Applications, Tools and Perspectives of AI in Education for Secondary School Teachers

eTwinning National Support Organisation

HELLENIC MINISTRY OF Education, Religious Affairs and Sports

CTI DIOPHANTUS

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ELLINOGERMANIKI AGOGI

Discovery Space

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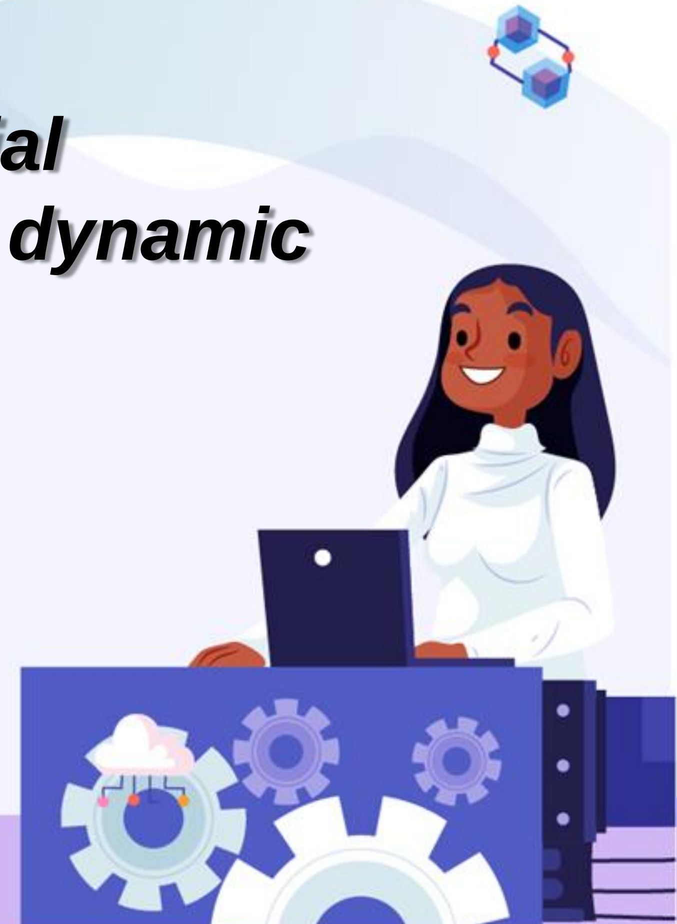
R&D Department
Ellinogermaniki Agogi

Discovery Space: artificial intelligence as a tool for dynamic student assessment



Contact Seminar

Reference Data: PISA 2015 (Standard School Environment)
Greece: 42% Low, 56% Moderate and 2% High Level Proficiency in Problem Solving

PISA 2015 Results

- Welcome to the PISA 2015 Results
- Selected Findings from PISA 2015
- Introduction
- Science Literacy
- Reading Literacy
- Mathematics Literacy
- Financial Literacy
- Collaborative Problem Solving
  - Average Scores
  - Proficiency Levels
  - Percentiles
  - Gender
  - School Poverty Indicator
  - Student Race/Ethnicity
  - Student Economic, Cultural and Social Status (ESCS)
  - Correlations
  - Standard deviations
- Trends in Student Performance
- State Results
- Methodology and Technical Notes

Overall

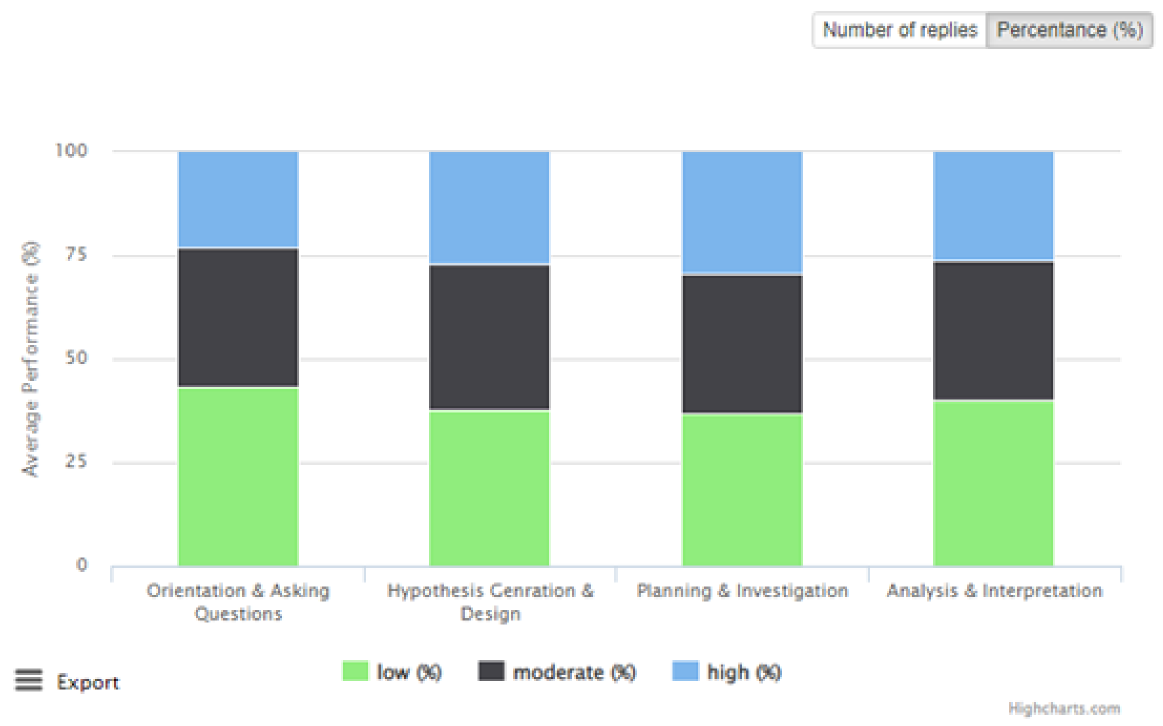
Excel Download

Table CPS2. Percentage distribution of 15-year-old students on the PISA collaborative problem solving scale, by proficiency level and education system: 2015

	Below level 1		Level 1		Level 2		Level 3		Level 4	
Education system	Percent	*s.e.*	Percent	*s.e.*	Percent	*s.e.*	Percent	*s.e.*	Percent	*s.e.*
OECD average	5.7	*0.10*	22.4*	*0.16*	36.2*	*0.18*	27.8	*0.17*	7.9*	*0.11*
Australia	4.3	*0.31*	15.6*	*0.58*	31.2	*0.61*	33.6*	*0.82*	15.3	*0.69*
Austria	4.5	*0.44*	20.2	*0.85*	35.8*	*0.99*	30.4	*1.01*	9.1*	*0.65*
B-S-J-G (China)	5.8	*0.66*	22.4*	*1.12*	37.9*	*1.16*	27.4	*1.30*	6.4*	*0.89*
Belgium	5.7	*0.49*	21.1	*0.79*	36.7*	*0.72*	29.3	*0.77*	7.1*	*0.56*
Brazil	21.2*	*0.76*	43.0*	*0.65*	27.7*	*0.74*	7.5*	*0.53*	0.6*	*0.13*
Bulgaria	15.3*	*1.14*	34.1*	*1.21*	32.6	*1.16*	16.0*	*1.02*	2.0*	*0.32*
Canada	3.4*	*0.28*	15.0*	*0.70*	32.0	*0.83*	33.8*	*0.86*	15.7	*0.66*
Chile	8.4*	*0.70*	33.9*	*1.15*	40.5*	*1.04*	16.0*	*0.97*	1.2*	*0.23*
Chinese Taipei	2.7*	*0.30*	14.2*	*0.74*	37.2*	*1.01*	36.3*	*0.98*	9.6*	*0.79*
Colombia	14.1*	*0.95*	42.3*	*0.98*	33.8	*1.00*	9.2*	*0.60*	0.6*	*0.16*
Costa Rica	9.4*	*0.63*	40.6*	*1.14*	39.6*	*1.09*	9.9*	*0.71*	0.5*	*0.15*
Croatia	6.6*	*0.64*	28.7*	*0.99*	41.8*	*1.00*	20.4*	*0.86*	2.4*	*0.31*
Cyprus	13.0*	*0.62*	36.0*	*1.08*	35.5*	*1.00*	14.0*	*0.66*	1.5*	*0.25*
Czech Republic	4.6	*0.45*	21.6*	*0.84*	39.6*	*1.00*	28.8	*1.01*	5.4*	*0.39*
Denmark	2.7*	*0.27*	16.3*	*0.80*	38.8*	*0.88*	33.4*	*0.93*	8.9*	*0.65*
Estonia	1.8*	*0.25*	13.5*	*0.69*	35.4	*1.12*	37.2*	*1.01*	12.2	*0.81*
Finland	3.4*	*0.39*	14.7*	*0.79*	32.2	*1.02*	35.2*	*0.98*	14.4	*0.77*
France	7.0*	*0.54*	22.6*	*0.73*	36.2*	*0.94*	27.6	*1.00*	6.6*	*0.53*
Germany	3.6	*0.42*	16.9	*0.84*	34.3	*0.86*	32.4*	*0.78*	12.7	*0.73*
Greece	10.4*	*1.05*	31.6*	*1.23*	37.9*	*1.07*	18.1*	*1.01*	2.0*	*0.30*
Hong Kong (China)	1.9*	*0.33*	11.7*	*0.82*	33.6	*1.13*	39.7*	*1.14*	13.0	*0.80*
Hungary	8.7*	*0.61*	28.6*	*0.97*	37.4*	*0.89*	22.0*	*0.91*	3.3*	*0.38*
Iceland	4.6	*0.50*	22.5*	*0.98*	38.1*	*1.21*	28.2	*1.03*	6.5*	*0.63*
Israel	11.5*	*0.93*	30.2*	*1.06*	30.7	*1.19*	22.1*	*1.00*	5.4*	*0.52*
Italy	7.8*	*0.61*	26.9*	*1.01*	38.5*	*1.05*	22.6*	*0.90*	4.2*	*0.52*
Japan	1.2*	*0.25*	8.9*	*0.66*	31.4	*1.05*	44.4*	*1.06*	14.0	*0.83*

Inspiring Science Programme (Inquiry-Based Instruction – data from 8000 students)
Greece: 33% Low, 40% Moderate and 27% High in complex problem solving

Class Profile

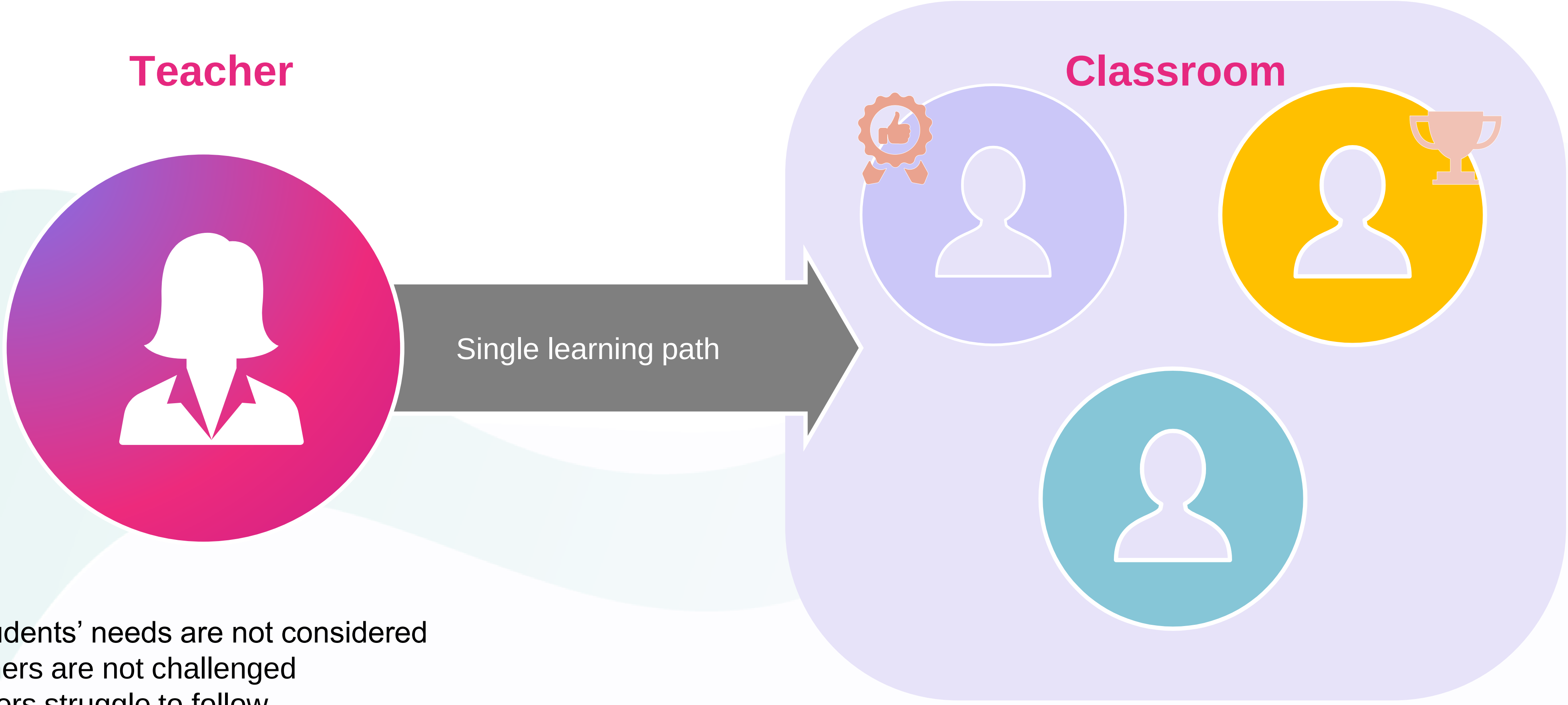


General information

Total runs:	579
Run Avg. Duration:	1:19:50
Students Participated:	12599
Students Completed PSQ:	8528 (67.7%)

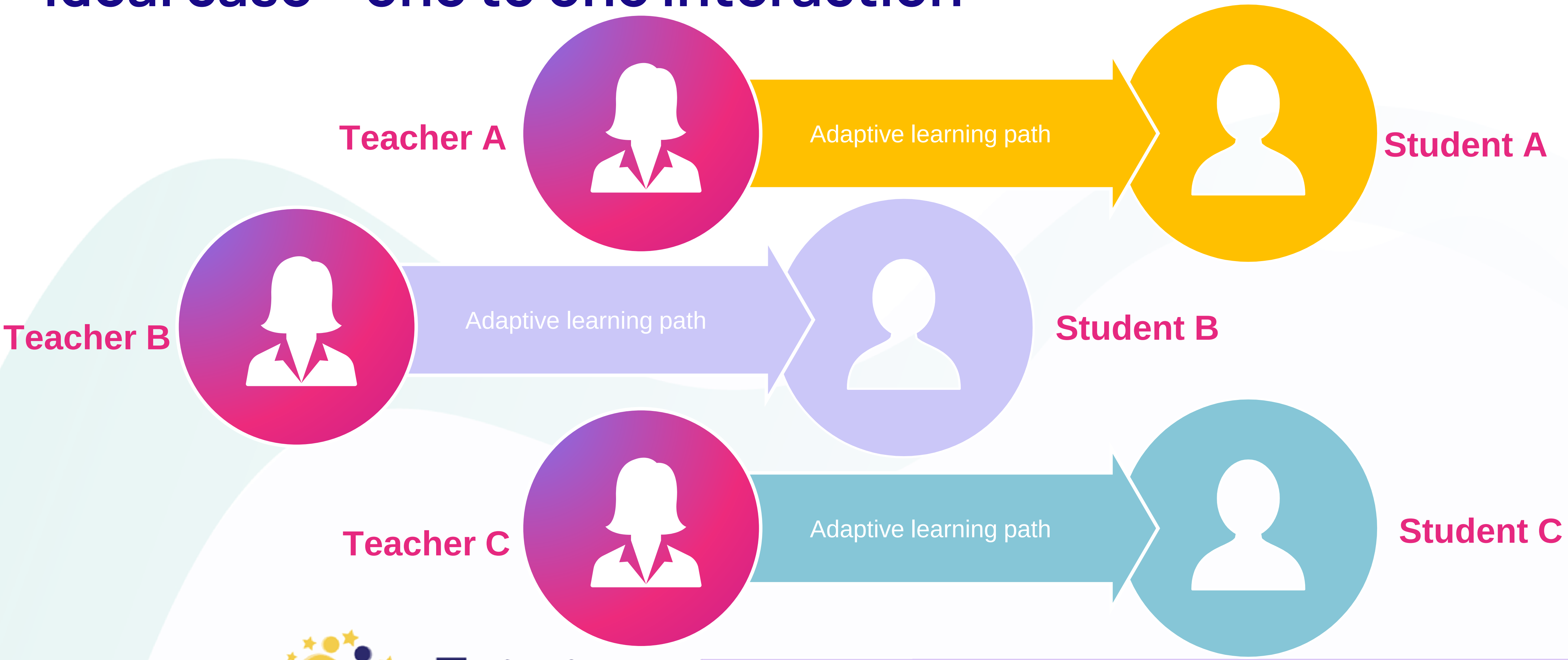
Summative assessment

Traditional Classroom Model



- Individual students’ needs are not considered
- High performers are not challenged
- Low performers struggle to follow

Ideal case – one to one interaction



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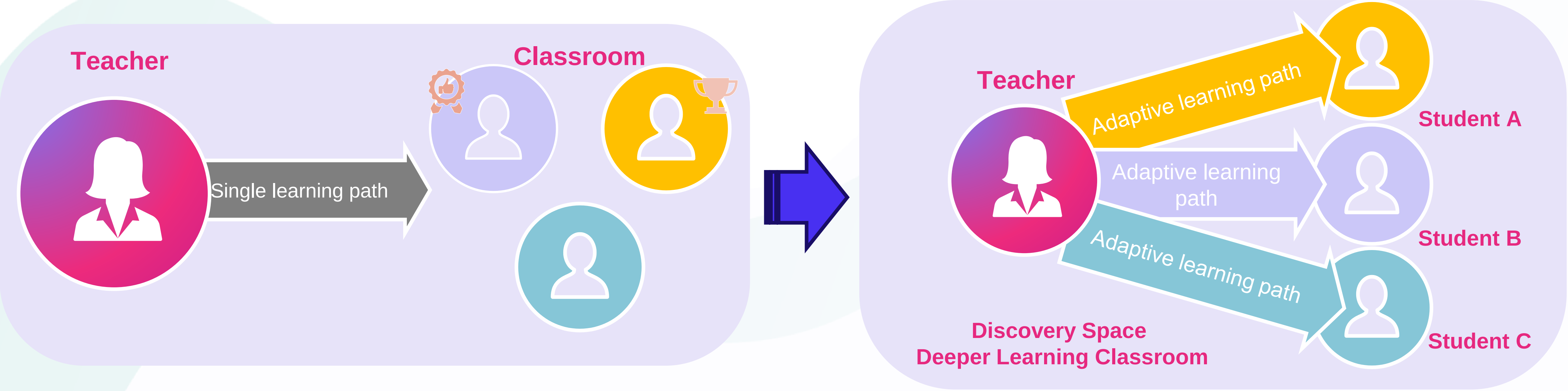
Transformation of the typical classroom



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Problem-solving in the spotlight

Definition [PISA 2015]: "*Collaborative problem-solving competence is the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution*".

Partial ability	
Exploring and understanding	The problem solver explores the problem situation
Representing and formulating	The problem solver is identifying the parameters of the problem and formulates a hypothesis
Planning and executing	The problem solver sets and executes a plan to tackle the problem
Monitoring and reflecting	The problem solver is monitoring the execution of the plan while reflecting through its different stages to validate or reject the hypotheses made

Inquiry-based learning in ELEs

In an Exploratory Learning Environment (ELE) students are encouraged to create their own knowledge by exploring the environment and making connections with their existing knowledge.

Enrich personalized instructional support

- Students encounter cognitive conflict
- Students learn through multiple representations:
  - Graphs
  - Equations
  - Animations
- Constructionism
- Students oversee their own progress

Developing the technology to support effective learning in exploratory environments still faces several significant challenges. ***Such an approach requires the adoption of AI platforms and data-based learning analytics as key technologies in building integrated lifelong learning systems to enable personalized learning anytime, anywhere and for every student. We need to exploit the potential of AI to enable flexible learning pathways and the accumulation, recognition, certification and transfer of individual learning outcomes.*** Allowing students to demonstrate their competencies while they learn is advantageous, but how this might be achieved without continuous monitoring – i.e. surveillance – is less clear.

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Virtual and remote labs

Remotely-operated educational labs ("remote labs") provide students with the opportunity to collect data from a real physical laboratory setup, including real equipment, from remote locations. As an alternative there are virtual labs that simulate the real equipment.

Advantages of remote labs

- Students learn how to operate real equipment
- Realistic view on scientific practice
- ***Measurement of errors***

Advantages of virtual labs

- Experiment without any cost
- Experiments can be repeated easily
- Reality can be adapted to serve the learning process

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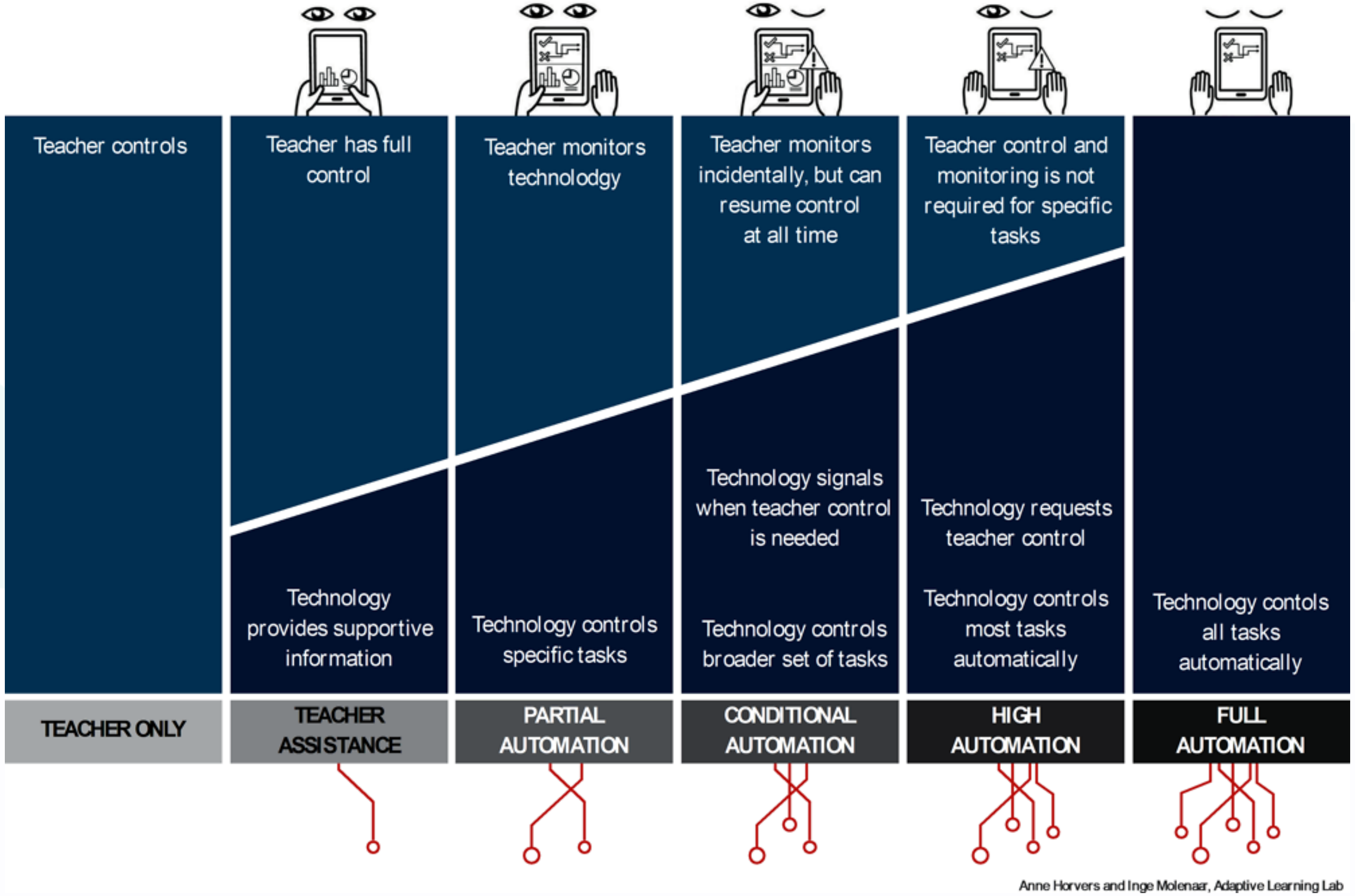
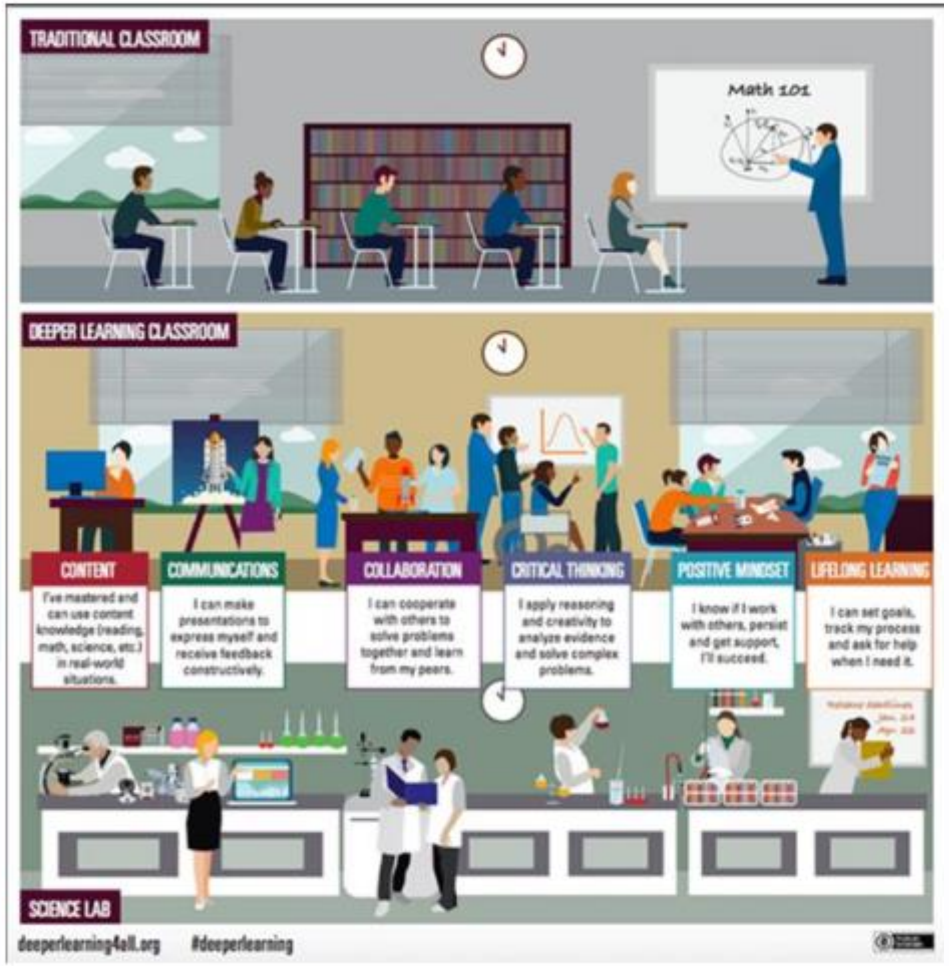
Six levels of automation of personalized learning



Source: Illustration - Anne Horvers and Inge Molenaar, Adaptive Learning Lab https://www.ru.nl/bsi/research/group-pages/adaptive-learning-lab-all/

Towards the Deeper Learning Classroom for STEM

Merge the traditional classroom with an actual science lab to fully exploit the advantages that both have to offer → AI-Enhanced Deeper Learning Classroom → Personalized learning with the help of the AI conversational agent, fostering inquiry-based learning



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Project goals

An AI conversational agent is continuously monitoring every student and provides targeted feedback.

Implementation of formative assessment of the students' problem-solving competence in real time.

The teacher is monitoring the whole process and decides when to resume control.

Each teacher can create his/her own educational scenario and uploads it to the portal.

The use of AI is combined with VR and AR laboratories.

A number of educational scenarios, for the STEM courses, should be created to acquire data and "train" the AI algorithms

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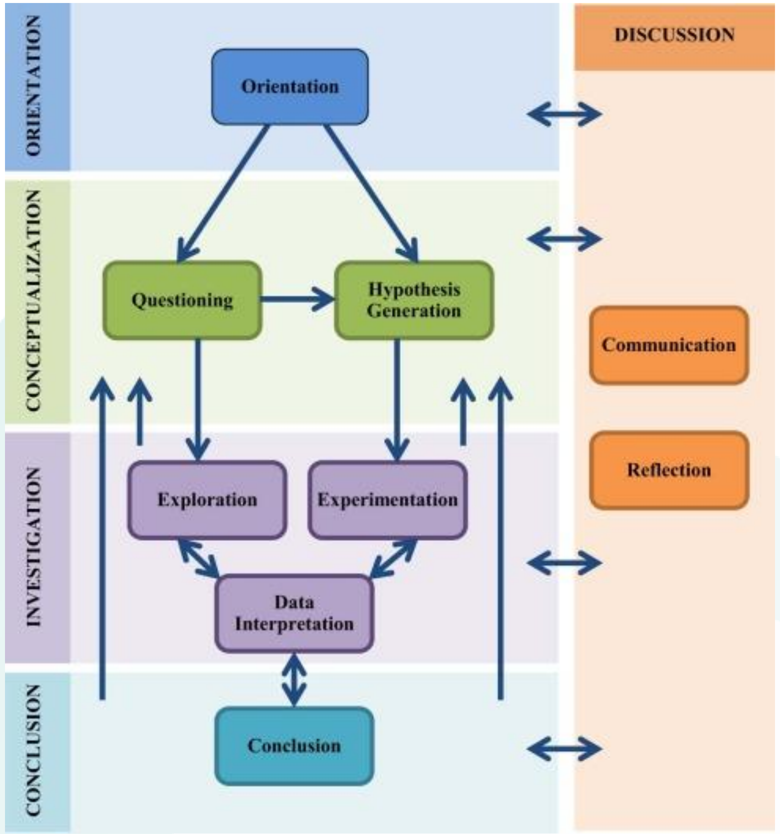
Phases of inquiry model

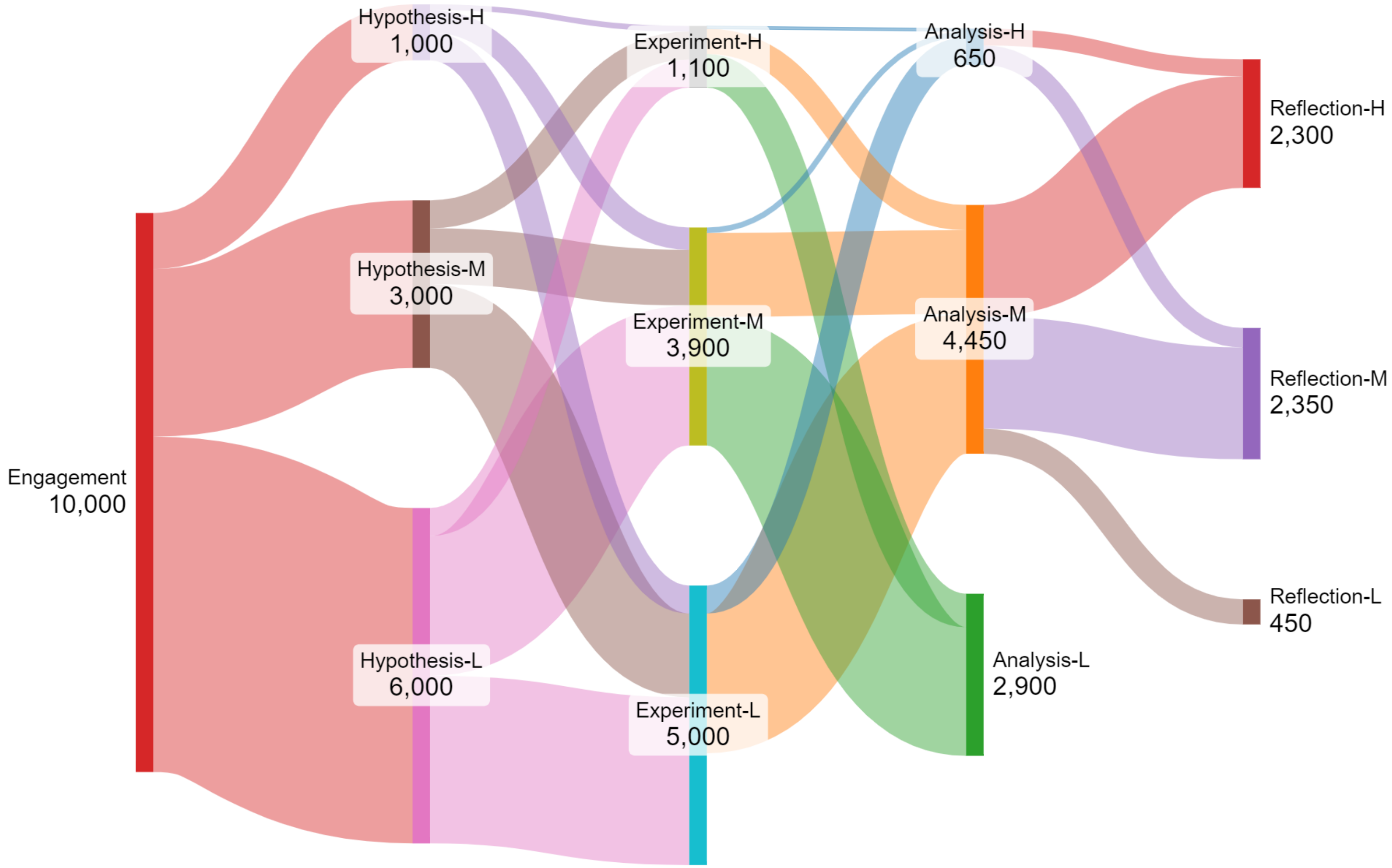


Pedaste *et al*., Educ. Res. Rev. **14**, 47 (2015)

1. **Engagement**: A phenomenon is presented to the students through an appropriate demonstration, to spark their interest and motivate them to work on its understanding.
2. **Hypothesis**: The students are asked to make a hypothesis to explain the phenomenon by identifying the main parameters for its explanation.
3. **Experiment**: At this stage the students are performing experimental work, using either a virtual or a remote lab, in order to see the effect that each identified parameter has on the phenomenon under discussion.
4. **Data analysis**: The sets of data collected at the previous phase are now analyzed and conclusions are drawn, which either reject or validate the hypothesis made at the second step above.
5. **Reflection**: At this stage the students reflect on what they have learned so far, while they are presented with a series of more demanding questions aiming to test how confident they are on their understanding.

Figure 4: The workflow of an inquiry-based scenario. The scenario consists of five different phases, while students who are demonstrating lower level of understanding are receiving additional scaffolds by the AI learning companion. This is shown here as exiting the phase and entering a loop before moving forward, demonstrating the learning cycle approach that is introduced.

Personalized learning paths



1. Describe the photoelectric effect and the setup necessary for its observation
2. Use the PhET platform to perform virtual experiments
3. Spot the weaknesses of classical Physics in the description of the photoelectric effect
4. Understand the photoelectric equation and the relative graphs
5. Learn about different applications of the photoelectric effect

Photoelectric effect: workflow plan

Engagement	Hypothesis	Experiment	Analysis	Reflection
Students observe the photoelectric effect through different demonstrations	Students create a hypothesis based on previously taught knowledge	**Students are performing experimental work using a virtual lab**	Explanation based on evidence – data analysis	Understanding the importance of the photoelectric effect in "real life" situations

Action needed for students with low performance

Guidance for students with moderate performance

Loop

Phase 1: Engagement of the students*

- The photoelectric effect is introduced to the students through one of its applications. A circuit consisting of a photocell and an amperometer is presented to the students. Then the students are asked to shine light (sunlight for example) onto the surface of the cell and observe the indication on the amperometer. Accordingly the surface of the cell is covered and the indication on the amperometer is recorded again by the students. Why do you think there is current (flow of electrons) in the circuit?

- Another demonstration in order to intrigue the students and try to make them get an experiential understanding of the photoelectric effect through a classical analogue is the following: An object weighting around 2.5 Kg is placed onto a table. The teacher is distributing very light ping-pong balls to the students and asks them to throw them *simultaneously* to the object in order to make it fall from the table. Then a basket ball is thrown by the teacher to the object and the object falls off the table. The object falling from the table symbolizes the release of an electron.

***Previous knoweledge of wave theory and Planck's hypothesis for the black body radiation is assumed**

1. Assume that the Sun is behaving like a black body, then according to Planck's hypothesis:
   A. The Sun emits radiation continuously
   B. Radiation gets emitted by the Sun only in discrete packets
   C. Both can happen

2. What do you think happens so that the amperometer records current? :
   A. Some emitted packets by the Sun have enough energy to release electrons from an atom of the cell
   B. No matter what the energy of the packet is, if we wait for a long time electrons will flow on the circuit anyway, since several packets would have been absorbed
   C. Both can happen

	Low	Moderate	High
1	A or C	B	B
2	B	C	A
Actions	Repeat and exaplain black body radiation emission-Planck hypothesis	Provide guidance in conjuction with demonstration 2	Move to the next phase

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LOW performers

- ***Energy gets emitted or absorbed in discrete packets.*** **An electron can absorb only a single energy packet (it is extremely unlikely for more than one packages to be absorbed)**. According to Planck the energy of a packet is E = nhf. This energy should be:
   A. Greater or equal to the energy keeping the electron bound to the surface of the cell
   B. Negative
   C. Half of the energy keeping the electron bound to the surface of the cell

If NOT A – provide detailed explanations

MODERATE performers

Guidance:
An electron can absorb only a single energy packet (it is extremely unlikely for more than one packages to be absorbed). With that in mind do you think that the electron ejection depends only on the number of the absorbed energy packets?:

A. Yes it should be
B. No
C. Can not tell

If NOT B – move to low performer & provide detailed explanations

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Phase 2: Hypothesis

In this phase students are called to create and test a hypothesis. The critical parameters for the understanding of the photoelectric effect have to be defined, namelly:

- The frequency (wavelength) of the light and accordingly its connection to the photon energy
- The intensity of the light and how its previously given definition should be modified in order to interpret the observations

1. Consider the demonstration with the ping-pong balls and the basket ball in the previous section. The object falling of the table symbolizes the release of electrons. Then:
   A. The number of balls is important for the release of electrons – with each hit the object is slightly moving till it falls off
   B. The kind of ball that we are throwing is the crucial parameter – no matter how many ping pong balls we are going to throw the object will never fall
   C. Both the number of balls and the kind of ball can release electrons
2. With Planck's hypothesis in mind, which of the following you think is correct:
   A. The mass of the ball should correspond to the frequency of a packet and the number of balls to the intensity of a beam of such packets
   B. The exact opposite from what is mentioned above is correct
   C. Neither of the previous is correct

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	Low	Moderate	High
1	A	C	B
2	B or C	B or C	A
Actions	Provide explanations and guidance -actions in phase 1	Provide guidance - Move to the next phase	Move to the next phase

LOW and MODERATE performers

- **The ping-pong ball is a low energy packet while the basket ball is a high energy packet. The energy of a packet is defined by the frequency according to Planck's hypothesis. Fill in the following table to get an idea of how the wavelength (frequency) affects the energy. E = nhf, set n=1 and *mind the units*.**

λ (nm)	f (Hz)	E (eV)
800		
1		

Hint $c=\lambda f$

$1\ eV = 1.6\times10^{-19}\ J$

$c = 3\times10^{8}\ m/s$

$h = 6.62\times10^{-34}\ J/Hz$

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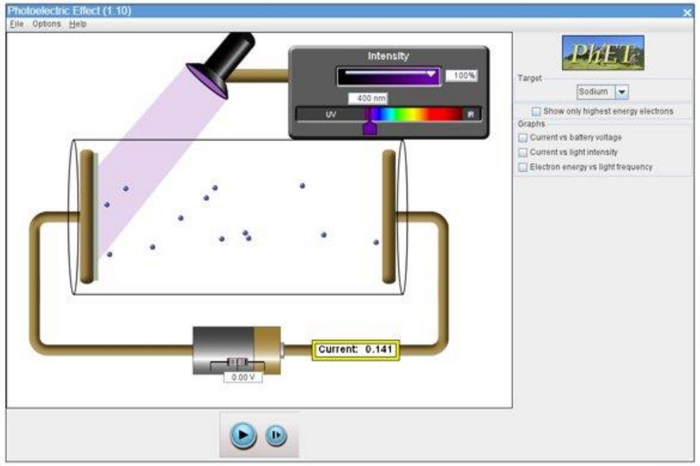
		Low	Moderate	High
Phase 1	1	A or C	B	B
	2	B	C	A
Phase 2	1	B	A	A
	2	B or C	B or C	A
Action		Extended use of the PhET platform – provide guidance and explanations at all phases	Extended use of the PhET platform – provide guidance	Use the PhET platform - advanced questions – applications of the photoelectric effect in the reflection phase

Phase 3: Experiment - Gather evidence from observations

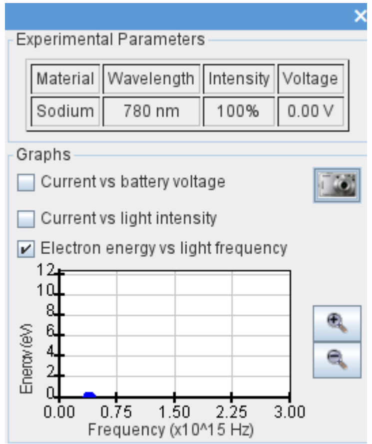
- Use the virtual lab https://phet.colorado.edu/sims/cheerpj/photoelectric/latest/photoelectric.html?simulation=photoelectric to test the hypotheses made in the previous phase and either validate them or reject them.
  - Which is the crucial parameter for the ejection of electrons?
  - What happens as the intensity of the light is changing?
  - What is the impact of the applied voltage on the recorded current?
  - What do you observe as the frequency of the light increases?

Experiment 1

- Choose the material of the cathode to be Sodium. Set the intensity of the light at 100%. Click on the "Electron energy vs light frequency" box. Set the value of the wavelegth to 780 nm. Do you observe the ejection of electrons? Decrease the wavelength in steps of 20 nm until you start seeing ejected electons. At each step note if you observe the ejection of electrons or not. Create a table like in the example below.



Wavelength (nm)	No electron ejection	Electron ejection
780	✓	
...		
260		✓



- Record the value of wavelength for which you get photoelectrons (Think of how you can get an accurate value)

- While you were varying the wavelength, a graph showing the dependence of the electron kinetic energy from the frequency should have been plotted.

Experiment 1 - Results

1. According to your measurements:
   A. The ejection of electrons depends on the frequency and there is a critical value
   B. The ejection of electrons depends on the frequency and the intensity
   C. The ejection of electrons depends only on the intensity
2. As you decrease the wavelength the energy of the light beam is:
   A. Decreasing
   B. Increasing
   C. Remaining the same
3. As the wavelength decreases, the number of ejected electrons:
   A. Increases
   B. Decreases
   C. I can't tell while the intensity is set at 100%
4. The value for which you observe the ejection of electrons in the plot and the one obtained from your table:
   A. Are very close to each other
   B. Are completely different
   C. Are the same if one of them is multiplied by ten

Experiment 1 - Results

	Low	Moderate	High
1	C	B	A
2	A or C	B	B
3	B or C	A	A
	B or C	A	A
Actions	Provide detailed explanations	Provide guidance – move to experiment 2	Move to experiment 2

- Since the intensity was kept constant during the experiment it can not affect the ejection of electrons. **If you varied the intensity repeat the measurements and keep it fixed**. The value you get from the table should be very close to the value that you get from the graph. *As the frequency increases electrons from **deeper energy levels** can be ejected.*

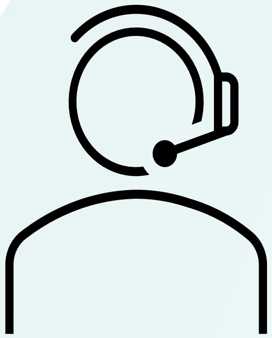
1. The frequency of the light is the only crucial parameter for the ejection of electrons and there is a threshold value. This statement is:
   A. True
   B. False
   C. It is the frequency and the max intensity that defines the ejection of electrons
2. Using the Planck hypothesis, the energy of the light beam is given by $E = hf = hc/\lambda$, thus as the wavelength increases, the energy of the light beam:
   A. Decreases
   B. Increases
   C. Remains constant

Low performer

If 1.B & 2.A or C LOW – detailed explanations
If 1.C & 2.B MODERATE – repeat experiment carefully (fast) – *constant intensity*
If 1.A & 2.B HIGH - move to the next experiment

Moderate performer

- **Guidance**: The intensity was supposed to be kept fixed during the measurements. Thus the ejection of electrons depends only on the value of the frequency (wavelength) chosen not the intensity. From your table, keep the intensity constant and vary the frequency around the critical value.
- Do you observe the ejection of electrons vanishing when the frequency is lower than the critical value:
  A. Yes
  B. No
  C. It's a trap, the intensity matters



If C move to low performer »

If B provide detailed explanations – show the effect using the platform

If A move to the next experiment

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info@discoveryspace.eu

English

Discovery Space

dkoulentianos

Dashboard Log out

My ELEs My groups

New ELE

Φωτοηλεκτρικό φαινόμενο	Εκκρεμές	Photoelectric effect

Save

Scenario: Photoelectric effect

Preview

Name of the ELE min. 2 characters

Photoelectric effect

Language *

Minimum age >= 0

16

Maximum age <= 18

18

Subject min. 2 characters

Physics

Duration (minutes)

700

Phase 1:

Engagement

Activity 1:

Planck hypothesis

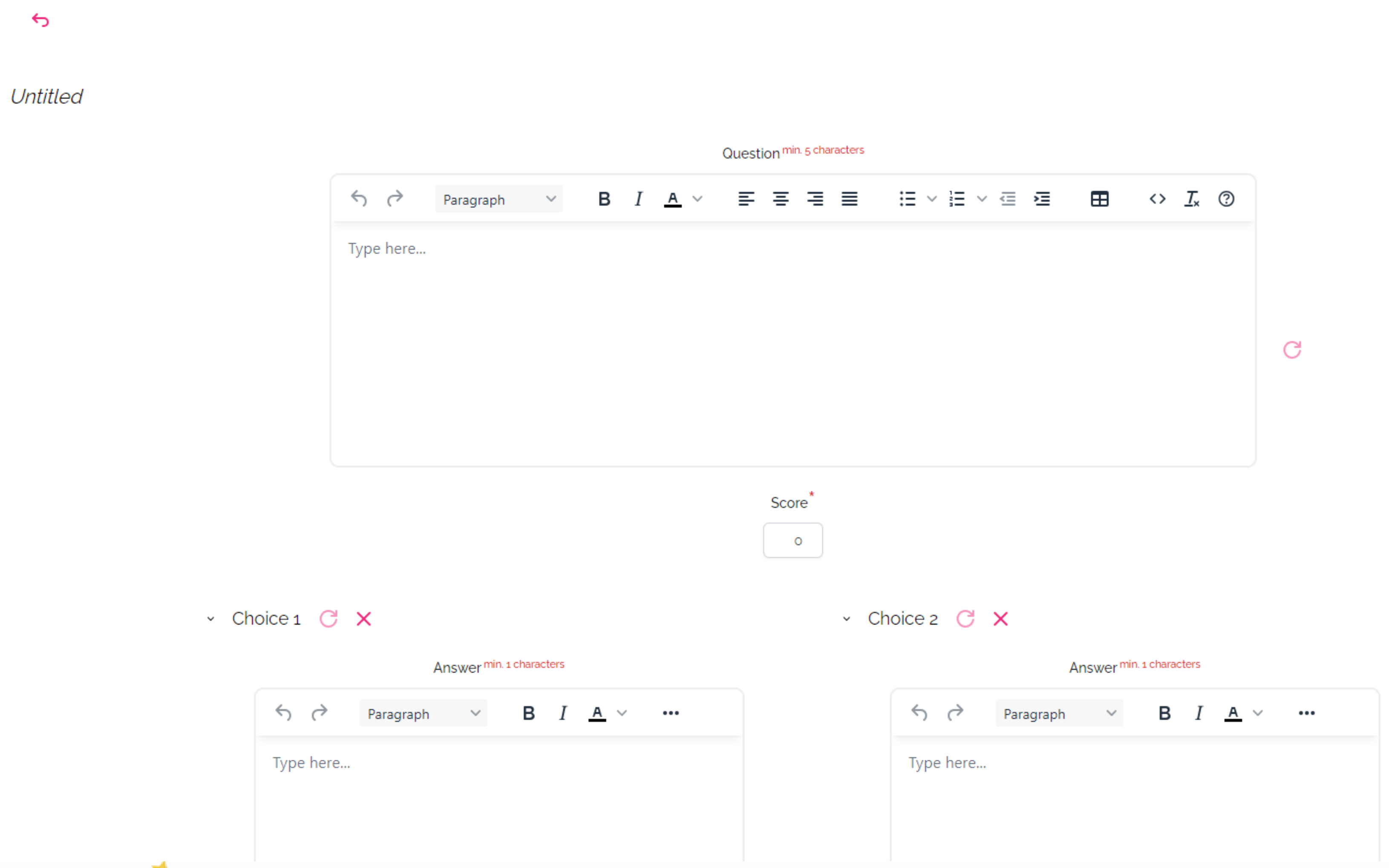
Add an activity

Phase 2:

Hypothesis

Activity 2:

Demonstration


Untitled
Question min. 5 characters
Paragraph
Type here...
Score *
0
Choice 1
Choice 2
Answer min. 1 characters
Paragraph
Type here...
Answer min. 1 characters
Paragraph
Type here...

Discovery Space

dkoulentianos

Dashboard Log out

Low performer	Moderate performer	High performer
If the final grade is < than 20	If the final grade is <= than 75	If the final grade is > than 75
then	then	then
Next	Next	Next
feedback: Your performance was below average.	feedback: Your performance was average.	feedback: Your performance was above average.

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English

Discovery Space

dkoulentianos

Dashboard Log out

Assume that the Sun is behaving like a black body, then according to Planck's hypothesis:

1. The Sun emits radiation continuously
2. Radiation gets emitted by the Sun only in discrete packets
3. Both can happen

Submit

Experiment

Save

Activity: Frequency dependece

Preview

Next

Name of the activity min. 5 characters

Frequency dependece

Age*

17

Language*

Subject min. 5 characters

Physics

Short description min. 5 characters

Paragraph

Clarify how the frequency of the light affects the ejection of electrons

Experiment description*

Paragraph

Choose the material of the cathode to be Sodium. Set the intensity of the light at 100%.
Click on the "Electron energy vs light frequency" box. Set the value of the wavelegth to 780 nm.
Do you observe the ejection of electrons? Decrease the wavelength in steps of 20 nm until you start seeing ejected electons.
At each step note if you observe the ejection of electrons or not. Create a table like in the example below.

Record the value of wavelength for which you get photoelectrons (Think of how you can get an accurate value)
While you were varying the wavelength, a graph showing the dependence of the electron kinetic energy from the frequency should have been plotted

Select an experiment

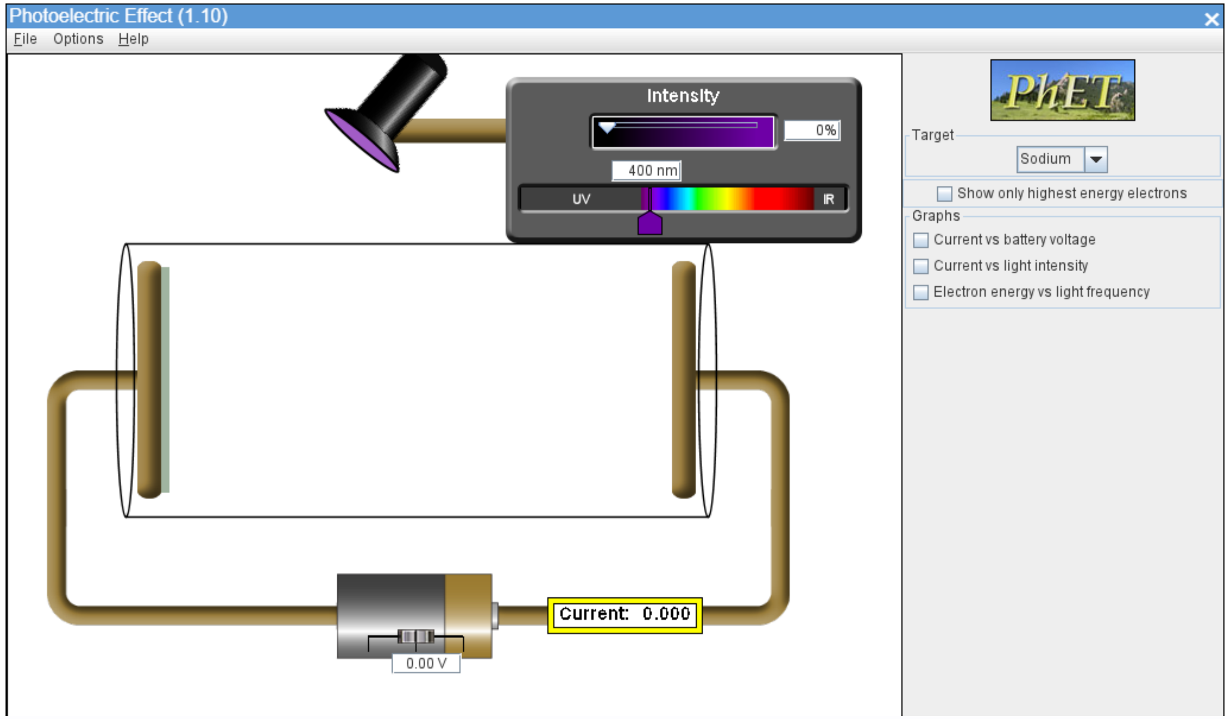
LabsLand VLab PhET Other

Search a simulation

HTML5 Java (CheerpJ)

Acid-Base Solutions | Alpha Decay | Area Builder | Area Model Algebra | Area Model Decimals

Choose the material of the cathode to be Sodium. Set the intensity of the light at 100%.
Click on the "Electron energy vs light frequency" box. Set the value of the wavelegth to 780 nm.
Do you observe the ejection of electrons? Decrease the wavelength in steps of 20 nm until you start seeing ejected electons.
At each step note if you observe the ejection of electrons or not. Create a table like in the example below.
Record the value of wavelength for which you get photoelectrons (Think of how you can get an accurate value)
While you were varying the wavelength, a graph showing the dependence of the electron kinetic energy from the frequency should have been plotted



- https://dspace.deustotech.eu/login

- test-AIworkshopN (N=1,2,3,…)
- Password: saturday

Your feedback is extremely useful and will be appreciated very much

Contact me at **dkoulentianos@ea.gr**

CONSORTIUM

meet the team

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Thank you very much!