learning products
- Learning products can be stored in portfolios to be retrieved and reused (reworked, revised, compared): In this regard, learning products can be used to restructure student navigation and performance in the learning environment
- Learning products can be used for assessment purposes
- Summative assessment: Learning products stored in portfolios; certification of skills and competences);
- Formative assessment: Teachers can focus on learning products to diagnose student performance and provide on-the-fly feedback; no need for other instruments which are external to the learning activity sequence
- Peer assessment: Students can assess the work of their peers in reciprocal peer assessment arrangements (each student will undertake the role of peer assessor and peer assessee)

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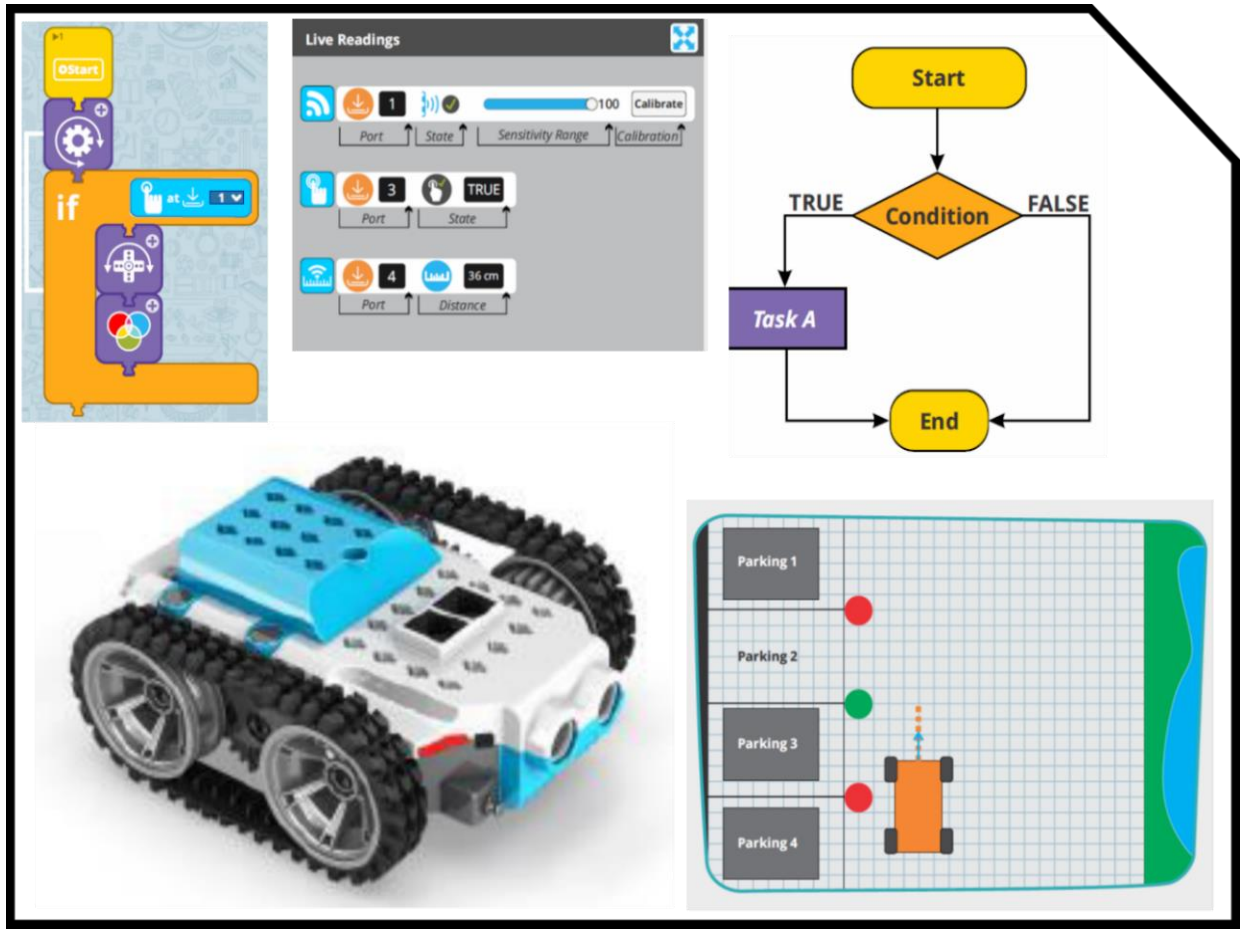

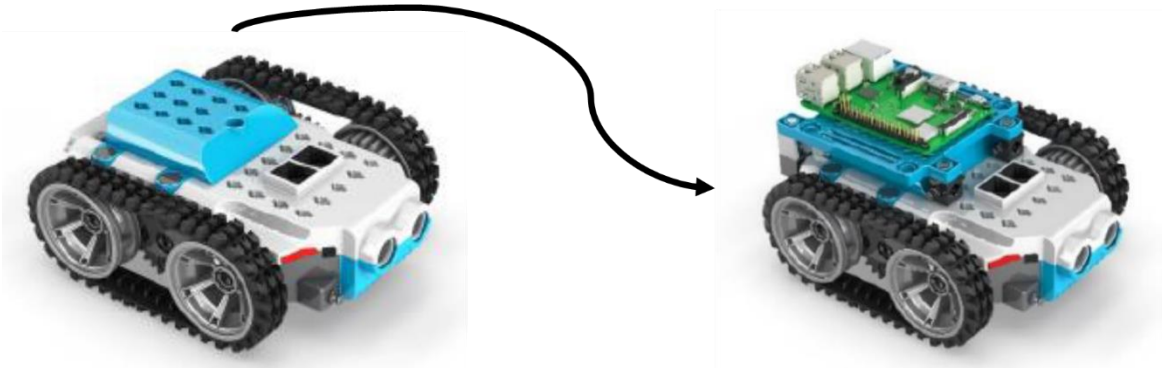

STUDENT PORTFOLIOS

OPTIMIZATION OF LEARNING PRODUCTS

Posters (text and pictures)

Websites (text and pictures)

Our designs are perfect for student life and/or outdoor life. Our houses are built on the customer's ideas in mind. Our houses are low cost, and we can

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Bonsignori.jpg

Campanelli.jpeg

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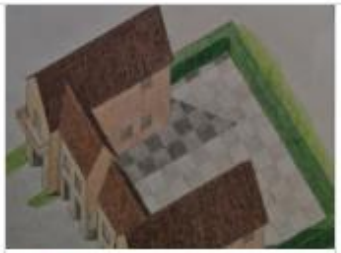

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Franceschilli.jpg

Norscia.jpeg

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Ranalli.jpeg

Rapacchiani.jpg

Designs

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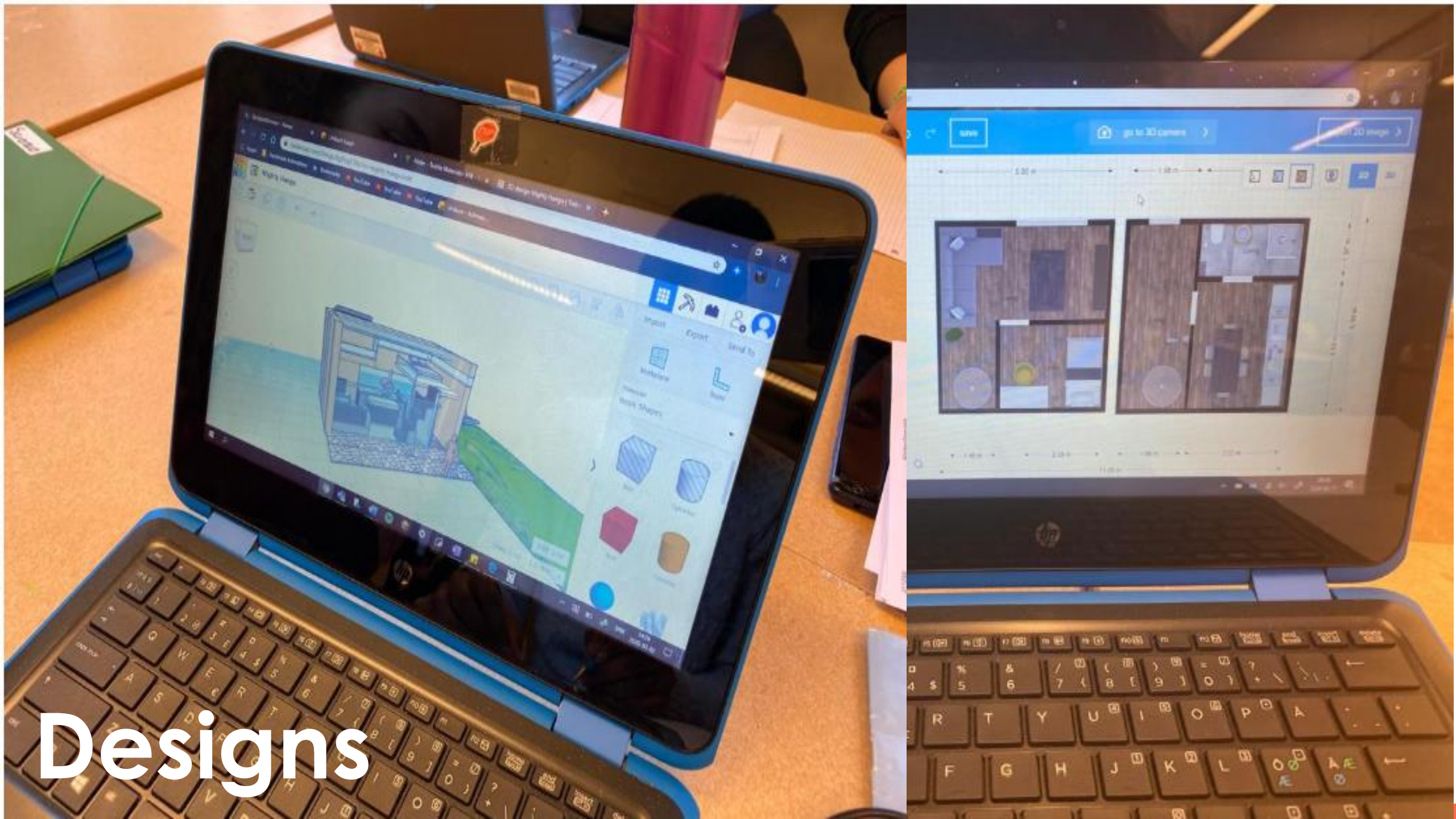
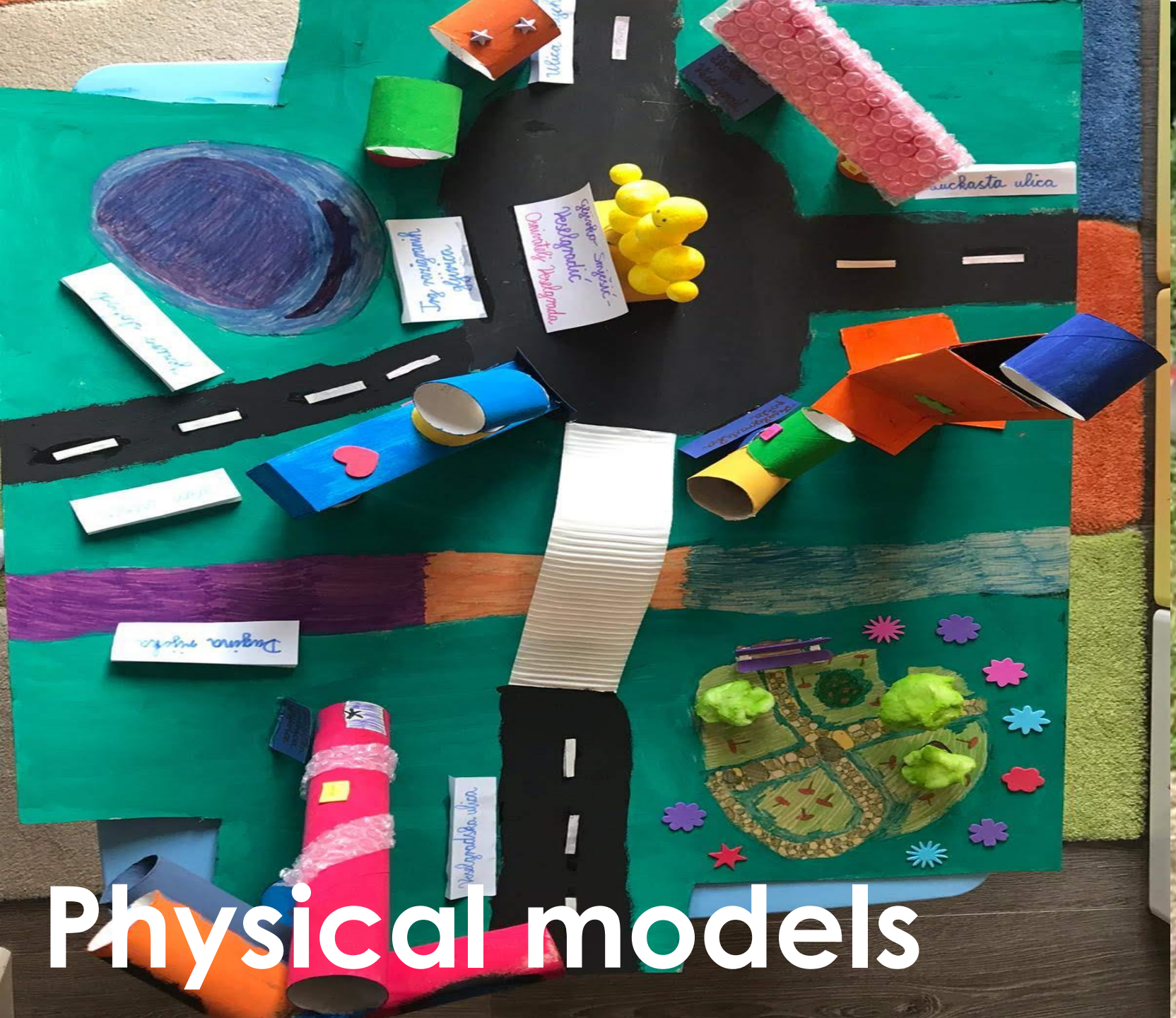

Designs

Physical models



Physical models

group2_graph.xlsx

	A	B	C	D	E	F
1	Minuti	dischi che risalgono	Dischi che affondano	Minuti		
2	1	0	0	1		
3	2	0	0	2		
4	3	1	1	3		
5	4	1	2	4		
6	5	1	3	5		
7	6	1	4	6		
8	7	1	4	7		
9	8	1	5	8		
10	9	1	6	9		
11	10	2		10		
12	11	2		11		
13	12	2		12		
14	13	3		13		
15	14	4		14		
16	15	5		15		
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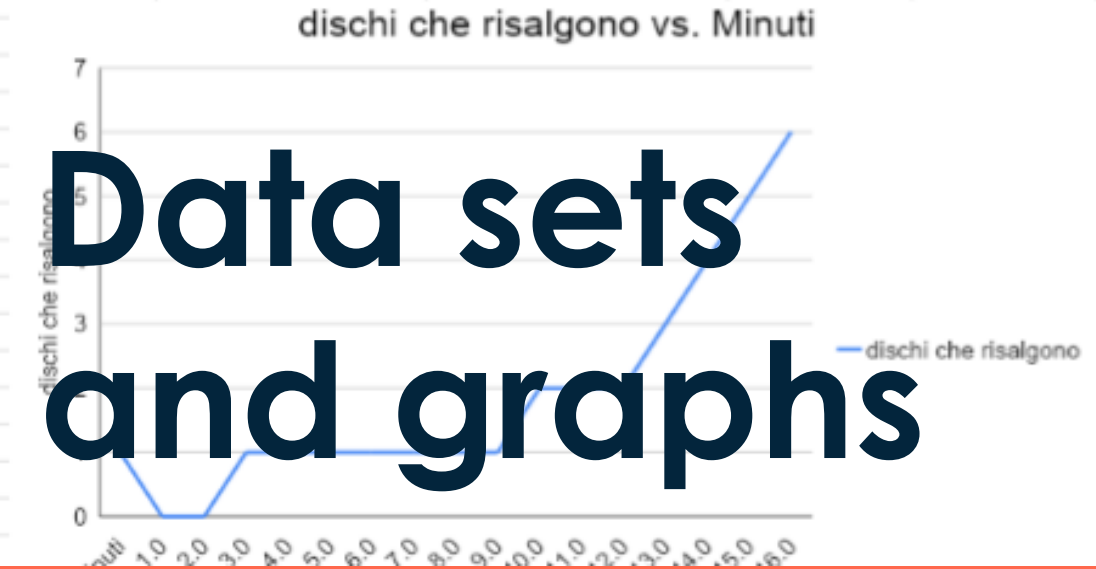


Data sets and graphs

Annex P7 – Experiment indeep answers

1) Investigate on the law that links illuminance to distance (Step 1). report your calculations in Table 2, add any columns you need; process the experimental errors too.

Distance (m) ±0.01	Illuminance (lx) ±5	I*d² (lx*m²)
0,40	5200	832
0,50	2785	696,25
0,60	1675	603
0,70	1150	563,5
0,80	780	499,2
0,90	520	421,2

I*d² avg=(832+696,25+603+563,5+499,2+421,2)lx*m²/6=602,525

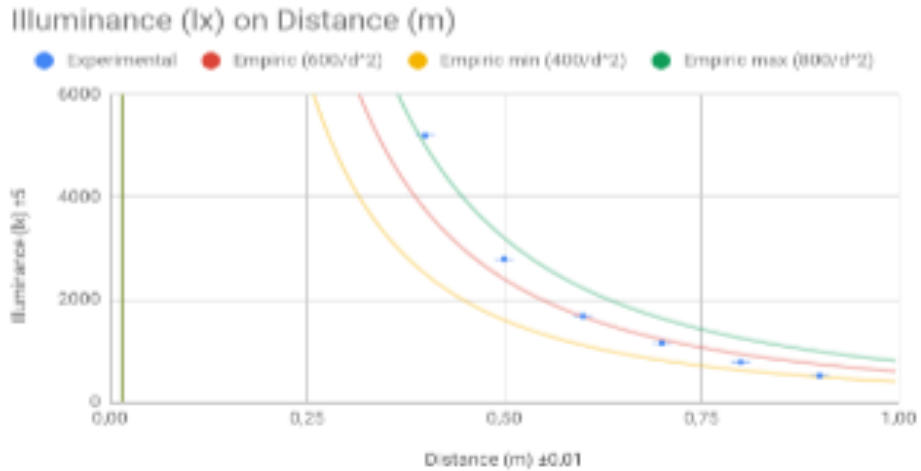
$\sigma_{stat} = (832-421,2)/2$ lx*m² = 205,4 lx*m² = 200 lx*m²

Table 2. Research of the proportionality between illuminance and distance.

2) within the experimental uncertainties, the brightness is ...inversely..... proportional ...to the square of the distance....

3) represent the collected experimental data in a graph, derives the theoretical law and represent it on the graph together with the experimental data

Being, as we said in point 2, I=k/d² 2, and being k=I*d² avg= 600 ± 200 lx*m², we have



4) Are all the data in agreement with the relationship found? If there are discordant data try to give a reason.

Not all the data are totally in agreement with the empiric relationship when using the average value for k (600 lx*m²) but all the data are between the maximum and minimum empiric values, that's because the


School garden

LEARNING PRODUCTS AND STAKEHOLDER DIALOGUE

- Stakeholders can structure a constructive dialogue focusing on learning products
- Teachers can use learning products for increasing the coherence and showcasing the strengths of their pedagogical design; teacher collaboration
- When educational interventions have been designed with reference to concrete learning products, students reveal increased self-regulated learning and metacognition
- Learning products have been found to foster inter-contextual transfer of knowledge and skills (transfer tasks)
- Learning products can be used to scaffold students work in the form of partially worked examples
- Ministries of Education can use learning products for exemplifying curriculum development and analysis: Collections of learning products as the curriculum under development (learning progressions)
- Industry partners can use learning products for highlighting desirable skills

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USING LEARNING PRODUCTS FOR ASSESSMENT PURPOSES

INSIGHTS FOR DEVELOPING NON-LINEAR THINKING

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BACKGROUND AND RATIONALE

- Systems thinking, non-linear phenomena
- Ecology: Population level; biocommunities, where populations of different species interact (e.g., prey–predator systems); ecosystems
- Develop non-linear reasoning
- Non-linear reasoning diverges substantially from linear reasoning
- Linear interactions between variables: Proportional or inversely proportional relationships; one-way, unidirectional causality

- Non-linear relationships in ecological systems are not proportional and imply two-way, bidirectional causality
- The latter type of causality is a crucial characteristic of feedback loops observed in ecological phenomena
- Main questions to be addressed:
  - (1) Good practice in pedagogical design to develop non--linear thinking
  - (2) How to use learning products within the frame of formative assessment for securing the developing of non-linear thinking
  - (3) Implications for learning and instruction

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GAME SIMULATION AND COMPUTER SIMULATION

Learning activity sequence focusing on a game simulation of a prey-predator system (Hovardas, 2016; Hovardas & Zacharia, 2019)

Learning activity (serial number)	Time to complete; class arrangement	Learning product
Eliciting initial ideas (1)	10min; individual	Text addressing an introductory scenario
Comparing initial ideas with scientific data (2)	10min; individual	Text focusing on the comparison at task
Playing the game (3)	20min; group	Table with number of prey and predator individuals
Constructing a graph (4)	20min; group	Graph presenting prey and predator population trends
Interpreting the graph (5)	10min; group	Text focusing on the interpretation of the graph
Comparing graph interpretation with initial ideas (6)	10min; group	Text focusing on the comparison at task
Discussing the comparison of graphs with initial ideas (7)	15min; whole-class	Table which includes similarities and differences
Predicting prey and predator population sizes in a new learning context (8)	10min; individual	Text addressing the new scenario
Revising the game to address the new scenario (9)	15min; individual	Text which includes revised rules for the game

Learning activity sequence focusing on a computer simulation of a prey-predator system (Hovardas, 2016; Hovardas & Zacharia, 2019)

Learning activity (serial number)	Time to complete; class arrangement	Learning product
Constructing a model of the prey-predator system (1)	20min; individual	Structural model of the prey-predator system
Inserting equations of population dynamics (2)	10min; individual	Equations describing the prey-predator system
Simulating the prey-predator system (3)	10min; individual	Graph depicting prey and predator population trends
Interpreting the graph (4)	10min; whole-class	Text which focuses on the interpretation of the graph
Constructing a scatterplot with prey and predator populations (5)	10min; individual	Scatterplot
Interpreting the scatterplot (6)	20min; whole-class	Text which focuses on the interpretation of the scatterplot
Exploring model behaviour for different initial population sizes (7)	15min; group	Scatterplot with multiple curves
Predicting prey and predator population sizes in a new learning context (8)	10min; group	Text presenting a new scenario
Revising the model to address the new scenario (9)	15min; group	Revised model

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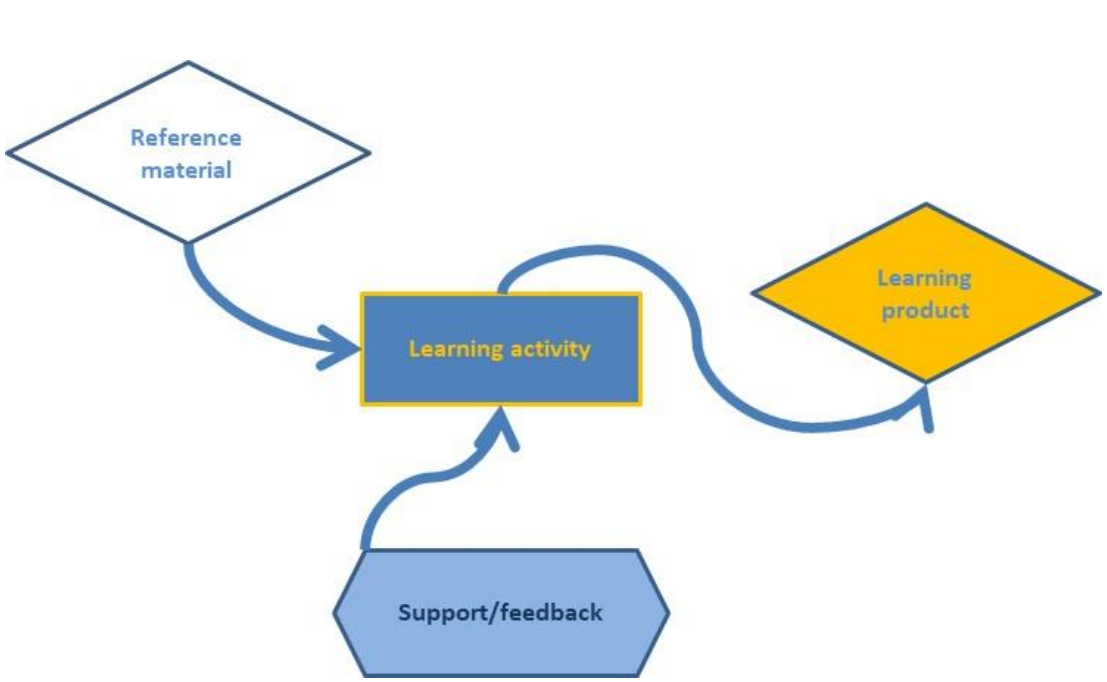
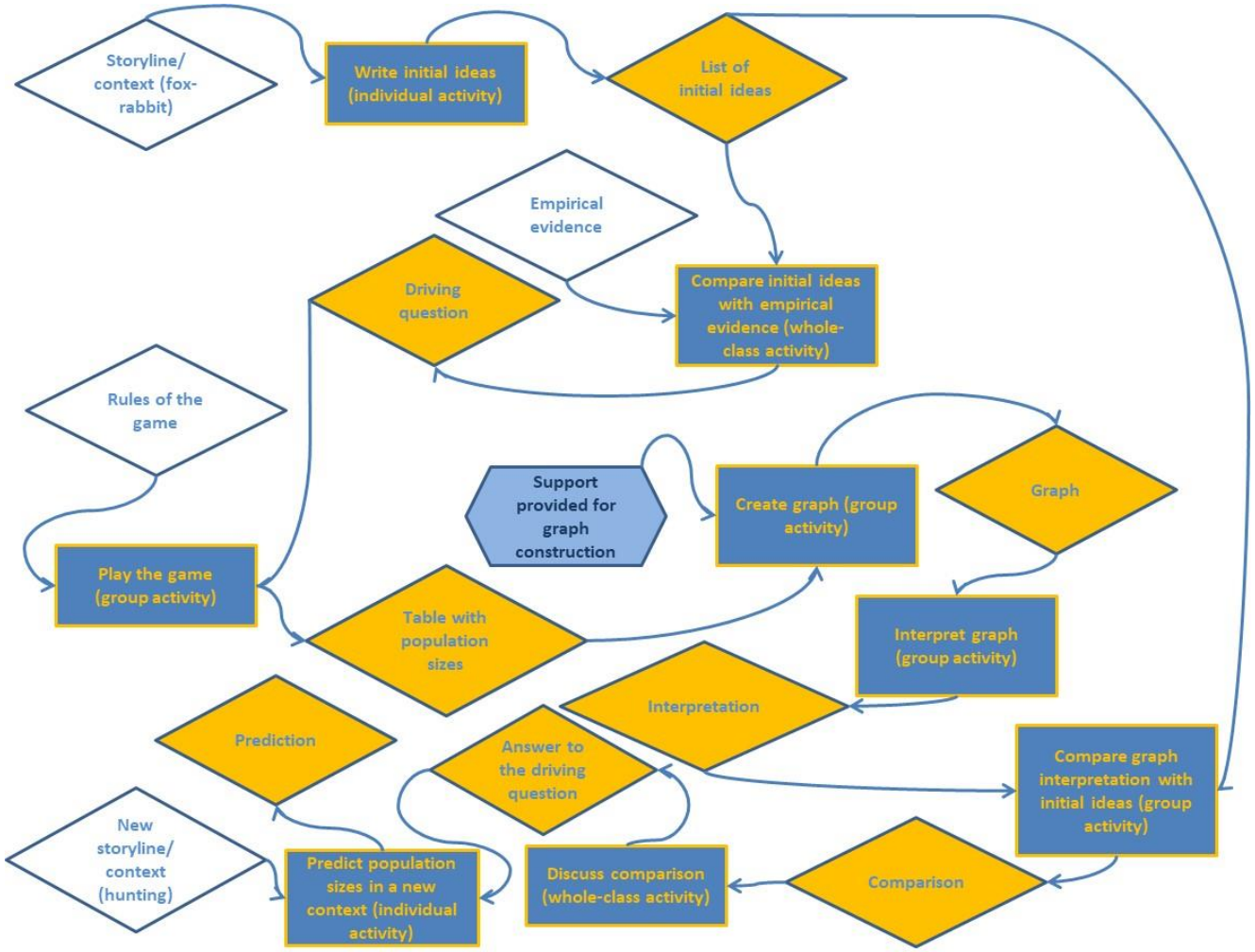




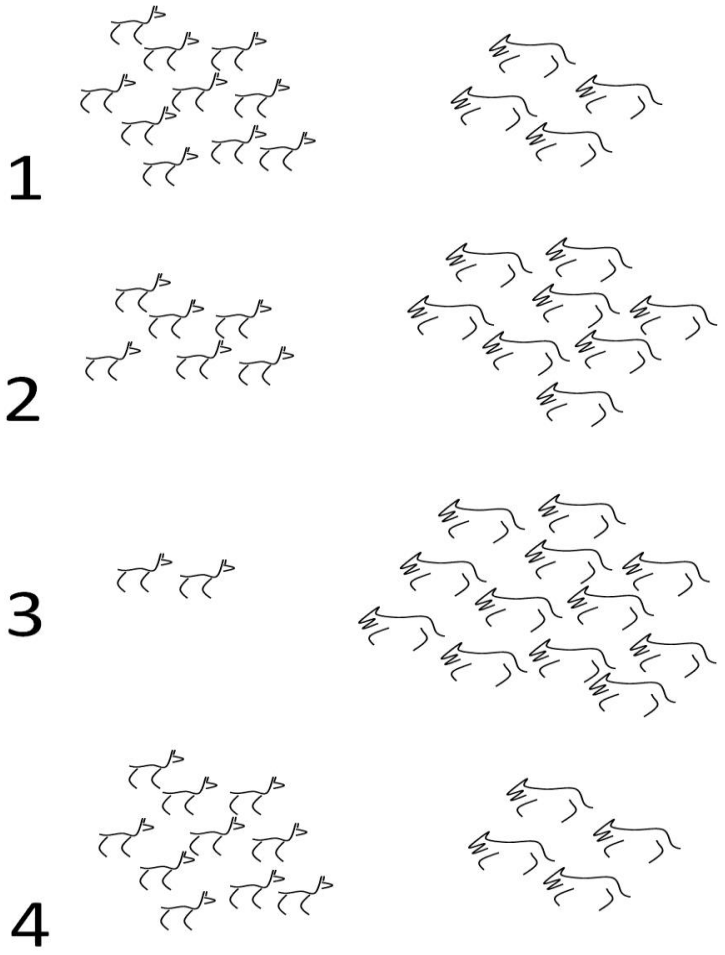
BUILDING BLOCKS OF LEARNING SCENARIOS: FOCUS ON LEARNING PRODUCTS

GAME SIMULATION OF THE PREY PREDATOR SYSTEM; FOCUS ON LEARNING PRODUCTS (YELLOW RHOMBUSES)

GAME SIMULATION

Rules of the game:

1. Each wolf consumes one deer in each time unit
2. Each deer consumed is "transformed" into a wolf
3. All wolves consume deer
4. If a wolf cannot find a deer to feed on, it is "transformed" into a deer



Time unit	Number of wolves	Number of deer
1	4	10
2	8	6
3	12	2
4	4	10
5	8	6
6	12	2
7	4	10
8	8	6
9	12	2
10	4	10

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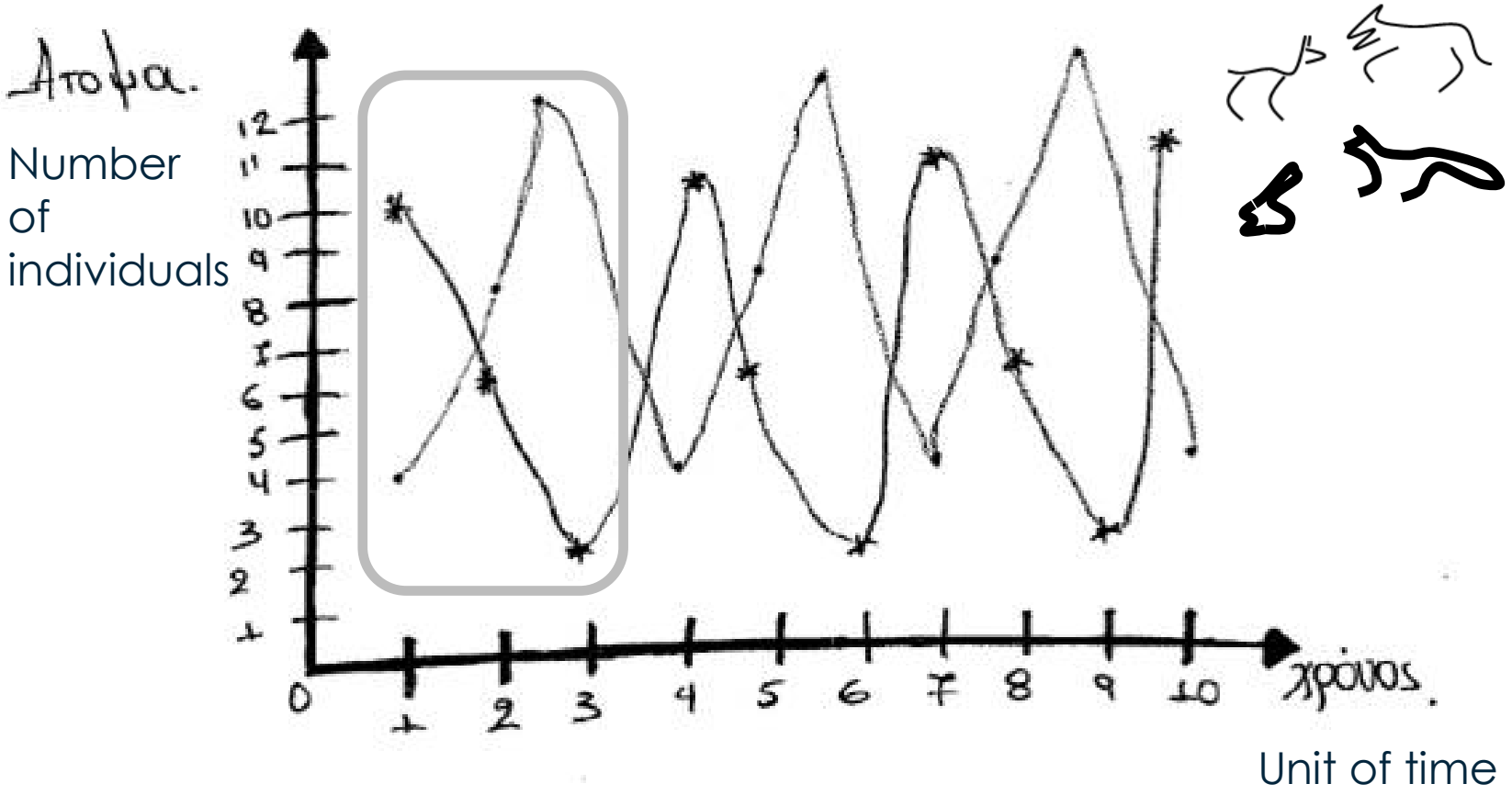

- Initial predictions of students are based an assumption that prey–predator interaction would evolve as a linear, monotonous trend; however, the prey population does not disappear
- Some students describe population trends as "inversely proportional"

❖ **Regression to linear thinking**

❖ **Learning products: Graph; graph interpretation**

GRAPH CONSTRUCTION AND INTERPRETATION

"When the one population increases, the other population decreases. When wolves increase in number, deer decrease. We can see that populations of wolves and deer relate in an inversely proportional way (Participant no 51)."

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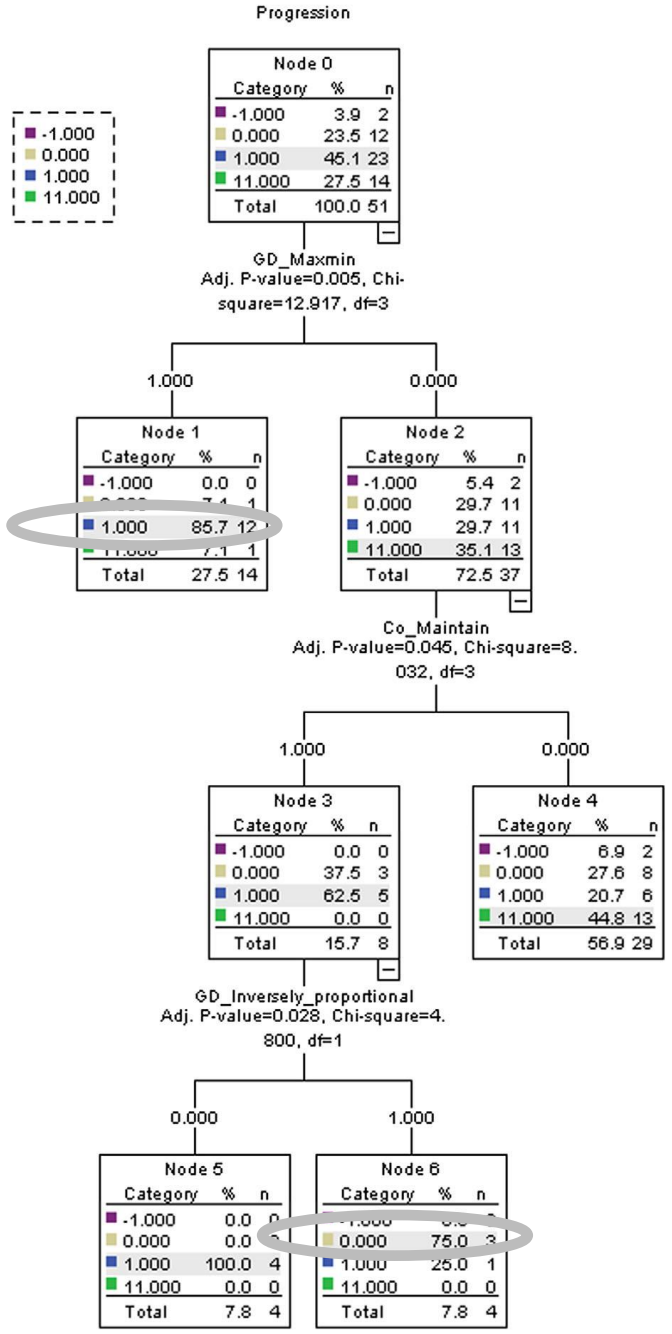
- If participants had identified maximum and/or minimum values in population curves or if they had observed the temporal pattern of oscillations of prey and/or predator populations, they were significantly less likely to resort to linear, unidirectional reasoning

DATA ANALYSIS BASED ON LEARNING PRODUCTS (TREE MODEL)



- If participants had observed maximum and/or minimum values of population curves during graph description they had most probably progressed to non-linear reasoning
- Those who recorded maintenance of both wolves and deer but depicted population trends as "inversely proportional" were most probable to not have progressed

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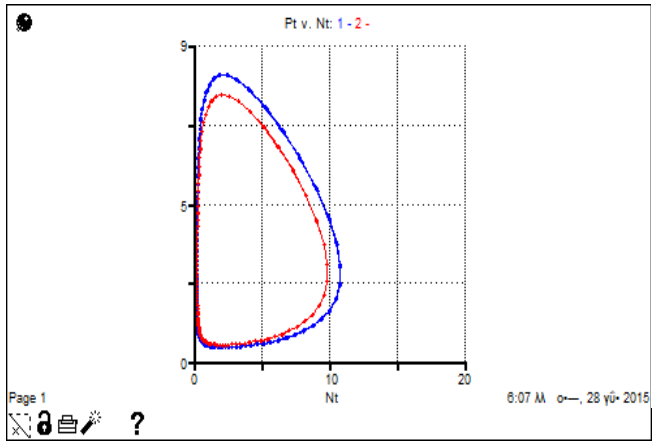
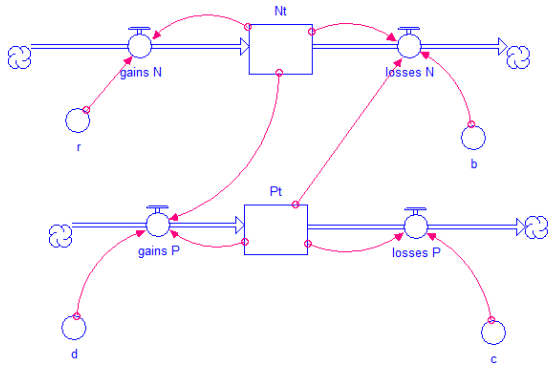
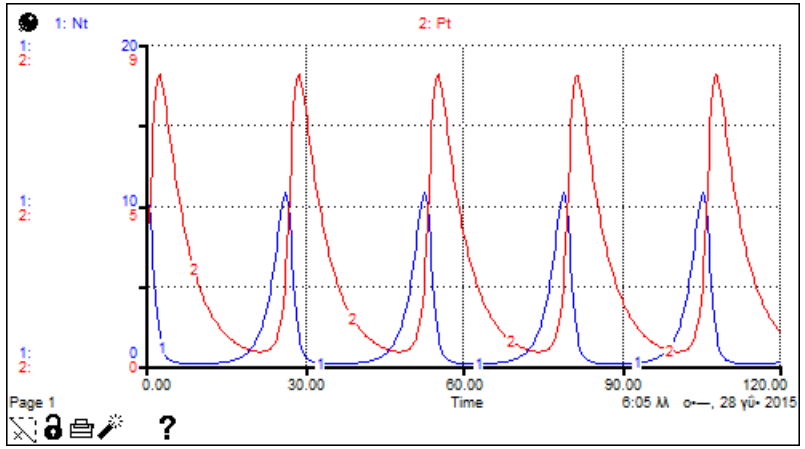
IMPLICATIONS FOR LEARNING AND INSTRUCTION (1)

- Concrete aspects of concrete learning products provide clear evidence of learner progression, stagnation, or even regression (formative assessment)
- Students who concentrated on the space delineated by maximum and minimum values of population curves interpreted trends as “inversely proportional.”
- However, proportionality in our case would be only possible to ascertain, if prey and predator population sizes would have been plotted the one against the other, for example in a scatter plot







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IMPLICATIONS FOR LEARNING AND INSTRUCTION (2)

- The powerfulness of linear heuristics might reach to the point of distorting novel information
- Linear heuristics are quite powerful and might re-surface even when targeted by instruction
- There is the possibility that schooling itself might be contradictory and that the curriculum may promote divergent objectives
- Linear thinking in physics; non-linear thinking in ecology
- Using graphing to approach only linear and proportional relationships might be counter-intuitive for addressing non-linear reasoning
- Graphs and graph descriptions might be instrumental in either challenging or perpetuating linear reasoning
- Curriculum design and development should incorporate a comparison among scientific fields/domains
- Such a perspective could very well match with nature of science (NOS) approaches in science education

REFERENCES

- de Jong, T., van Joolingen, W. R., Giemza, A., Girault, I., Hoppe, U., Kindermann, J., Kluge, A., Lazonder, A. W., Vold, V., Weinberger, A., Weinbrenner, S., Wichmann, A. Anjewierden, A., Bodin, M., Bollen, L. d´Ham, C., Dolonen, J., Engler, J., Geraedts, C., Grosskreutz, H., Hovardas, T., Julien, R., Lechner, J., Ludvigsen, S., Matteman, Y., Meistadt, Ø., Næss, B., Ney, M., Pedaste, M., Perritano, A., Rinket, M., von Schlanbusch, H., Sarapuu, T., Schulz, F., Sikken, J., Slotta, J., Toussaint, J., Verkade, A., Wajeman, C., Wasson, B., Zacharia, Z., & van der Zanden, M. (2010). Learning by creating and exchanging objects: the SCY experience. *British Journal of Educational Technology*, 41, 909-921.
- de Jong, T., Weinberger, A., van Joolingen, W. R., Ludvigsen, S., Ney, M., Girault, I., Kluge, A., Lazonder, A., Pedaste, M., Wasson, B., Wichmann, A., Geraedts, C., Hovardas, T., Julien, R., Lejeune, A., Manoli, C., Matteman, Y., Sarapuu, T., Vold, V., Wanders, B., Zacharia, Z. (2012). Using scenarios to design complex technology-enhanced learning environments. *Educational Technology Research & Development*, 60, 883 – 901.
- Efstathiou, C., Hovardas, T., Xenofontos, N., Zacharia, Z., de Jong, T., Anjewierden, A., & van Riesen S. A. N. (2018). Providing guidance in virtual lab experimentation: The case of an experiment design tool. *Educational Technology Research & Development*, 66, 767–791.
- Hovardas, T., Tsivitanidou, O. E., Zacharia, Z. (2014). Peer versus expert feedback: Investigating the quality of peer feedback among secondary school students assessing each other's science web-portfolios. *Computers & Education,* 71, 133 - 152.
- Hovardas, T. (2016). A learning progression should address regression: Insights from developing non-linear reasoning in ecology. *Journal of Research in Science Teaching*, 53, 1447-1470.
- Hovardas, T., Xenofontos, N., & Zacharia, Z. (2017). Using virtual labs in an inquiry context: The effect of a hypothesis formulation tool and an experiment design tool on students' learning. In: I. Levin, & D. Tsybulsky (Eds.), *Optimizing STEM Education With Advanced ICTs and Simulations* (pp. 58-83). Hershey PA, USA: IGI Global.
- Hovardas, T., Pedaste, M., Zacharia, Z., & de Jong, T. (2018). Model-based science inquiry in computer-supported learning environments: he case of Go-Lab In: A. K. M. Azad, M. Auer, A. Edwards, & T. de Jong (Eds.), *Cyber-physical laboratories in engineering and science education* (pp. 241-268). Springer, Dordrecht.
- Hovardas, T., & Zacharia, Z. (2019). A model-based inquiry approach to explore system dynamics and modeling aspects of the prey-predator system. In: Y. Cai, W. van Joolingen, & Zachary Walker (Eds.), Virtual Reality, Simulations and Serious Games for Education (pp. 99-109). Singapore: Springer Nature.
- Xenofontos, N., Hovardas, T., Zacharia, Z., & de Jong, T. (2020). Inquiry-based learning and retrospective action: Problematizing student work in a computer-supported learning environment. *Journal of Computer Assisted Learning*, 36, 12-28.

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QUESTIONS TO BE DISCUSSED

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QUESTIONS TO BE DISCUSSED

- Can traditional assessment instruments (e.g., multiple choice items) be employed to effectively evaluate learning outcomes in integrated STEM education?
- Can we use learning products instead?
- How easy would it be to base pedagogical design and implementation of integrated STEM education on collections of learning products?
- Can we use learning products to describe learning progressions?
- Can we use learning products to describe curriculum standards?
- Can we use learning products to describe desirable skills and competences?
- Can we use learning products for certifying skills and competences?
- Can we use learning products (digital) to facilitate a transition from the "traditional" classroom to a "digital" classroom?

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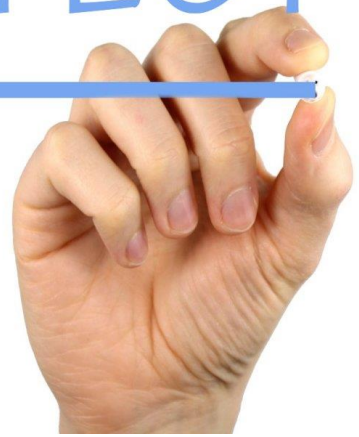
LEARNING PRODUCTS AND LEARNING PORTFOLIO

NIKOLETTA XENOFONTOS

UNIVERSITY OF CYPRUS

This course is co-funded by the STE(A)M IT and Scientix 4 projects, funded by the EU's ERASMUS+ programme (GA 612845-EPP-1-2019-1- BE-EPPKA3-PI-FORWARD), and EU's H2020 research and innovation programme (GA 101000063) respectively. The content of the document is the sole responsibility of the organizer and it does not represent the opinion of the European Union or the Education, Audiovisual and Culture Executive Agency, which are not responsible for any use that might be made of the information contained.

ARCHITECT



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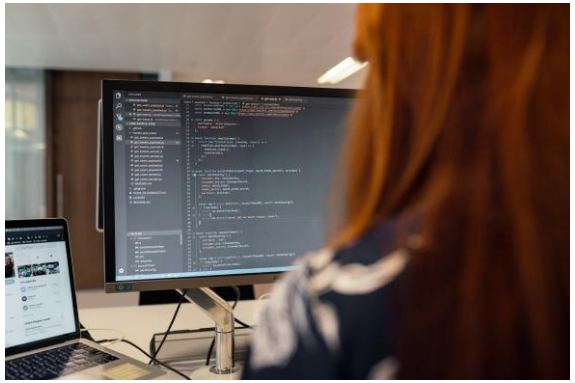
Researcher

Publications

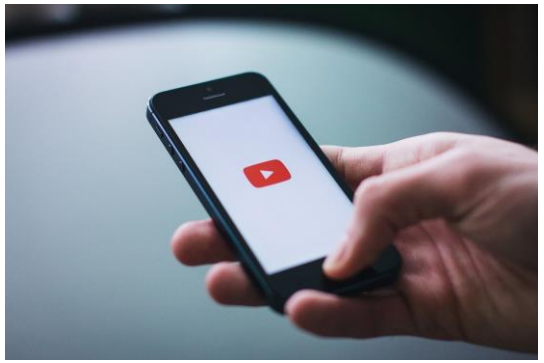
Mechanical engineer

Web applications and traffic analytics

Software engineer



Video demonstration



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LEARNING PORTFOLIO

A COLLECTION OF STUDENT WORK THAT SHOWCASES STUDENT'S PROGRESS, ACHIEVEMENTS AND COMPETENCIES

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WHY LEARNING PORTFOLIO?

Provides **aggregated information** about student learning

Showcases **evidence** of what specific learning goals student achieved

Allows teachers to **monitor** student progress and provide formative assessment

Allows student to **reflect** on their learning

It can be presented to **parents**

It can be given to the **next teacher** (following grade)

It can be scored based on **rubrics** (match of the intended learning goals with the assessment criteria)

Students are involved in the creation of their learning portfolio (**self-regulated learners**)

Allows student **self-assessment** and **peer-assessment**

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EXAMPLES FROM THE STE(A)M IT INTEGRATED STEM TEACHING AND LEARNING SCENARIOS

LEARNING PORTFOLIOS AND ASSESSMENT

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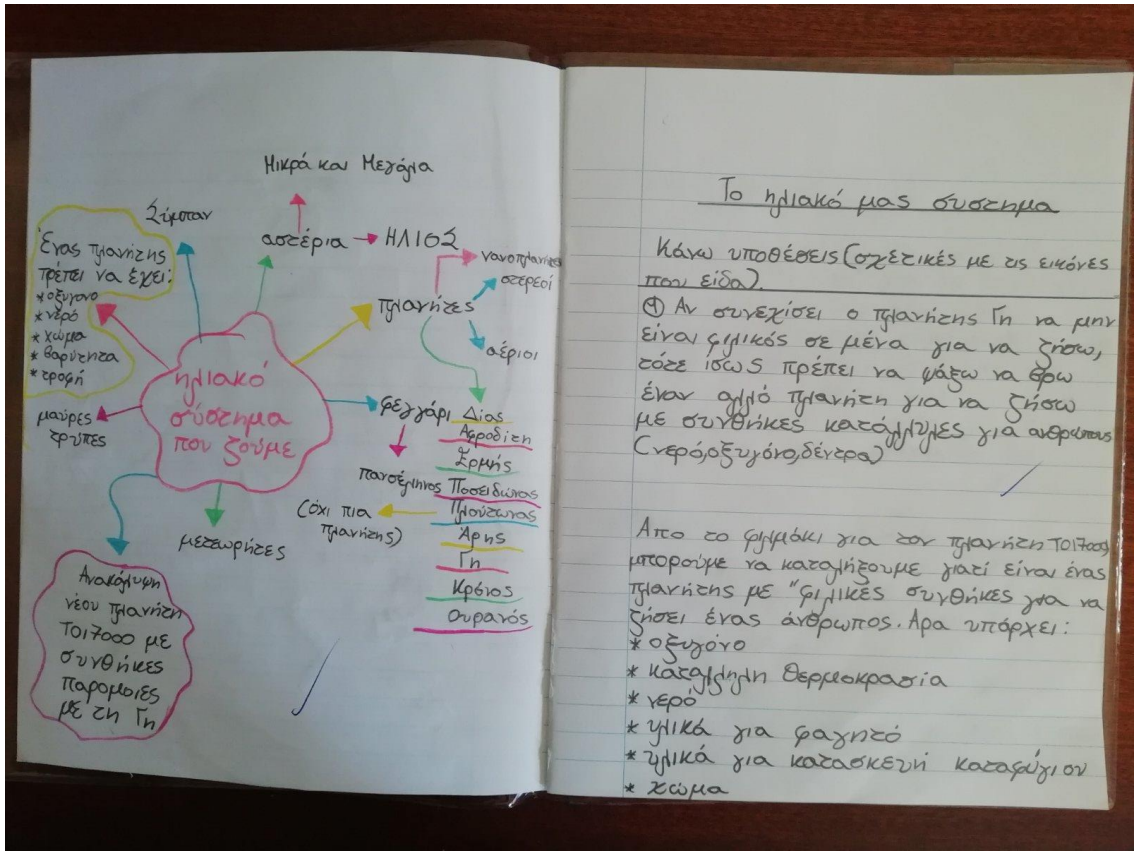
THE SOLAR SYSTEM AND THE EARTH: WHERE COULD HUMANS LIVE INSTEAD OF THE PLANET EARTH?

Subjects: Science, Technology, Mathematics and Language (Primary education)



Learning goals (Lesson 2 - Science)

1) name other planets (and comets or meteorites) of the Solar system

2) interpret gravity as a factor that makes Earth habitable

3) argue on the factors that make Earth habitable compared to other planets

4) argue on the habitability of other planets in relation to Earth

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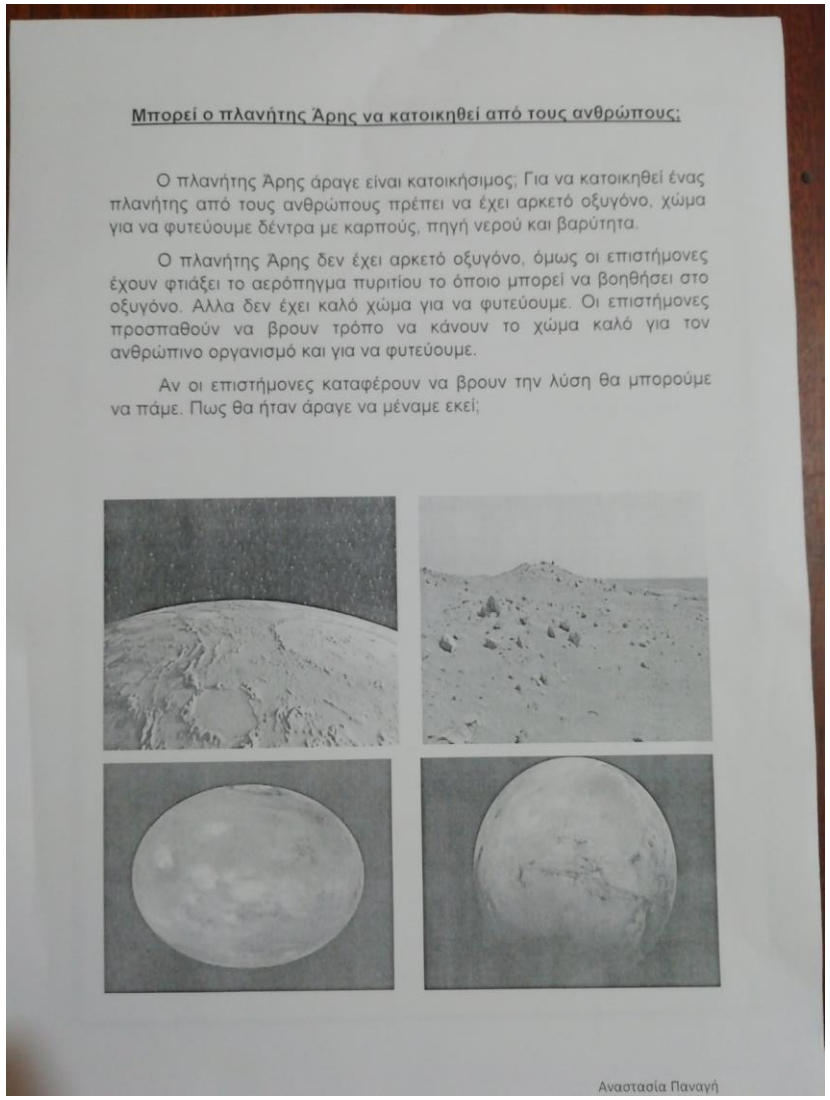
THE SOLAR SYSTEM AND THE EARTH



Μπορεί ο πλανήτης Άρης να κατοικηθεί από τους ανθρώπους;

Ο πλανήτης Άρης άραγε είναι κατοικήσιμος; Για να κατοικηθεί ένας πλανήτης από τους ανθρώπους πρέπει να έχει αρκετό οξυγόνο, χώμα για να φυτεύουμε δέντρα με καρπούς, πηγή νερού και βαρύτητα.

Ο πλανήτης Άρης δεν έχει αρκετό οξυγόνο, όμως οι επιστήμονες έχουν φτιάξει το αερόπηγμα πυριτίου το όποιο μπορεί να βοηθήσει στο οξυγόνο. Αλλα δεν έχει καλό χώμα για να φυτεύουμε. Οι επιστήμονες προσπαθούν να βρουν τρόπο να κάνουν το χώμα καλό για τον ανθρώπινο οργανισμό και για να φυτεύουμε.

Αν οι επιστήμονες καταφέρουν να βρουν την λύση θα μπορούμε να πάμε. Πως θα ήταν άραγε να μέναμε εκεί;

Αναστασία Παναγή

Learning goals (Lesson 5 - Language)

1) argue on where humans could live in case living conditions on Earth become less friendly for humans by writing an article

2) reflect upon their article based on certain (con)textual and structural criteria

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THE SOLAR SYSTEM AND THE EARTH

Rubric for Self-Assessment

I reflect upon my text (ARTICLE) and make corrections!

- What was my goal? = ...

.....

.....

- Have I accomplished my goal? YES ..... MAYBE ..... NO .....
- What did I like the most in my text? (Underline with a green color in your text)
- What did I like the least in my text? (Underline with a red color in your text)
- Check if the following criteria are included in your article.

  - YES NO

a) Introductory paragraph – main idea ....

b) 2-3 arguments supporting the main idea ....

c) Quoting scientific evidence ....

d) Concluding paragraph ....

e) No personal opinion, objectivity ....

f) Challenging headline ....

Learning goals (Lesson 5 - Language)

1) argue on where humans could live in case living conditions on Earth become less friendly for humans by writing an article

2) reflect upon their article based on certain (con)textual and structural criteria

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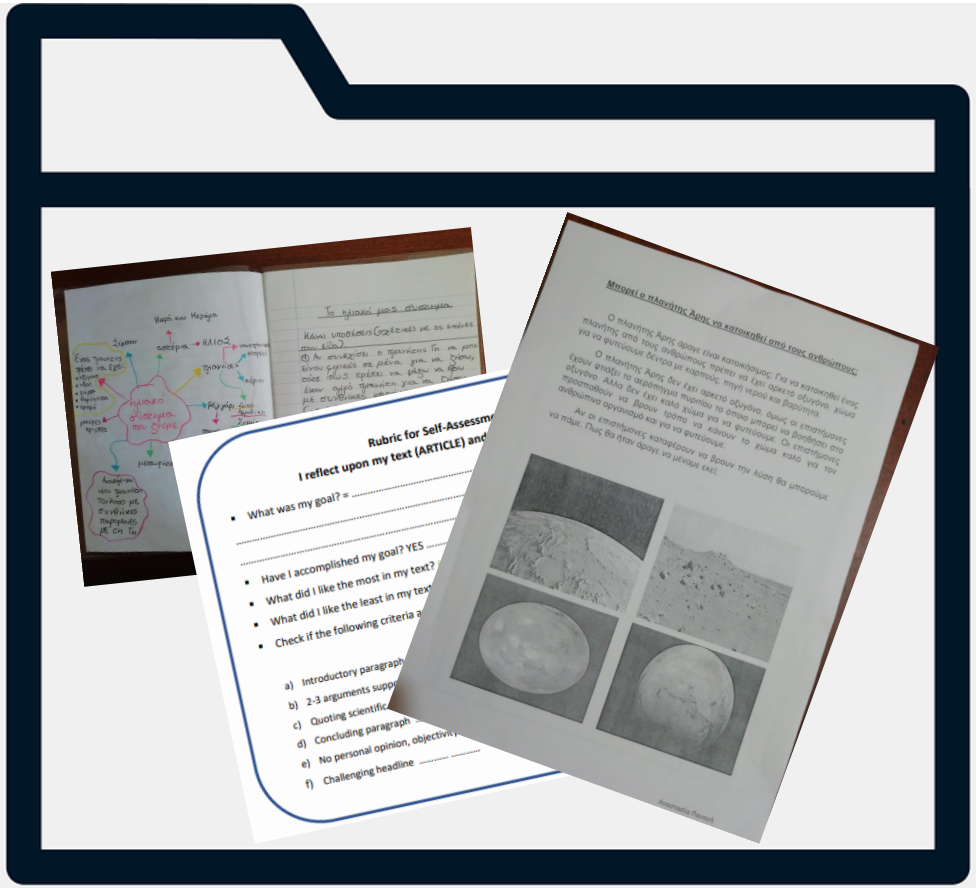
LEARNING PORTFOLIO



Critical thinking and problem solving skills:

Analyze, interpret, compare and evaluate different data to seek and validate evidence.

Creative-thinking skills:

Ability to use new knowledge derived from their analysis, comparison and evaluation of different data to write a scientific article and argue in which planet humans could live, in case living conditions on Earth become less friendly for humans.

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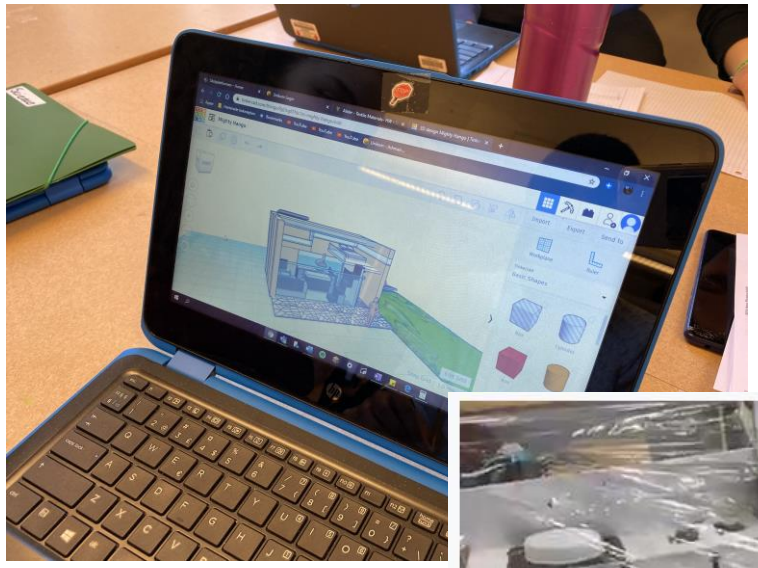
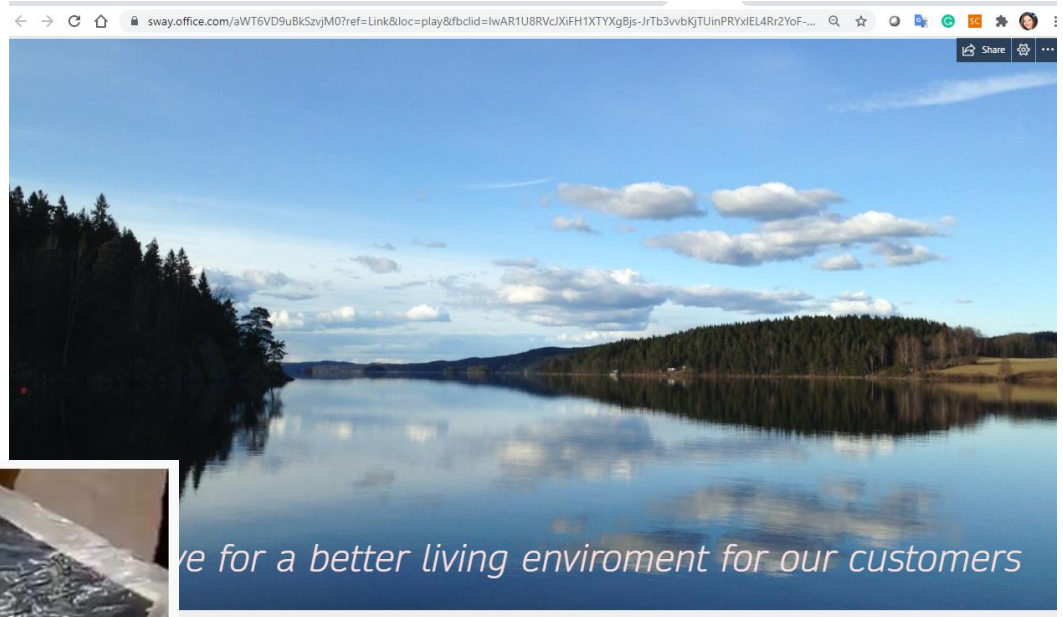
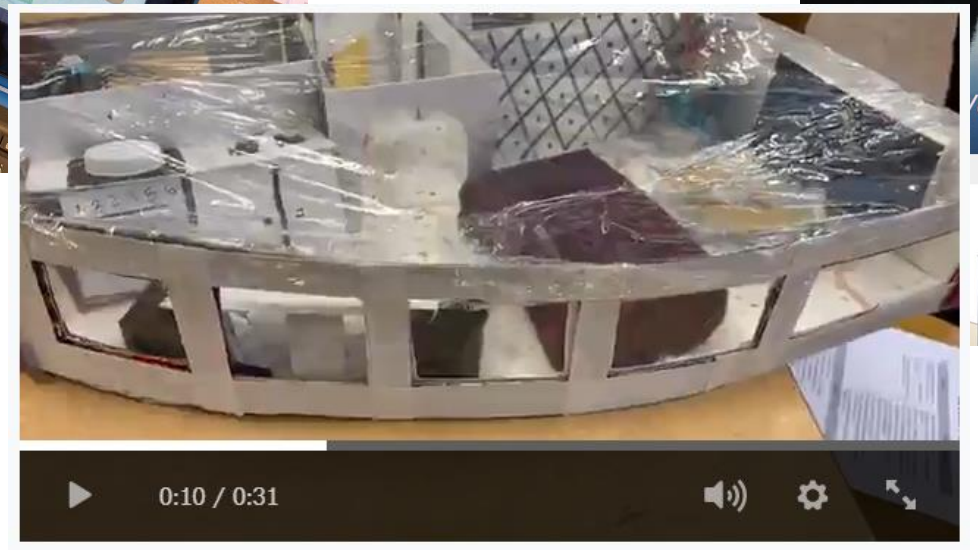
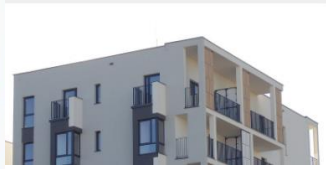
LIGHT UP FUTURE HOMES

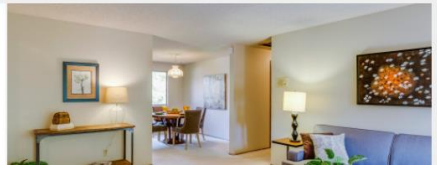
Subjects: Technology, Physics and Art (Secondary education)











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LIGHT UP FUTURE HOMES

These learning products can be stored in an electronic learning portfolio:

Local storage

Cloud storage, e.g.:

- Google drive
- One drive
- Dropbox

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ASSESSMENT BEHIND LEARNING PRODUCTS

COLLABORATIVE TASKS

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ASSESSMENT OF COLLABORATION AND COMMUNICATION SKILLS

Example of a collaboration rubric teacher may use to evaluate each student's collaboration skills.

If it is too hard to complete this rubric for every student, then train students to do it by themselves …

Student Proficiency	**Undeveloped**	**Developing**	**Accomplished**	**Advanced**
Group Communication	Little if any talking with group. Not actively listening to the speaker. Body language does not reflect engagement.	Uses voice, body language, and listening to communicate most of the time.	Voices opinions and ideas throughout the task. Voice, body, and mind are fully engaged when speaking and listening.	Additionally, uses energy, patience, and inquiry to encourage group members to communicate as well.
Role	Does not know role in the collaborative task.	Knows role, but relies on team members to assign and clarify it.	Knows own role and also the role of other team members. Uses roles of each individual to maximize collaboration.	Additionally, can assign self roles based on own strengths and weaknesses.
Contribution of Ideas	Did not contribute ideas that helped the group achieve success.	Shares ideas and acknowledges others'. However, some ideas lack detail and support.	Contributes ideas to the group and has strong reasoning and support to justify the use of those ideas.	Along with own ideas, builds on others' ideas and incorporates them in the final product.
Self Advocacy	Does not seek assistance from group when necessary.	Asks questions and for assistance from group members as a last resort.	Confidently seeks help from group members whenever necessary.	Additionally, asks others if they need assistance throughout the task.
Work Ethic	Completes few if any of the assigned tasks. Often off-task.	Completes most tasks by the deadline. Mostly on-task.	Completes all tasks by the deadline, and the work is quality and adds significantly to the group's effort.	Along with completing own work, inspires and leads group members to work hard and meet deadlines.

The Collaborative Classroom

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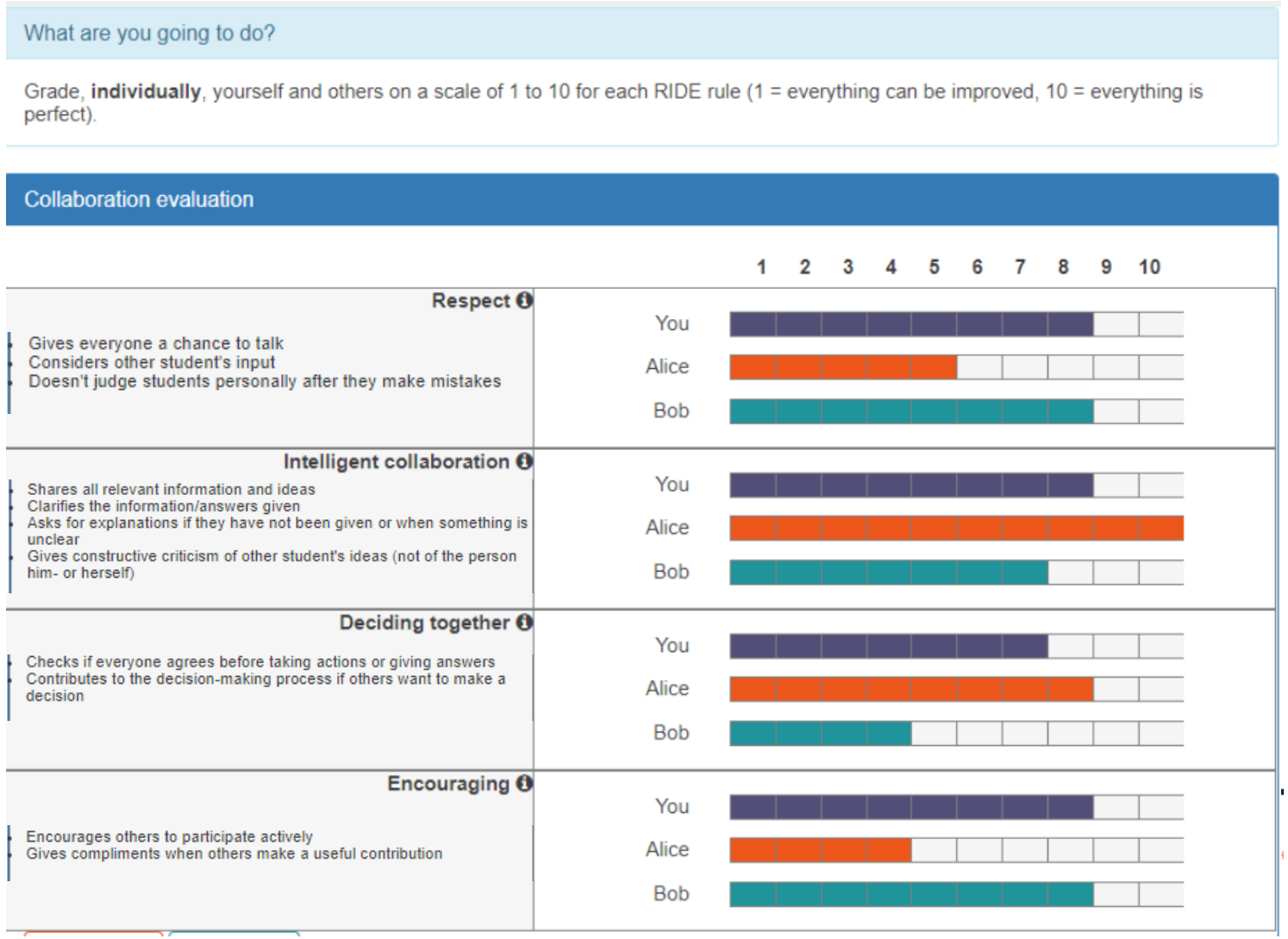
ASSESSMENT OF COLLABORATION AND COMMUNICATION SKILLS

… For example:

RIDE Assessment tool from Go-Lab (www.golabz.eu)



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IN SUMMARY

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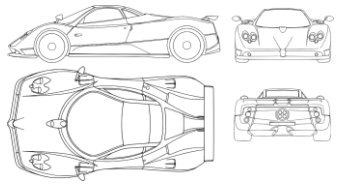


Drawing

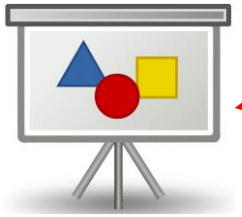
3D model

Text

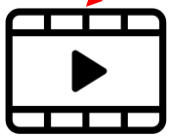
Images

Learning portfolio

Collection of learning products



Presentation



Video

Audio recording

Report /
Self-reflection
Peer Assessment
Teacher evaluation

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COVID-19 CHALLENGE

Distance and online learning → Real or electronic learning products

E-Learning portfolio → Storage of electronic files

Synchronous collaboration → Online collaboration and communication

Useful tool: Go-Lab ecosystem: www.golabz.eu

Learning analytics apps

Export to E-book (i.e., e-portfolio)

Apps for collaboration and communication

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INTEGRATED STEM LEARNING SCENARIO IN THE CONTEXT OF EDUCATIONAL ROBOTICS – FOCUS ON PEER ASSESSMENT

NIKOLETTA XENOFONTOS

UNIVERSITY OF CYPRUS

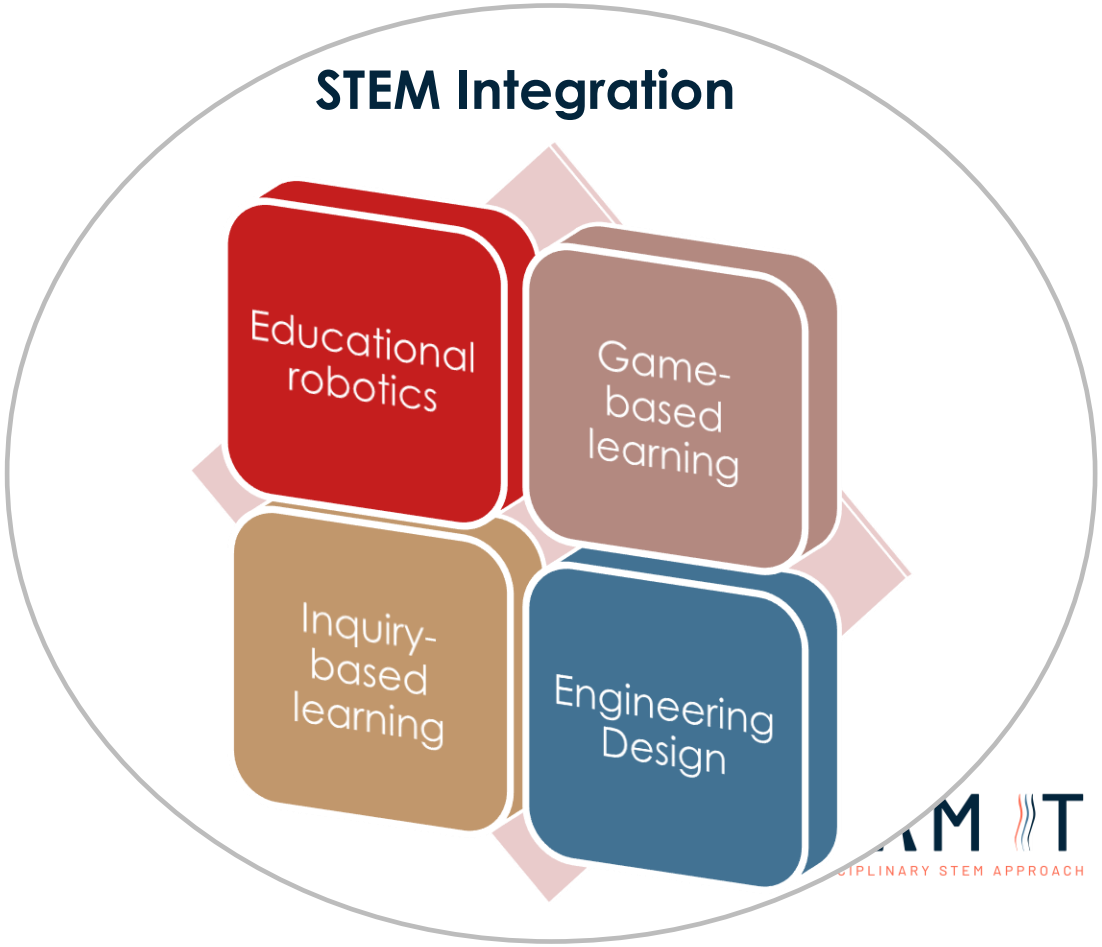
This course is co-funded by the STE(A)M IT and Scientix 4 projects, funded by the EU's ERASMUS+ programme (GA 612845-EPP-1-2019-1- BE-EPPKA3-PI-FORWARD), and EU's H2020 research and innovation programme (GA 101000063) respectively. The content of the document is the sole responsibility of the organizer and it does not represent the opinion of the European Union or the Education, Audiovisual and Culture Executive Agency, which are not responsible for any use that might be made of the information contained.

GINOBOT PROJECT

Funded by the Cypriot Research and Innovation Foundation

Consortium: ENGINO.net Ltd and University of Cyprus

Pedagogical Approach:



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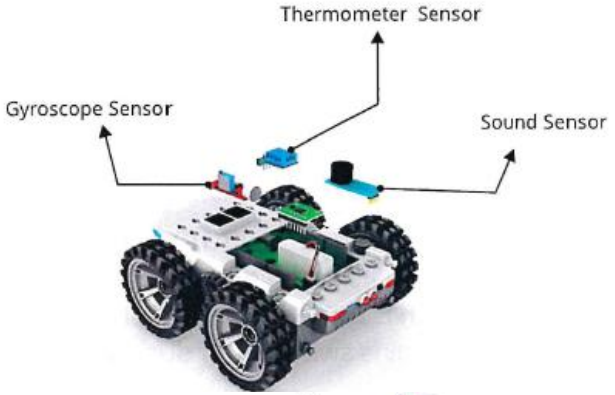
GINOBOT

BUILD-IN PERIPHERALS

1. 2x DC Motors
2. 5x Proximity Sensors
3. 2x Color Sensors
4. 1x Ultrasonic Sensors
5. 1x Buzzer module
6. 4x RGB LEDs

Optional add-on electronics



Compatible with:

ARDUINO

micro:bit

Raspberry Pi

HEXAPOD

EXCAVATOR

CRANE

HUMANOID

GRIBBER

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MARS CHALLENGE

BUDDLE OF THREE LESSONS

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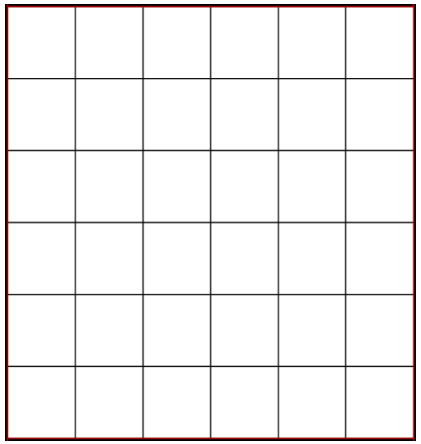
LEARNING SCENARIO – SUMMARY

Main Idea: The GINOBOT scans an unexplored, unknown surface in Mars and identifies the location of areas of interest or concern (i.e., rocks to be avoided and dusty hills to be explored).

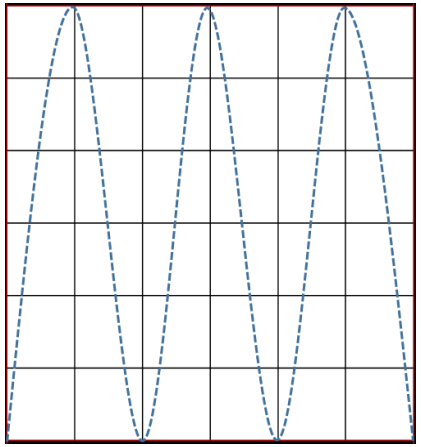
Subjects: Computer Science, Technology and Mathematics

Lesson 1: Students have to find a way to make their robot move over the entire surface and, at the same time, use the sensors of the GINOBOT to screen the surface and identify rocky areas (represented as red cells on a grid) and dusty hills (represented as green cells on a grid).

Unknown surface in the form of grid paper



Expected route that the GINOBOT should follow to scan the unknown surface



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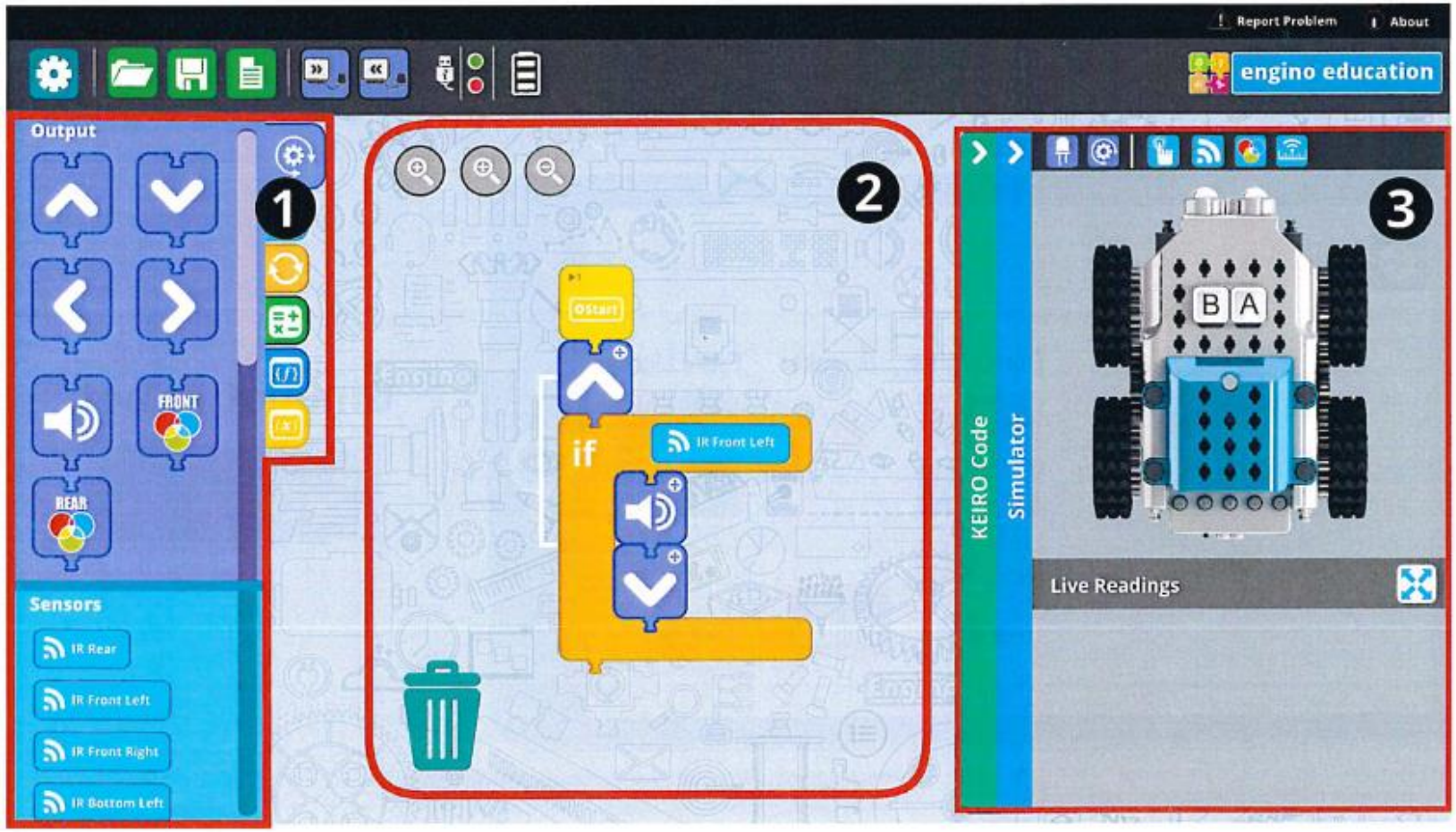
KEIRO SOFTWARE



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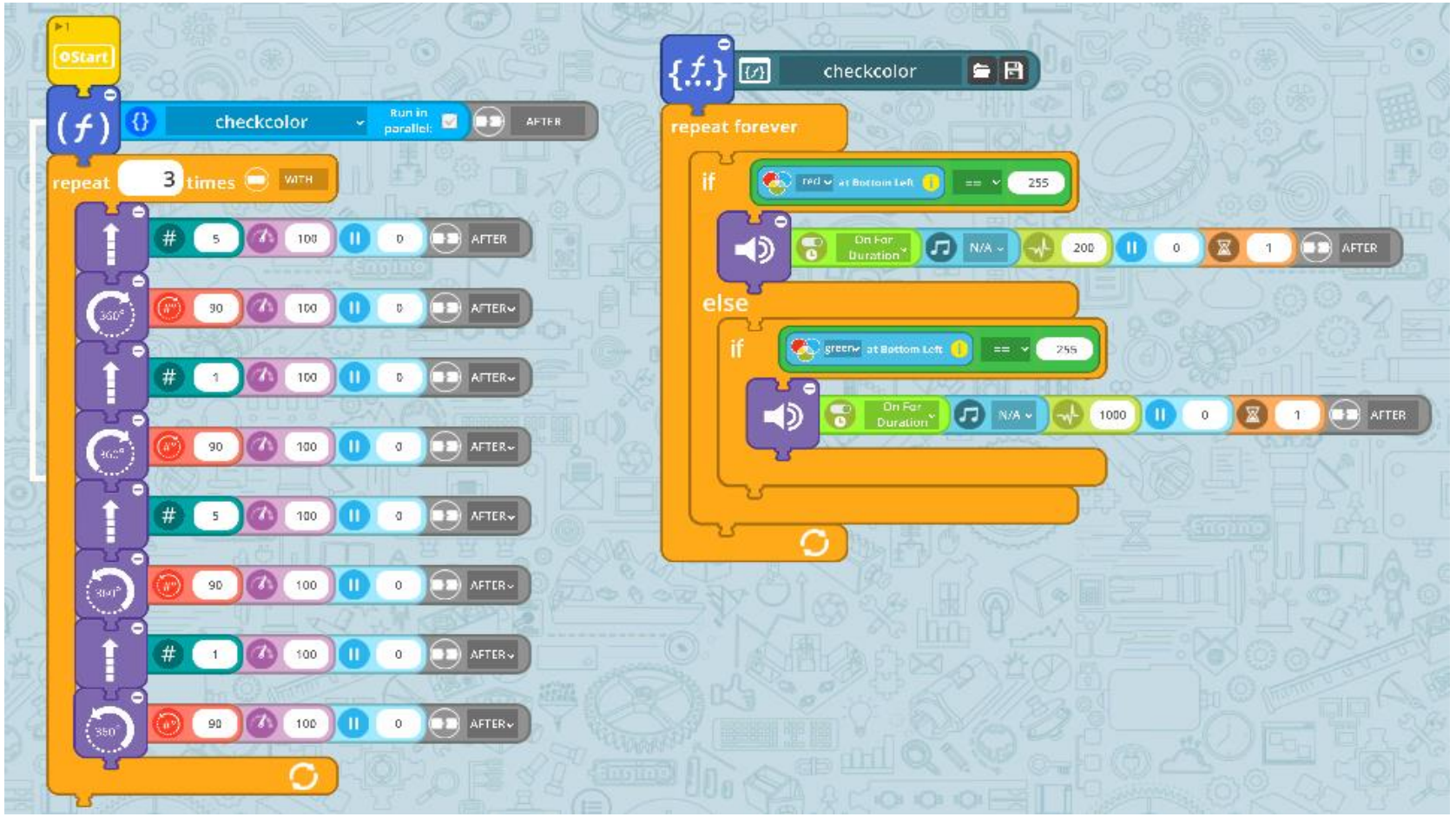
LEARNING PRODUCT – KEIRO FLOW DIAGRAM (1)



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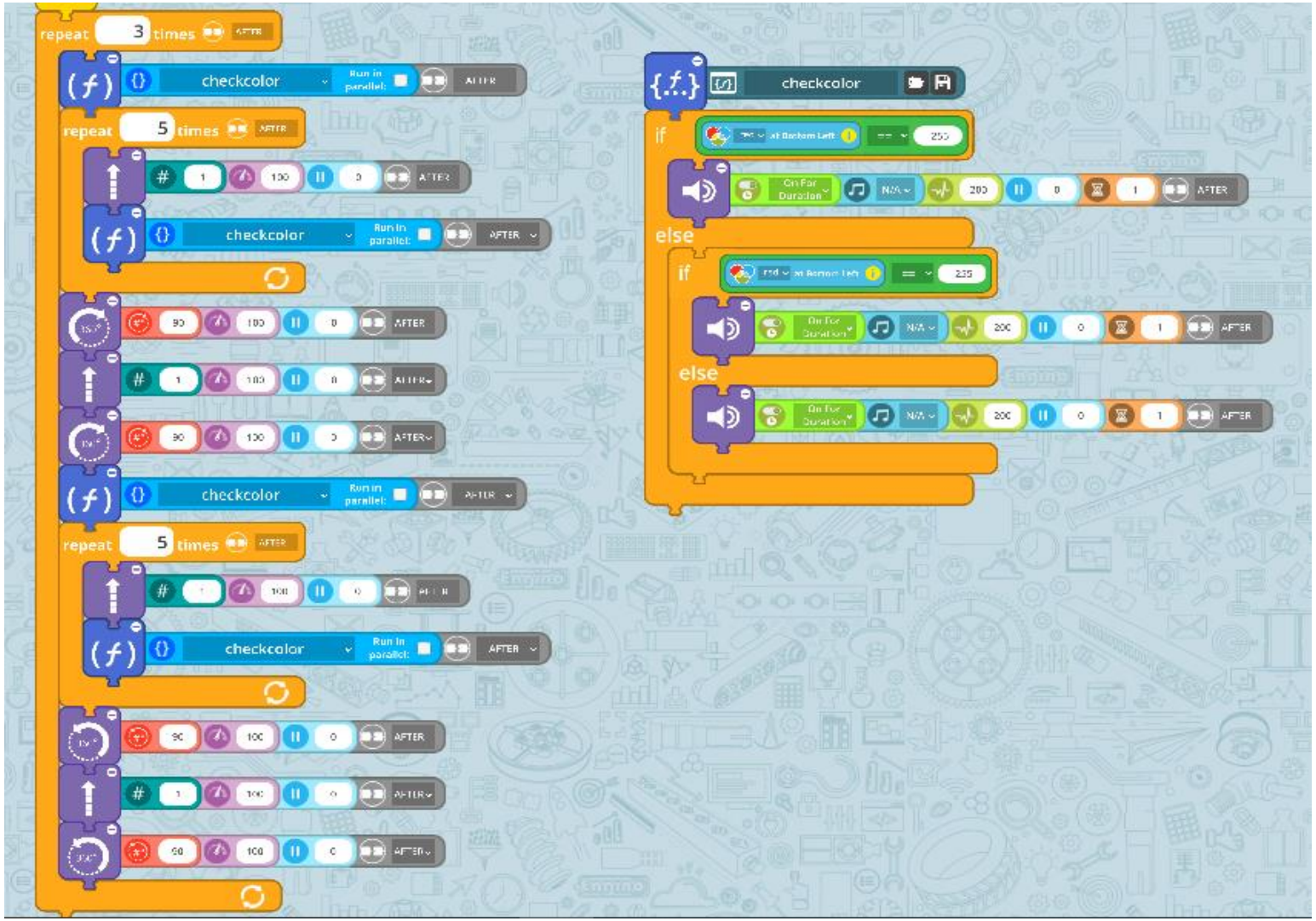
LEARNING PRODUCT – KEIRO FLOW DIAGRAM (2)



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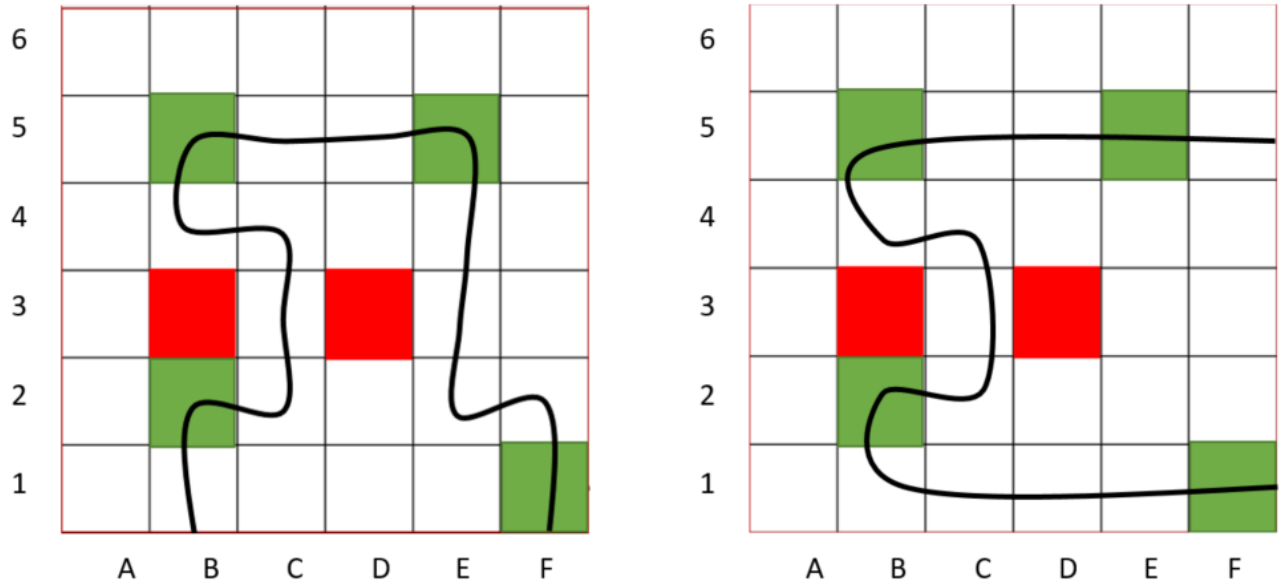
LEARNING SCENARIO – SUMMARY

Lesson 2: After screening the Mars surface (grid), students must draw a line for robots to move on the Mars surface (grid) in order to avoid rocky areas (red cells) but pass over dusty hills (green cells), where the GINOBOT will stay for some seconds for further exploration.

Line follow examples



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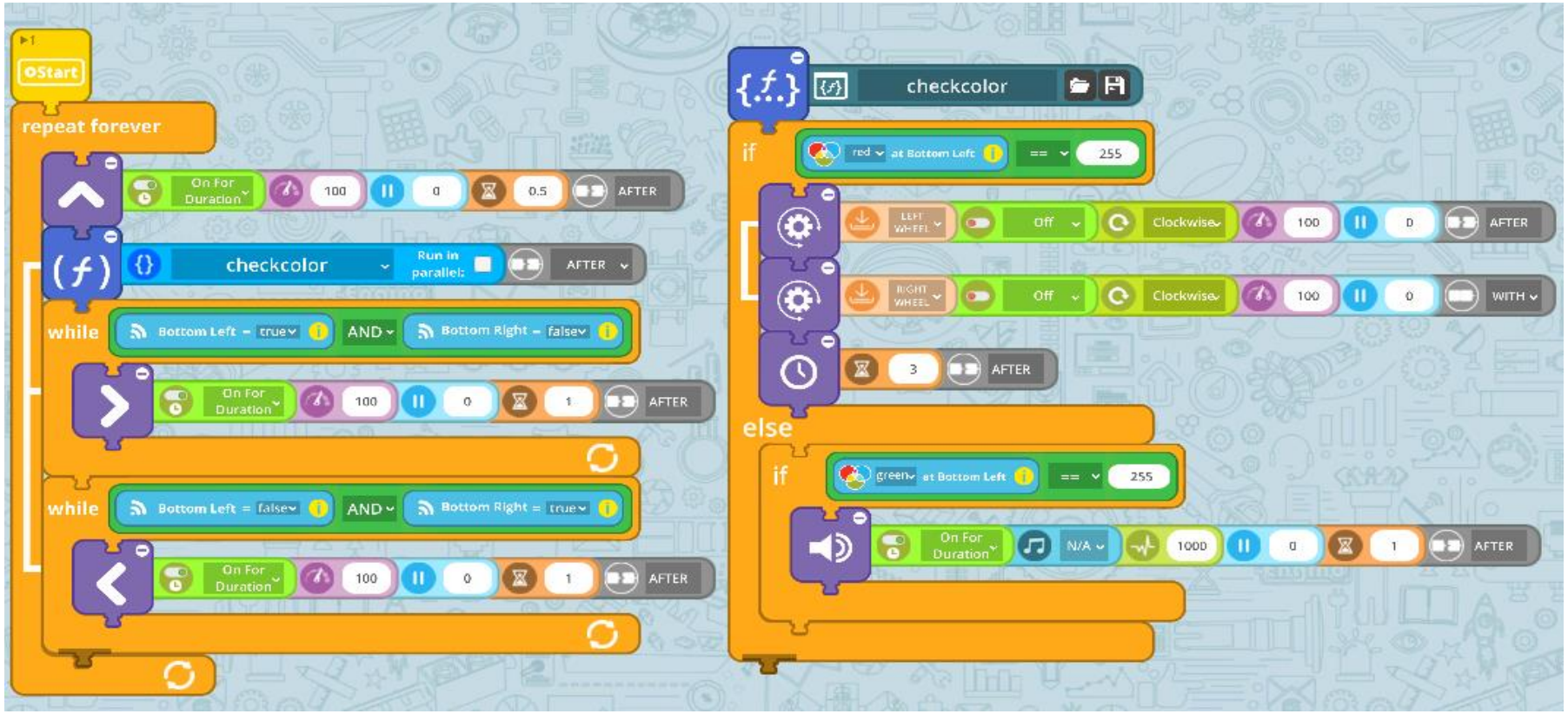
LEARNING PRODUCT – KEIRO FLOW DIAGRAM



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LEARNING SCENARIO – SUMMARY

Lesson 3: Students are assigned the role of peer assessors and peer assessees. Each group evaluates if the identification of the location of the red and green cells by another peer student group was correct. Moreover, they evaluate if the line-follow program of the assessee group worked correctly. The peer assessment process gives the opportunity to the students to improve their work. The lesson concludes with the creation of a short documentary video about their mission and a reflection on the possible next steps for continuing the Mars' challenge.

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PEER ASSESSMENT

A reciprocal process during which learners provide feedback to each other, based on a set of assessment criteria.

Type of collaborative learning

Self-reflection

Metacognitive awareness

(Bollen et al., 2017; Hovardas et al., 2014; Tsivitanidou et al., 2011)

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REFERENCES

Bollen, L., Hovardas, T. & de Jong, T. (Ed.). (2017). *Specifications, mock-ups and/or prototypes of 21st century apps, self- and peer assessment apps, ePortfolio, and modelling app*. Deliverable 3.1. Next-Lab project: Grant Agreement no. 731685

Hovardas, T., Tsivitanidou, O. E., Zacharia, Z. (2014). Peer versus expert feedback: Investigating the quality of peer feedback among secondary school students assessing each other's science web-portfolios. *Computers & Education, 71*, 133 - 152.

Tsivitanidou, O. E., Zacharia, Z., & Hovardas, T. (2011). Investigating secondary school students' unmediated peer assessment skills. *Learning and Instruction, 21*, 506-519.

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THANK YOU

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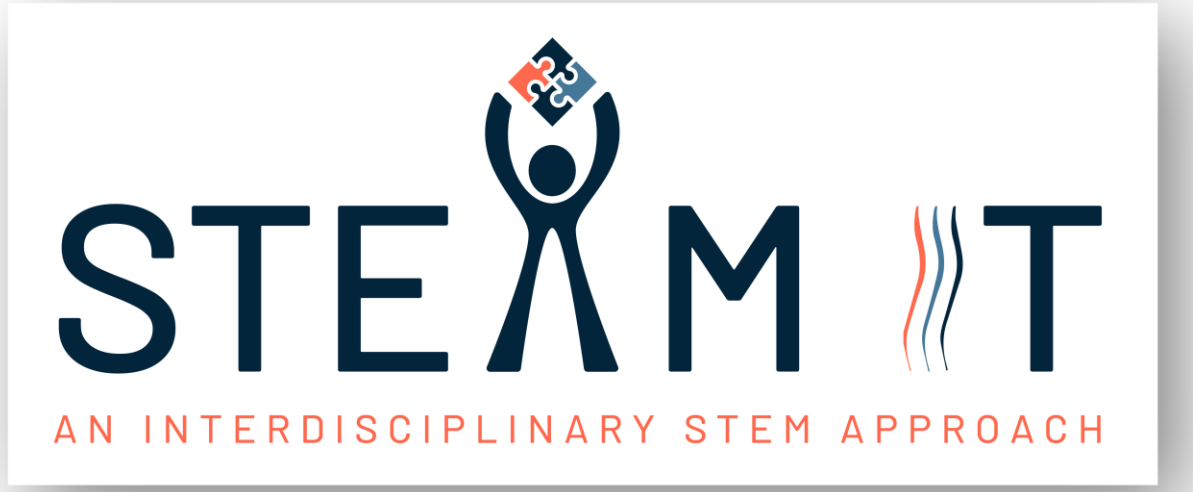

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