



UNIVERSITY OF
WESTERN MACEDONIA

Designing Inclusive Learning Activities for Nanoscience in Primary Education

Contributors:

Konstantinos Alexiou

Giorgos Peikos

Angelos Sofianidis



This study presents the implementation of Universal Design for Learning (UDL) in the teaching of a challenging science topic, namely Nanoscience and Nanotechnology, in primary schools.

Contributors:

Konstantinos Alexiou

Giorgos Peikos

Angelos Sofianidis

Nanoscience and Nanotechnology (NST)

<u>What is the NST?</u>	NST constitutes an interdisciplinary research field that seeks to understand and manipulate matter at the nanoscale (Bhushan & Bharat, 2010).
<u>Educational significance of NST with the usage of inquiry-based learning</u>	• Nanoliteracy • Students interest • Carreers(Spyrtoy et al. 2021).
<u>NST in primary education</u>	• Size of objects • Observation tools • Size-dependent properties • Applications of NST • Models and modelling (Peikos et al., 2025; Peikos et al., 2022; Mandrikas et al., 2020; Manou et al., 2018).

Gecko Effect

What is Gecko Effect?

The Gecko Effect refers to the ability of gecko lizards to walk upside down freely, defying gravity.(Bhushan, & Bharat. 2010)



Gecko Effect

How is Gecko Effect explained?

- Lamellae
- Setae
- Spatulae

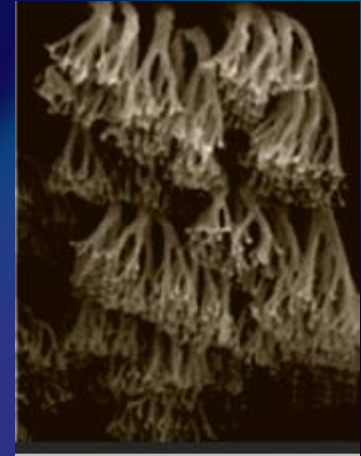
(Bhushan, & Bharat. 2010)



Macroworld



Microworld



Nanoworld

Gecko Effect

Alternative Ideas

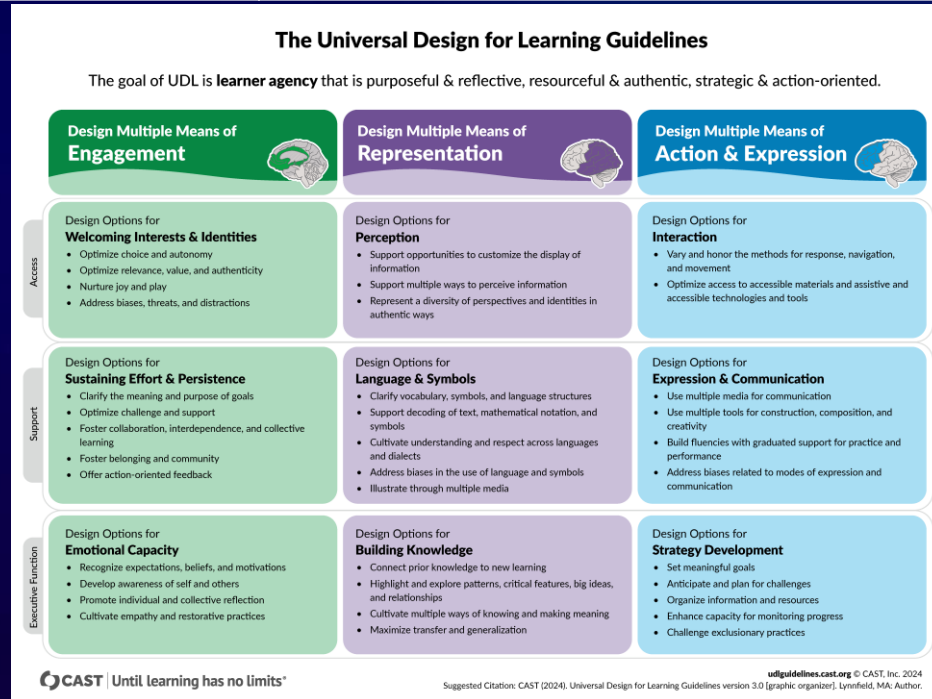
- Glue
- Suction cups
- Claws
- Magnets

(Peikos et al. 2025· Alexiou
et al. 2017)

Universal Design Learning (UDL)

What is UDL?

UDL is a teaching method that gives qual chances to students. (CAST, 2024)



Augmented Reality (AR)

How does UDL benefits from Augmented Reality?

AR is a flexible, multimodal, and engaging learning environment that combines digital and real-world elements while promoting engagement and a collaborative learner community (Sofianidis & Stylianidou, 2025; Sofianidis et al., 2024).

Design Multiple Means of
Engagement



Design Multiple Means of
Action & Expression



Design Multiple Means of
Representation



The indented learning outcomes of the activities

We expect students to be able to:

- Categorize objects into macro-micro-nano world based on the observation tool
- Explain Gecko effect

Main Menu

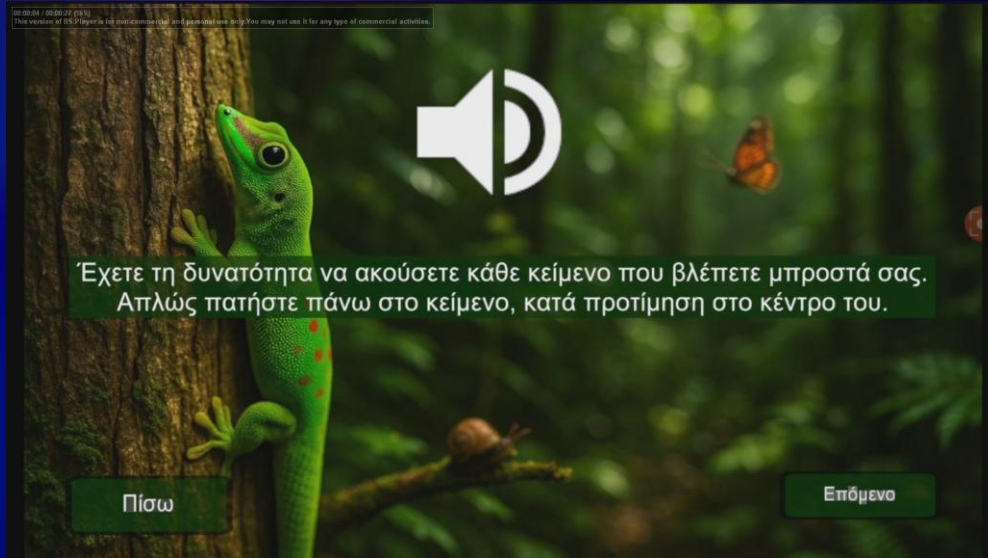


- Support opportunities to customize the display of information

Design Multiple Means of Representation



Main Menu

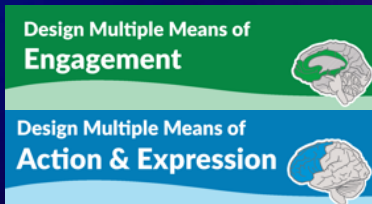
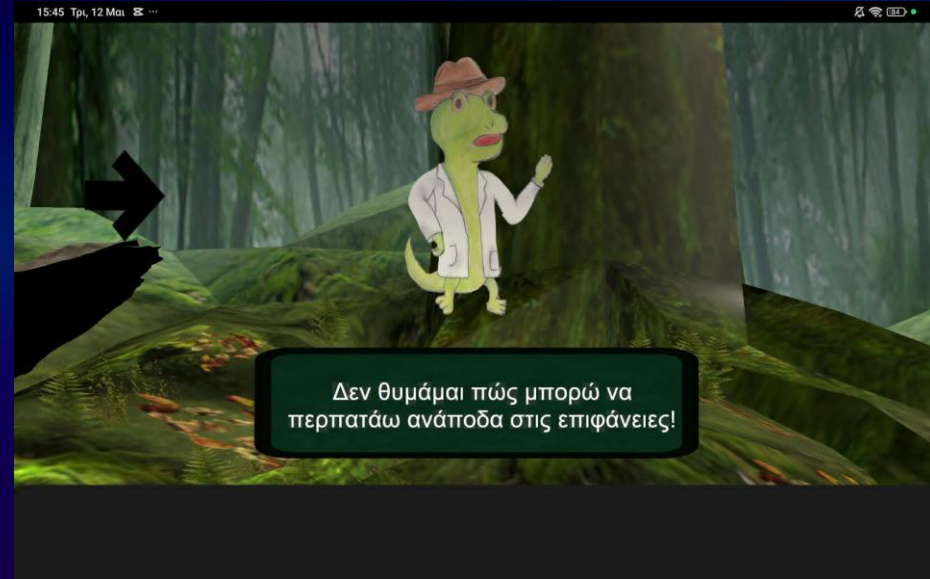
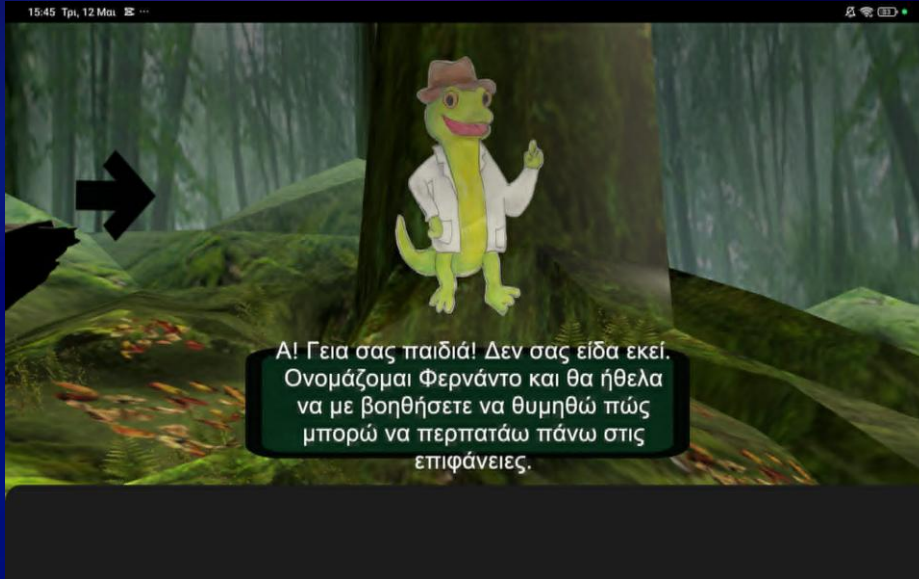


- Support multiple ways to perceive information

Design Multiple Means of
Representation



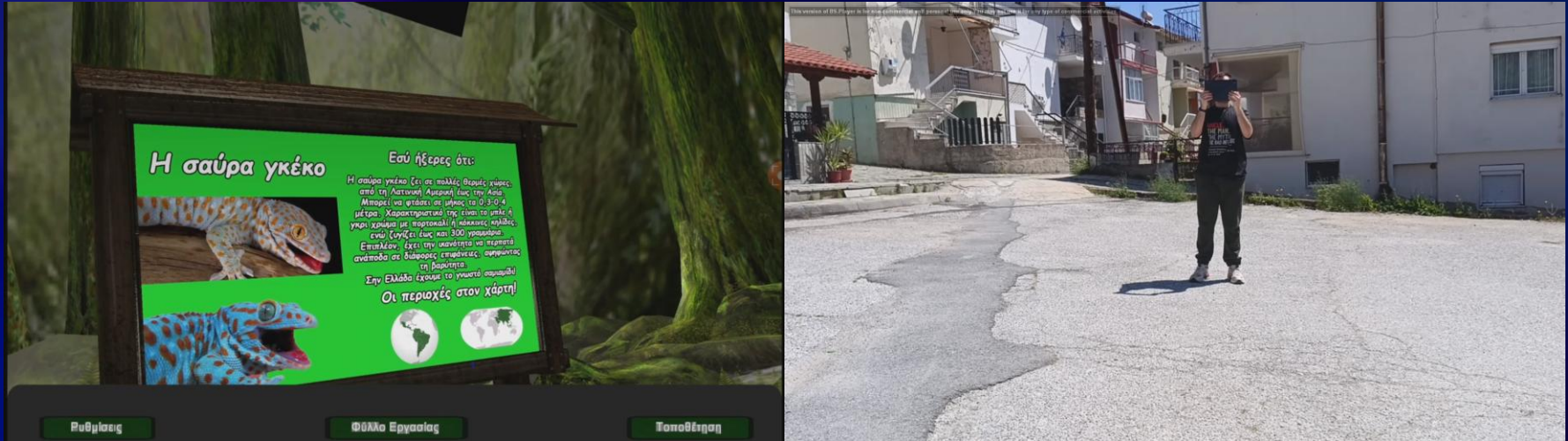
Orientation of the inquiry activities: the story of a gecko lizard facing a problem



- Nurture joy and play
- Clarify the meaning and purpose of goals
- Setting meaningful goals

Macroworld

- Exploration of the Macroworld characteristics of gecko lizard



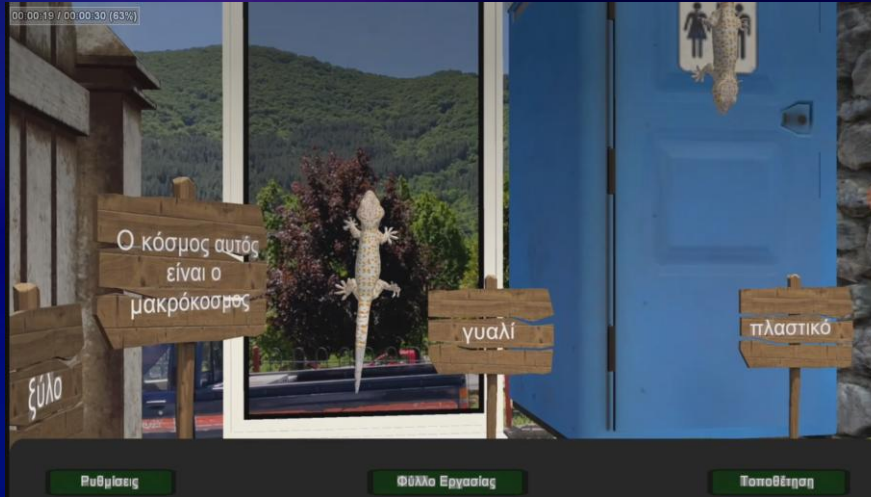
Design Multiple Means of
Engagement



- Optimize choice and autonomy
- Nurture joy and play
- Foster belonging and community

Macroworld

- Exploration of the Macroworld characteristics of gecko lizard

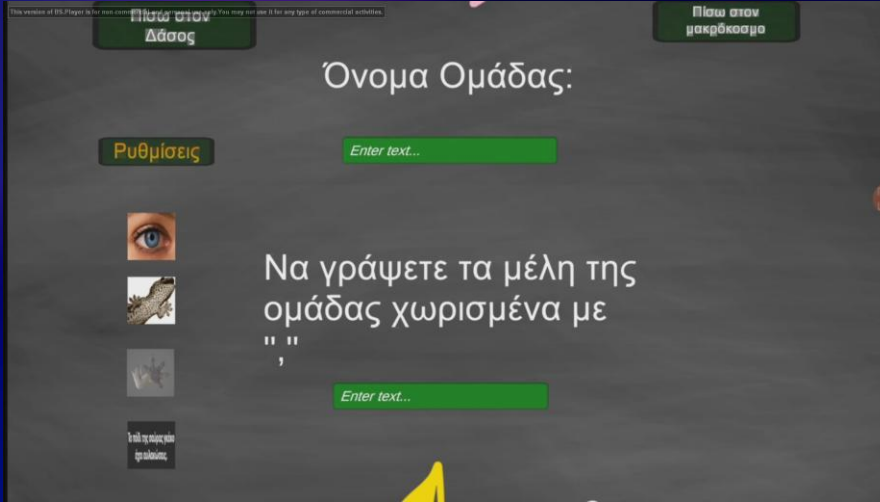


Design Multiple Means of
Engagement



- Optimize choice and autonomy
- Nurture joy and play
- Foster belonging and community

Worksheets



- Optimize access to accessible materials and assistive and accessible technologies and tools
- Use multiple media for communication
- Connect prior knowledge to new learning
- Promote individual and collective reflection

Φύλλο Εργασίας

Όνομα Ομάδας:

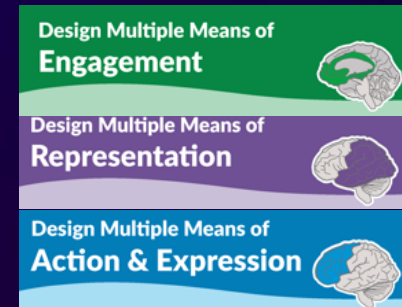
Ημερομηνία:

Μέλη της ομάδας:

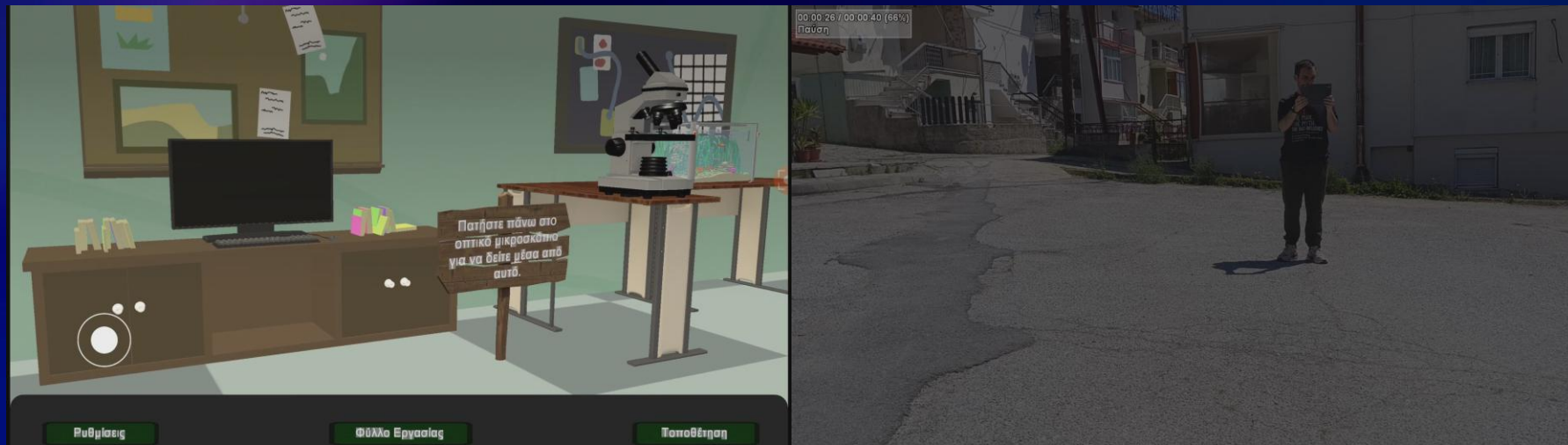


1) Να χρησιμοποιήσετε την εφαρμογή που βρίσκεται στο τάμπλετ με το όνομα «Γκέκο», ώστε να γνωρίσετε τη σαύρα γκέκο. Να συζητήσετε μεταξύ σας και να συμπληρώσετε τον παρακάτω πίνακα.

Τίως λέμε τη σαύρα γκέκο στην καθημερινότητά μας;	
Σε ποιες περιοχές μπορούμε να τη συναντήσουμε;	
Ποιο είναι το χαρακτηριστικό της χρώμα;	
Μέχρι πόσο μεγάλο μήκος μπορεί να φτάσει το σώμα της;	
Μέχρι πόσο μεγάλο βάρος μπορεί να φτάσει;	
Ποια είναι η ικανότητα της σαύρας που μας εντυπωσιάζει;	



Microworld



Design Multiple Means of
Representation

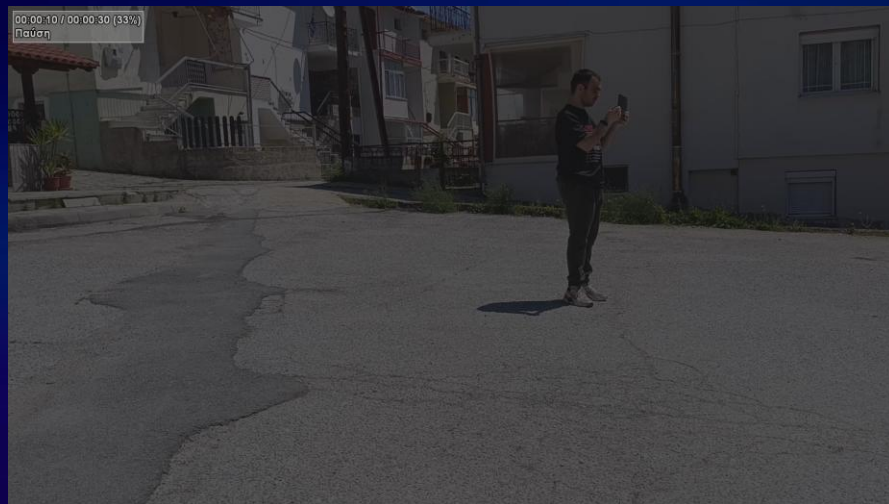


Design Multiple Means of
Action & Expression



- Vary and honor the methods of response
- Support multiple ways to perceive information

Microworld



- Microscope
- Model of setae
- Actual photo of a Gecko lizard's foot under the microscope

Nanoworld



- Electron Microscope
- Presentation of Electron Microscope

Nanoworld

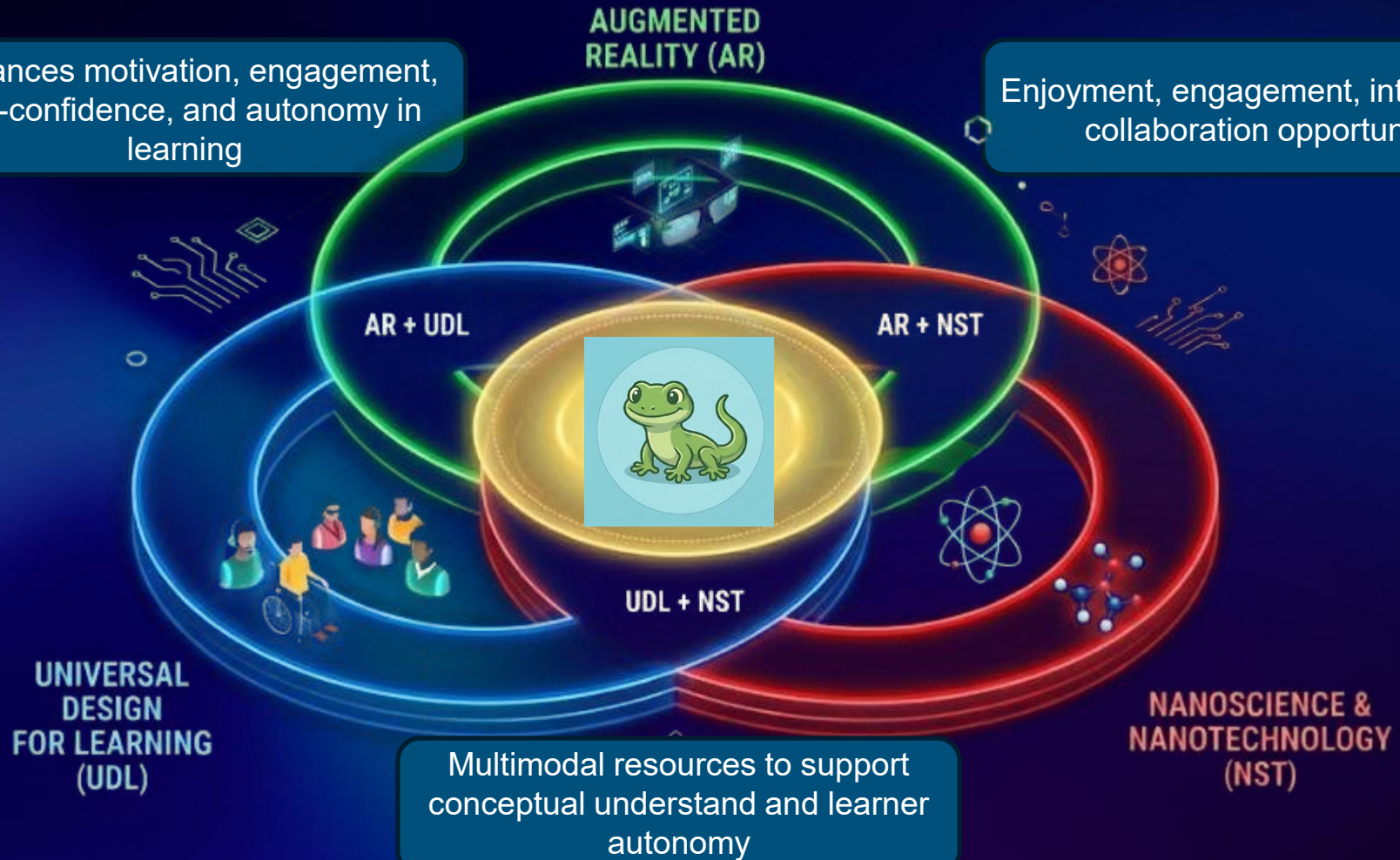


- Model of spatulae
- Explanation of Gecko Effect
- Presentation of gecko inspired man-made materials

Conclusion

Enhances motivation, engagement, self-confidence, and autonomy in learning

Enjoyment, engagement, interest, and collaboration opportunities



References

1. Spyrtou, A.; Manou, L.; Peikos, G. Educational Significance of Nanoscience–Nanotechnology: Primary School Teachers’ and Students’ Voices after a Training Program. *Educ. Sci.* 2021, 11, 724. <https://doi.org/10.3390/educsci11110724>
2. Giorgos Peikos, Anna Spyrtou, Dimitris Pnevmatikos & Penelope Papadopoulou (2022) A teaching learning sequence on nanoscience and nanotechnology content at primary school level: evaluation of students’ learning, *International Journal of Science Education*, 44:12, 1932–1957, DOI:10.1080/09500693.2022.2105976
3. Peikos, G., Spyrtou, A., Antoniadis, G., Karategou, K., Tzioli, M., Kremmyda, O., & Gkiremezi, S. (2025). *Is It Possible to Teach Nanoscience–Nanotechnology Content to Kindergarten Students?* (pp. 75–97). https://doi.org/10.1007/978-3-031-94207-5_5
4. Manou, L., Spyrtou, A., Hatzikraniotis, E., & Kariotoglou, P. (2018). Content transformation for experimental teaching nanoscale science and engineering to primary teachers. *Journal of Physics: Conference Series*, 1076, 012006. <https://doi.org/10.1088/1742-6596/1076/1/012006>
5. Mandrikas, A., Michailidi, E., & Stavrou, D. (2020). Teaching nanotechnology in primary education. *Research in Science & Technological Education*, 38(4), 377–395. <https://doi.org/10.1080/02635143.2019.1631783>
6. Bhushan, & Bharat. (2010). *Springer Handbook of Nanotechnology* (B. Bhushan, Ed.). Springer Berlin Heidelberg. <https://doi.org/10.1007/978-3-642-02525-9>

References

7. Αλεξίου, Δ., Πέικος, Γ., & Μάνου, Λ. (2017). Οι Ιδέες Μαθητών Δημοτικού Σχολείου για Φαινόμενα της Φύσης στην Κλίμακα του Νάνο: Το Φαινόμενο του Λωτού και της Σαύρας Gecko. Στο Δ. Σταύρου, Α. Μιχαηλίδη, & Α. Κοκολάκη (Επιμ.), 10ο Πανελλήνιο Συνέδριο Διδακτικής Φυσικών των Επιστημών και Νέων Τεχνολογιών στην Εκπαίδευση (σσ 868–873). Παιδαγωγικό Τμήμα Δημοτικής Εκπαίδευσης, Πανεπιστήμιο Κρήτης.
8. Sofianidis, A., & Stylianidou, N. (2025). Towards an inclusive science education: preparing twenty-first century preschool student teachers for inclusive science teaching and learning. *International Journal of Science Education*, 1–26. <https://doi.org/10.1080/09500693.2025.2595578>
9. CAST (2024). Universal Design for Learning Guidelines version 3.0. Retrieved from: <https://udlguidelines.cast.org>
10. Sofianidis, A., Skraparlis, C., & Stylianidou, N. (2024). Combining Inquiry, Universal Design for Learning, Alternate Reality Games and Augmented Reality Technologies in Science Education: The IB-ARGI Approach and the Case of Magnetman. *Journal of Science Education and Technology*, 33(6), 928–953. <https://doi.org/10.1007/s10956-024-10135-7>