

**mLearn 2018 „ Mobilized Learning: Pedagogical and Technological Innovation for Teaching & Learning “  
11<sup>th</sup> to 14<sup>th</sup> Nov 2018**

# Mobile Inquiry-based Learning: Relationship among levels of inquiry, learners' autonomy and environmental interaction

Esther Tan, Ellen Rusman, Olga Firssova, Stefaan Ternier,  
Marcus Specht, Roland Klemke & Hyo-Jeong So



Open Universiteit  
welten-instituut.ou.nl



Dutch and Flemish student enrolment on 31 December 2016	14.101
New Dutch and Flemish student inflow	4.273
Diplomas (certificates in a legal sense)	254 bachelor degree programmes 698 master degree programmes
Student opinion on the programme in general (according to the National Student Survey)	84.1% gave a score of 4 or 5
Number of preliminary exams sat	35.896
Number of times students passed a preliminary exam	21.527
Number of European Credits (EC) for which students registered	219.018 ECTS (2016: 207.253 ECTS)
Number of study points achieved per student (part of the Performance Agreements)	8.64 ECTS credits (2016: 7.85 ECTS credits)

## Introducing Open University of the Netherlands





Seamless Learning



# Introducing

## Dr. Esther Tan

- education officer with the Educational Technology Division, Ministry of Education, Singapore
- research team at the Learning Sciences Lab (LSL) National Institute of Education (NIE) for the Singapore Future School project on mobile learning activities to foster critical thinking and collaborative knowledge building
- Assistant professor in Welten institute, Center for learning, teaching & technology, Open university of the Netherlands
- Assistant professor in CEL (Centre for Education and Learning) in Delft



# Presentation Outline

1. Introduction:
2. Theoretical framework on and experiences with mobile inquiry-based learning
3. Reflection and questions
4. Findings
5. Challenges and Implications

# Introduction

Two main strands of mobile learning research:

1. Empirical studies on the affordances of emerging mobile devices and evolving Web technologies to overcome the constraints of time, space and location (e.g., Specht, Ternier, & Greller, 2011; Ternier, Klemke, Kalz, Van Ulzen, & Specht, 2012)



# Introduction

Two main strands of mobile learning research:

2. Research studies focused on pervasive knowledge construction bridging in and out of the school learning contexts (with technological mediation) (Kerawalla et al., 2012; Tan & So, 2011; 2016; Wong & Looi, 2011).



# Goal of the paper

1. To explore relations between levels of inquiry, task types and technological mediation on learners' autonomy and learners' interaction with the environment in mobile learning.
2. To revisit the notion of environment interaction in outdoor learning spaces (open and enclosed spaces).



# Mobile Inquiry-Based Learning (MIBL)

How MIBL distinguishes itself from other forms of learning?

- Learning is intentional (Duschl & Grandy, 2008)
- Learners are active agents of learning (Driver, Newton & Osborne, 2000)
- Learners develop a sense of situational intent (Choi & Hannafin, 1995) => dependent on time and situation

# Mobile Inquiry-Based Learning (MIBL)

This paper draws on the theories of constructivist (intentional learning), socio-constructivist (knowledge co-construction) and situated cognition (situated learning) to explore the relationship between levels of inquiry, learners' autonomy and environmental interaction in mobile learning.



# Reflective questioning:

Is there, and if so, what is the relation between levels of inquiry (task structuredness) and technological mediation on:

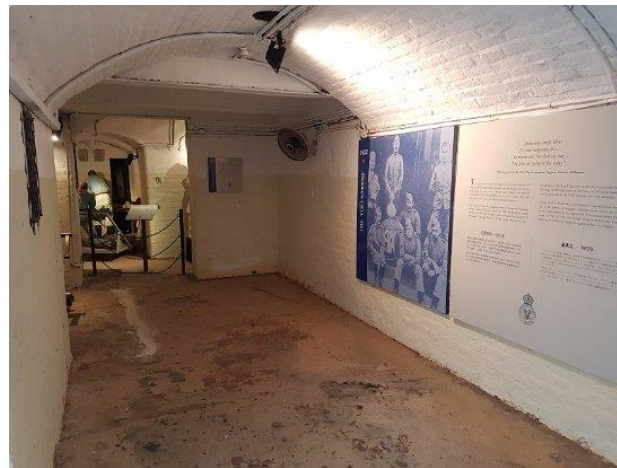
- Learners' autonomy in MIBL?
- Learners' interaction with the outdoor learning environment in open and enclosed learning spaces?

# Outdoor Learning: Open vs Enclosed space

Outdoor **open space** e.g. a river trail, a nature ramble.



Outdoor **enclosed space** e.g., tunnel at a fortress, exhibition area inside a castle.





# Levels of inquiry

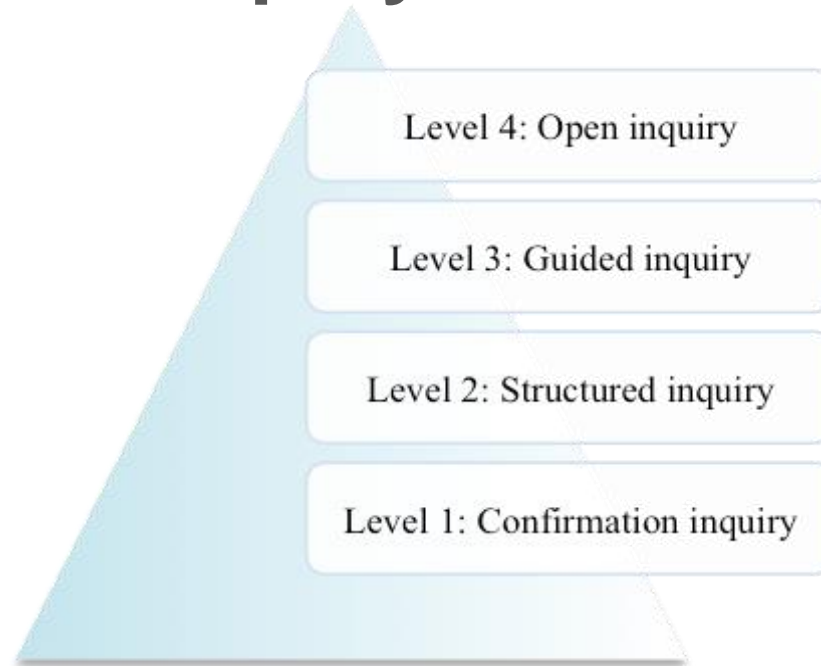


Figure 1. Levels of inquiry (adapted from Tafoya et al., 1980)

# Levels of inquiry: Teacher & Student Agency

	<b>Level 1</b> <b>Confirmation</b> <b>inquiry</b>	<b>Level 2</b> <b>Structured</b> <b>inquiry</b>	<b>Level 3</b> <b>Guided inquiry</b>	<b>Level 4:</b> <b>Open inquiry</b>
<b>Problem</b>	Teacher-led	Teacher-led	Teacher-led	Student-initiated
<b>Procedure</b>	Teacher-led	Teacher-led	Student-initiated	Student-initiated
<b>Solution</b>	Teacher-led	Student-initiated	Student-initiated	Student-initiated

**Table 1. Levels of inquiry on teacher agency and learner autonomy (adapted from Tafuya et al.,1980)**

# Levels of inquiry: Technological Affordances and learners' autonomy

## Netherlands

weSPOT project (Working Environment with Personal Open Tools) to foster environmental literacy (Firssova et al., 2014):

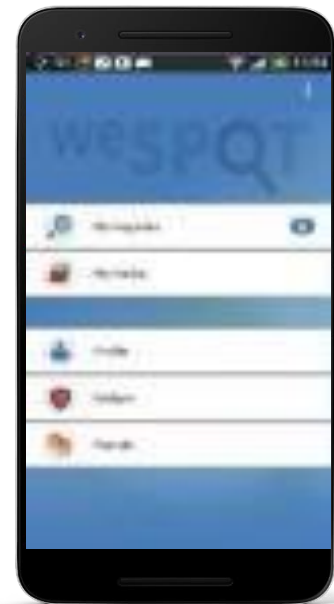
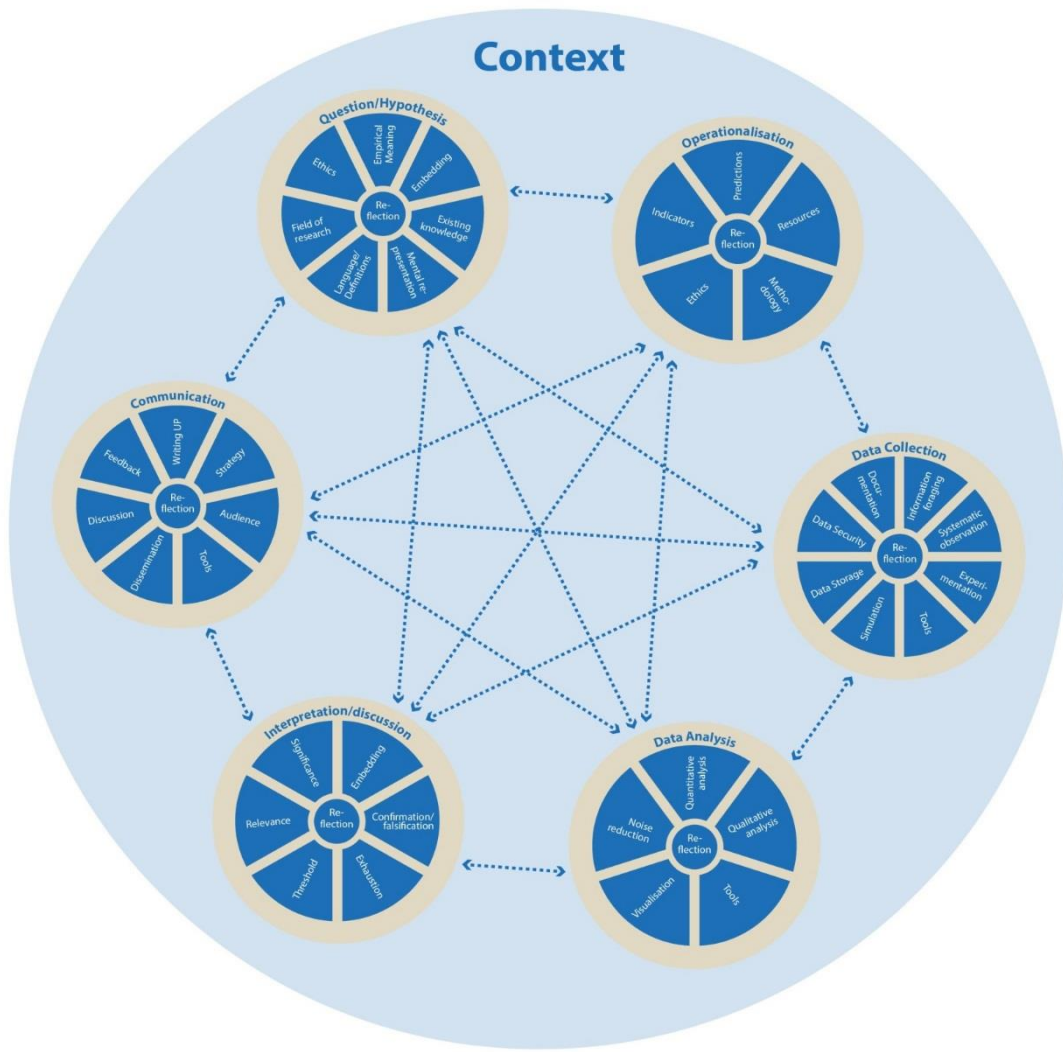
- weSPOT inquiry model: activities ranged from highly structured to open inquiries.
- Technological mediation: mobile personal inquiry manager to support self-directed learning, context-aware notification system to enable contextualized sharing and notification of real world experiences & mobile data collection system.



Seamless Learning



## Context



Open Universiteit  
welten-instituut.ou.nl





Meedoen aan de jury

Het Energiespel rond je af met **twee** opdrachten:

Dit is de tweede opdracht - meedoen aan de JURY voor de beste posterpresentatie van het Energiespel.

Loop rond, stel vragen, vorm je eigen indruk.  
Maak foto's van de posters die je leuk vindt, spreek als je wilt je indruk in.

Waarover kun je vragen stellen?

- De **onderzoeksvraag** (waarom deze vraag? wat is het doel?)
- De **uitvoering** (Waar heeft het plaatsgevonden? Waarom deze aanpak)



Test je kennis

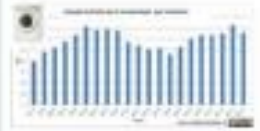

Welke stelling is correct? Ju kunt verder pas als je de correcte stelling kiest.

- Hypothese is een vraag
- Hypothese is een verwachting die daadwerkelijk uitkomt
- Hypothese is een verwachting, je weet nog niet zeker of die uitkomt

Submit answer

Test je kennis

Hoe formuleer je een vraag als je een vergelijkend onderzoek wilt uitvoeren, bijvoorbeeld naar het energieverbruik van een wasautomaat. Bestudeer deze grafiek en spreek je vraag in.

# Levels of inquiry: Technological Affordances and learners' autonomy

Key findings from weSPOT Energy consumption project:

- Students could be overwhelmed if cognitive requirements demanded by the system were too high
- Motivation diminished and the learning effect was not as expected owing to a lack of structure and teacher support and flaws in the infrastructure
- Game ownership and understanding of inquiry

# Levels of inquiry: Technological Affordances and learners' autonomy

## Netherlands

DojoIBL (Suárez, Ternier, Prinsen, & Specht, 2016):

- Inquiry model: Inquiry process was segmented into phases, and the phases into activities with role assignment to structure the learning process.
- Technological mediation: Mobile Messaging component and the Mobile Notification component to support communication with peers & teachers.



# Levels of inquiry: Technological Affordances and learners' autonomy

Key findings from DojoIBL project:

- DojoIBL platform enabled the teacher to structure the inquiry-based learning process by means of activities.
- Improved communication with peers and teachers via the technological mediation and this increases awareness of the learning progress at both individual and collaborative level.



# Levels of inquiry: Technological Affordances and learners' autonomy

## Singapore

Mobile learning trail at the Singapore Sentosa Island  
(Tan & So, 2011; 2015 & 2016)

- Task type and structuredness: from well structured (knowledge performative task e.g., locate a tunnel using the coordinates) to tasks to ill-structured task (knowledge generative task e.g., explain the purpose of the tunnel)



Task 1: Measure & calculate the gradient of three slope & rank the slope from the gentlest to the steepest.  
(performative)

Task 7: Identify a problem area in Sentosa & propose solutions using design thinking – brainstorm, share, categorise & solutioning.  
(knowledge generative)

Task Design



# Levels of inquiry: Technological Affordances and learners' autonomy

## Singapore

- Technological mediation: mobile device and web 2.0. technology affords immediacy of feedback



# Levels of inquiry: Technological Affordances and learners' autonomy

Key findings from the mobile learning trails:

- Task structuredness: the well-structured tasks leading to the ill-structured task types enabled a gradual increase of learner's capacity for reflective inquiry (scaffolding)
- Technological mediation enhanced students' autonomy and thereby increased students' capacity to take control of their learning journey: Students were able to re-evaluate their initial findings and re-negotiate meaning based on the immediacy of feedback.





Seamless Learning



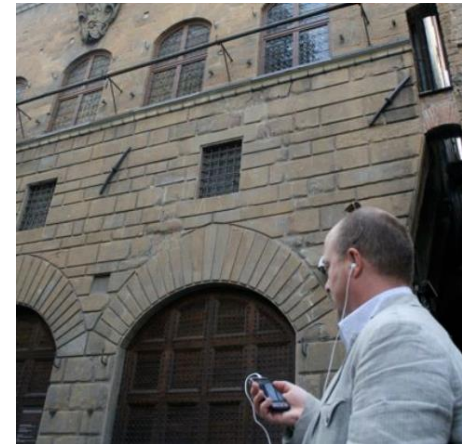
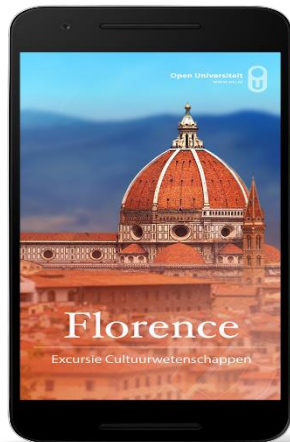
Open Universiteit  
welten-instituut.ou.nl



# Levels of Inquiry: Outdoor-outdoor (open space) vs. outdoor-indoor (enclosed space) environmental interaction

Netherlands

Outdoor open space: A city trip in Florence using the architecture of ARLearn system (Ternier et al., 2012) or MijnStad





# Levels of Inquiry: Outdoor-outdoor (open space) vs. outdoor-indoor (enclosed space) environmental interaction

Netherlands

Key findings (Ternier et al., 2012) :

- Students were able to reflect in contexts and create learning content and successfully construct new knowledge as they moved from one location to another.
- Technology mediation enhanced students' interaction with the environment, enables them to work on their own and synchronised their notes with the cloud and later revisit them.

# Levels of Inquiry: Outdoor-outdoor (open space) vs. outdoor-indoor (enclosed space) environmental interaction

## Singapore

Outdoor open space: measure gradients of slopes at the beach on a island trail (Tan & So, 2011)

### Key findings:

- The presence of the real physical environment certainly presented a different facet: straight-forward application tasks such as the measuring and ranking of the gradient of slopes saw unusual engagement in the task-discourse and greater collective knowledge construction. It is no longer as clear-cut owing to the spatial scale as compared to the slopes near the school basketball court where they first practiced measuring the gradient of a slope.

# Levels of Inquiry: Outdoor-outdoor (open space) vs. outdoor-indoor (enclosed space) environmental interaction

## Singapore

Outdoor enclosed space: visit to war exhibits & displays in the tunnels on a mobile learning trial (Tan & So, 2015; 2016)

Key finding:

- Most students tended to approach exhibits to look for answers to the inquiry tasks regardless of task type & structuredness. Environment interaction became brief, superficial and conservative.

# Challenges & Implications

## 1. Teacher agency vs. Learner autonomy:

Apart from task structuredness and technological mediation, learner autonomy to exercise more self-regulation in the learning process also depends on the learning context and content, socio-cultural practices and learner profile.

# Challenges & Implications

## 2. Technological affordances enable:

- Immediate interaction with the rich physical affordances of the outdoor environment.
- Immediacy of feedback, interaction & collaboration.
- Contextualized learning, content creation & knowledge construction.



# Challenges & Implications

## 3. Levels of inquiry & task design:

The four levels of inquiry and task type ought to align with the desired learning outcomes, the outdoor learning contexts (open vs. enclosed spaces) and students' capacity for autonomous learning in situated learning.

# Thank you...

## Questions & Discussion

## Contact Information:

Dr. Esther Tan

[E.T.B.K@tudelft.nl](mailto:E.T.B.K@tudelft.nl)

Dr. Ellen Rusman

[Ellen.Rusman@ou.nl](mailto:Ellen.Rusman@ou.nl)

# References

- Firssova, O., Kalz, M., Börner, D., Prinsen, F., Rusman, E., Ternier, S., & Specht, M. (2014, September). Mobile inquiry-based learning with sensor-data in the school: Effects on student motivation. In *European Conference on Technology*.
- So, H. J. & Tan, E. (2014). Designing the situation for pervasive knowledge building: Future school experiences. In Tan, S. C., So, H. J. and J. Yeo, J. (Eds.), *Knowledge creation in education*, (pp. 123-142). Singapore: Springer.
- So, H. J., Tan, E., Y. Wei., & Zhang, X. J. (2015). What makes the design of mobile learning trails effective: A retrospective analysis (pp. 335-352). In L. S. Wong., M. Milard., & M. Specht. (Eds.), *Seamless learning in the age of mobile connectivity*, (pp.335 – 352). Singapore: Springer.
- Specht, M., Ternier, S., & Greller, W. (2011). Dimensions of mobile augmented reality for learning: a first inventory. *Journal of The Research Center For Educational Technology*, 7(1).
- Suárez, Á., Ternier, S., Prinsen, F., & Specht, M. (2016, September). Nurturing communities of inquiry: A formative study of the DojoIBL platform. In *European Conference on Technology Enhanced Learning* (pp. 292-305). Springer, Cham.

# References

- Tan, E. & So, H. J. (2011). Location-based collaborative learning at a Geography trail: Examining the relationship among task design, facilitation and discourse types. In H. Spada, G. Stahl, N. Miyake, & N. Law. (Eds.). In the proceedings of CSCL 2011 conference: *Connecting computer-supported collaborative learning to policy and practice, Volume 1*, (pp.41-48). Hong Kong: The International Society of the Learning Sciences.
- Tan, E. & So, H. J. (2015). How learners employ semiotic resources for collaborative meaning-making in outdoor mobile learning. In Lindwall, O., Häkkinen, P., Koschman, T. Tchounikine, P. & Ludvigsen, S. (Eds.) (2015). *Exploring the Material Conditions of Learning: The Computer Supported Collaborative Learning (CSCL) Conference 2015, Volume 1*, (pp. 268-275). Gothenburg, Sweden: The International Society of the Learning Sciences.
- Tan, E., & So, H. J. (2016). Students' Use of Knowledge Resources in Environmental Interaction on an Outdoor Learning Trail. In Looi, C. K., Polman, J. L., Cress, U., and Reimann, P. (Eds.) (2016). *Transforming Learning, Empowering Learners: The International Conference of the Learning Sciences (ICLS) 2016, Volume 2*, (pp. 745-752). Singapore: The International Society of the Learning Sciences.



# References

- Tan, E., So, H. J., & Zhang, X. J. (2012). Teacher Agency and Student Autonomy in an Inquiry-based Mobile Learning Trail. In the *proceedings of the 20th International Conference on Computers in Education (ICCE)*, Nov 26 to 30, 2012, Singapore.
- Ternier, S., Klemke, R., Kalz, M., Van Ulzen, P., & Specht, M. (2012). ARLearn: Augmented Reality Meets Augmented Virtuality. *Journal of Universal Computer Science*. 18(15), 2143-2164.