D2.4 Guidance and assessment tutorial: Inquiry Guidance and Assessment Tutorial

weSPOT

IST (FP7/2007-2013) under grant agreement N° 318499

Deliverable number	*D2.4*
Deliverable Title	*Guidance and assessment tutorial: Inquiry Guidance and Assessment Tutorial*
Dissemination level	*PU*
Delivery date	*31 March 2014*
Status	*Final*
Author(s)	Aristidis Protopsaltis, Sonia Hetzner
Contributors	Foteini Haimala, Karen Stepanyan, Marcus Specht

The weSPOT Consortium

Number	Partner	Country
1	OPEN UNIVERSITEIT NEDERLAND	Netherlands
2	THE OPEN UNIVERSITY	United Kingdom
3	TECHNISCHE UNIVERSITAET GRAZ	Austria
4	KATHOLIEKE UNIVERSITEIT LEUVEN	Belgium
5	SOFIISKI UNVERSITET SVETI KLIMENT OHRIDSKI	Bulgaria
6	FRIEDRICH-ALEXANDER-UNIVERSITAT ERLANGEN NURNBERG	Germany
7	FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS	Greece
8	LATTANZIO LEARNING SPA	Italy
9	IPAK INSTITUT ZA SIMBOLNO ANALIZO IN RAZVOJ INFORMACIJSKIH TEHNOLOGIJ VENENJE ZAVOD	Slovenia

Document Control

Coordinating Editor: Aristidis Protopsaltis

E-mail: **Aristidis.Protopsaltis@fim.uni-erlangen.de**

Amendment History

Version	Date	Comment	Modifications made by
0.1	02.03.2014	First Draft	Aristidis Protopsaltis FAU, Germany
0.2	10.03.2014	Second Draft	Aristidis Protopsaltis FAU, Germany
0.3	15.03.2014	Third Draft	Aristidis Protopsaltis FAU, Germany, Michael Bedek TUG, Austria
0.4	25.03.2014	Fourth Draft	Aristidis Protopsaltis FAU, Germany, Michael Bedek TUG, Austria
0.5	30.03.2014	Fifth Draft	Aristidis Protopsaltis FAU, Germany
0.6	31.03.2014	Sixth Draft	Aristidis Protopsaltis FAU, Germany
0.7	02.03.2014	Seventh Draft	Aristidis Protopsaltis FAU, Germany
0.8	0.3.03.2014	Eighth Draft	Aristidis Protopsaltis FAU, Germany
0.6		Review	Foteini Haimala FORTH, Greece Karen Stepanyan**,** OU
0.9		Integration of review comments and suggestions	Aristidis Protopsaltis FAU, Germany, Marcus Specht OU, Netherlands

Table of Contents

1. Executive Summary

The weSPOT project aims at propagating scientific inquiry as the approach for science learning and teaching in combination with today's curricula and teaching practices. It lowers the threshold for linking everyday life with science teaching in schools by technology. weSPOT supports the meaningful contextualization of scientific concepts by relating them to personal curiosity, experiences, and reasoning. weSPOT addresses several challenges in the area of science learning and technology support for building personal conceptual knowledge. The project focuses on inquiry-based learning with a theoretically sound and technology supported personal inquiry approach.

The project is focused on three main development aspects: (a) define a reference model for inquiry-based learning skills, (b) create a diagnostic instrument for measuring inquiry skills, and (c) implement a working environment that allows the easy linking of inquiry activities with school curricula and legacy systems. The foreseen weSPOT Toolkit gives smart support for personal scientific inquiry to address a lack of scientific inquiry skills in an age group of 12-25.

The current deliverable, D2.4, outlines the inquiry guidance and assessment tutorial, to support teachers in their quest for scientific inquiry. The inquiry guidance tutorial includes several items that will introduce the weSPOT IBL model to the teachers, provide them with examples of how to use it in practice, describe the available tools and show them how they work.

This diagnostic tutorial is focused on the diagnostic instrument which will look at the entire inquiry life cycle which may start with the formulation of a research question and may end with the valorisation of the results and it will cover the four different complexities of inquiry, from confirmation inquiry to open, self-directed inquiry. The second part of the deliverable focuses on the diagnostic framework describing the adopted approach. The weSPOT diagnostic instrument for inquiry skills and competences aimed at a) to establish a European baseline of the current level of inquiry skills in the target group and b) to demonstrate the potential of the weSPOT-technology for STEM-learning in general.

2. Introduction

weSPOT is a project supported by the European Commission aiming at propagating scientific inquiry as the approach for science learning and teaching in combination with today's curricula and teaching practices. It lowers the threshold for linking everyday life with science teaching in schools by technology. weSPOT supports the meaningful contextualization of scientific concepts by relating them to personal curiosity, experiences, and reasoning. weSPOT addresses several challenges in the area of science learning and technology support for building personal conceptual knowledge. The project focuses on inquiry-based learning with a theoretically sound and technology supported personal inquiry approach. In inquiry based-learning learners take the role of an explorer and scientist and are motivated by their personal curiosity, guided by self-reflection, and develop knowledge personal and collaborative sense-making and reasoning.

2.1 The Structure of the Deliverable

The remainder of this deliverable is structured as follows: first, we present the inquiry diagnostic tutorial and then the assessment tutorial. The inquiry diagnostic tutorial includes a number of documents that explain how the weSPOT IBL model and the developed tools can be use in educational settings. It contains the following documents: Inquiry-based Learning Brief, weSPOT IBL Model, weSPOT IBL Model Example, Levels of Inquiry, weSPOT Toolset, The use of weSPOT IBL Model and its Toolset.
The assessment tutorial explains how to use the weSPOT IBL taxonomy and the assessment components in educational settings.

3. Inquiry Guidance Tutorial

The inquiry guidance tutorial presents to the teachers all the necessary information in order to use the weSPOT IBL model and tools successfully. The first part of the inquiry guidance tutorial includes an introduction on the inquiry-based learning approach in a simplified manner, description of the weSPOT IBL mode (presented in D2.3.1) accompanied by a PowerPoint presentation, an example using the weSPOT IBL model, different levels of inquiry with examples and the weSPOT toolset with post casts and videos. The aim of this section is provide to the teachers a comprehensive introduction and tutorial to all available material. All the material will be available to the teachers and students via the projects website (http://portal.ou.nl/web/wespot/teachers) and the projects YouTube channel (https://www.youtube.com/user/ProjectWeSPOT).
To avoid repetition, since some of the material have been introduced in other deliverables (e.g. D2.3.1), a short description of the material will be provided and the reference to the website when the material have been uploaded.

3.1 Inquiry-based learning (IBL) brief

The Inquiry-based learning brief is a document that introduces IBL to the teachers by providing a short introduction describing inquiry-based learning based on existing research. Then the document explains the key characteristics of the learning method and describes the different inquiry-based learning types accepted by the research and learning community. Further, the inquiry-based learning brief describes the weSPOT approach, the use of IBL with technology and in

the end describes the skills involved in an inquiry according to the weSPOT approach. The aim of the document is to introduce IBL to the teachers whom might not know and introduce the weSPOT approach. The inquiry-based learning brief is available on the projects website (http://portal.ou.nl/en/web/wespot) at the teachers section (http://portal.ou.nl/web/wespot/teachers).

4. weSPOT IBL model

The next document of the inquiry guidance tutorial focuses on the weSPOT IBL model described in D2.3.1 Pedagogic and Diagnostic Framework. The document introduces the IBL model, giving an overview of all its phases and sub phases. The teachers can find this description as a separate document on the projects website, at teachers section (http://portal.ou.nl/web/wespot/teachers). Along with the weSPOT model documents the teachers can find a PowerPoint presentation. Furthermore, these documents will be used by the weSPOT consortium at the planned workshops with the teachers to introduce and explain the model to them.

5. weSPOT IBL model example

This section focuses on an example developed by the weSPOT team (Mikroyannidis, Okada et al. 2013). The scenario used to show case the weSPOT IBL model is a scenario within a secondary education context, about microclimates. Microclimates are areas where the normal temperature and conditions are slightly different from the surrounding areas. The aim of this scenario is to find the best place to have a bench at the school.
The aim of this example is to show how the teachers can use the weSPOT IBL model in practice and transfer it to their own scenario. Furthermore, the scenario will be use during the workshops with the teachers, so it can be evaluated and updated if needed. The example is available to the teachers at the projects website, at the teachers section (http://portal.ou.nl/web/wespot/teachers).

6. Levels of inquiry

As it has been mentioned before, four types inquiry-based learning are recognized based on the level of student autonomy in the process. The simplest level is the **confirmation inquiry** in which students are provided with the question and procedure (method) as well as the results, which are known in advance. The next level is called **structured inquiry**. The learning goal here is to introduce students to the experience of conducting investigations or practicing a specific inquiry skill, such as collecting and analysing data. The third level of inquiry is called **guided inquiry**. In this inquiry the question and procedure are still provided by the teacher. The most demanding level of inquiry is the **open inquiry**. In an open inquiry students have the opportunity to act like scientists, deriving questions, designing and carrying out investigations as well as communicating their results.
To describe how teachers can apply the different types of inquiry in the classroom we again used the microclimate scenario to create four different documents, one for every level of inquiry. Teachers can find the microclimate example in the four different types of inquiry on the teachers section on the project's website http://portal.ou.nl/web/wespot/teachers).

7. weSPOT TOOL SET

The weSPOT tool set includes a number of tools to assist the teachers and students in their inquiries. For the inquiry guidance tutorial a YouTube channel has been created with all the screencasts and videos explaining the tools. The YouTube channel can be found at the following url: https://www.youtube.com/user/ProjectWeSPOT

7.1 Inquiry workflow engine -Elgg

The inquiry flow engine (Figure 8) based on the open source software called Elgg (http://inquiry.wespot.net/) is the base of the weSPOT inquiries. In the inquiry flow engine teachers and students need to register either by using a social network account or by registering on the platform. After registration, they gain access to the environment and the can start their inquiry. The weSPOT inquiry flow engine allows teachers and students to set up an inquiry and structure it according to their needs, to upload files (pictures, docs, values etc.), communicate with each other etc.

Teachers and students can find a screencast tutorials on the projects YouTube channel (https://www.youtube.com/user/ProjectWeSPOT), where is explain all the aspects of the software and its uses, such as how to set up an inquiry (https://www.youtube.com/watch?v=6R8yxdih5t8&list=UUoy04HtVkunK_cuVJgovTsQ), and performing an inquiry (https://www.youtube.com/watch?v=cbMSTvqAC6k&list=UUoy04HtVkunK_cuVJgovTsQ).

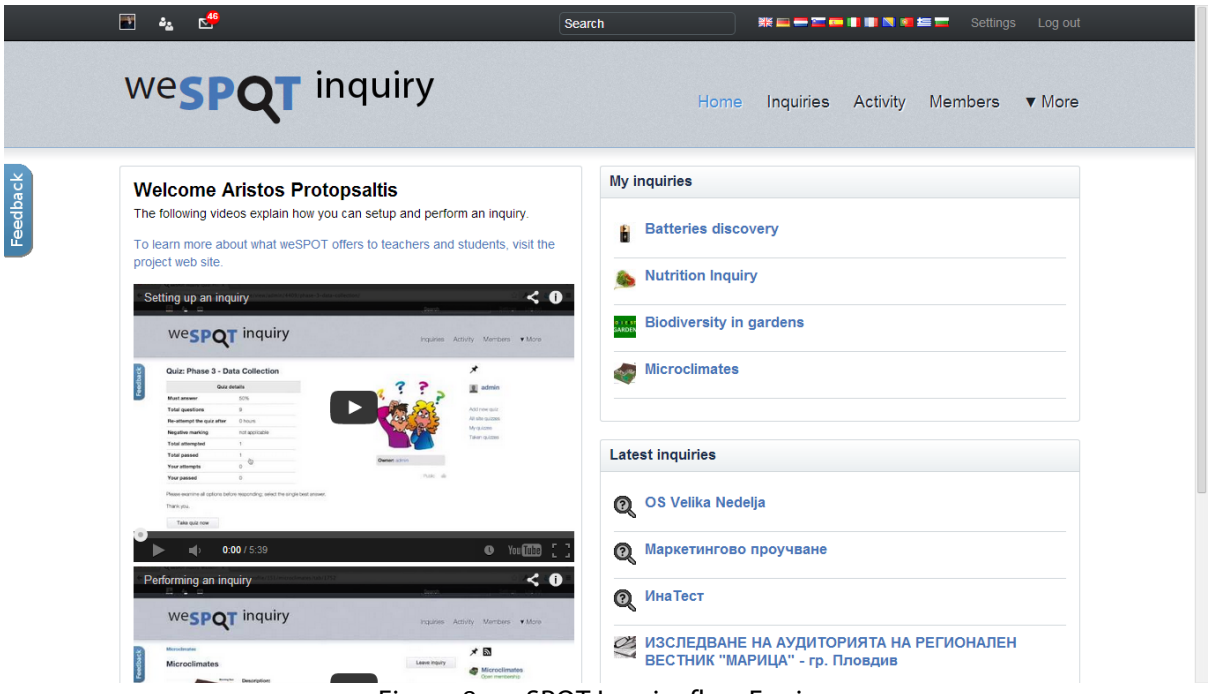

Figure 8: weSPOT Inquiry flow Engine

7.2 Personal inquiry manager

The Personal Inquiry Manager (PIM) is a mobile application to support the inquiry process and gives students mobile access to their inquiries. With the PIM students can create inquiries, join existing inquiries, add friends, displaying badges achieved and collect data for their inquiries. Via the PIM, users receive data collection tasks and through the PIM students can collect data for these tasks. Currently there are three versions under development: (1) Android, (2) iOS and (3) Google Glass.

The screencast tutorial can be found on the following url http://www.youtube.com/watch?v=BoYB5ScHDx0.

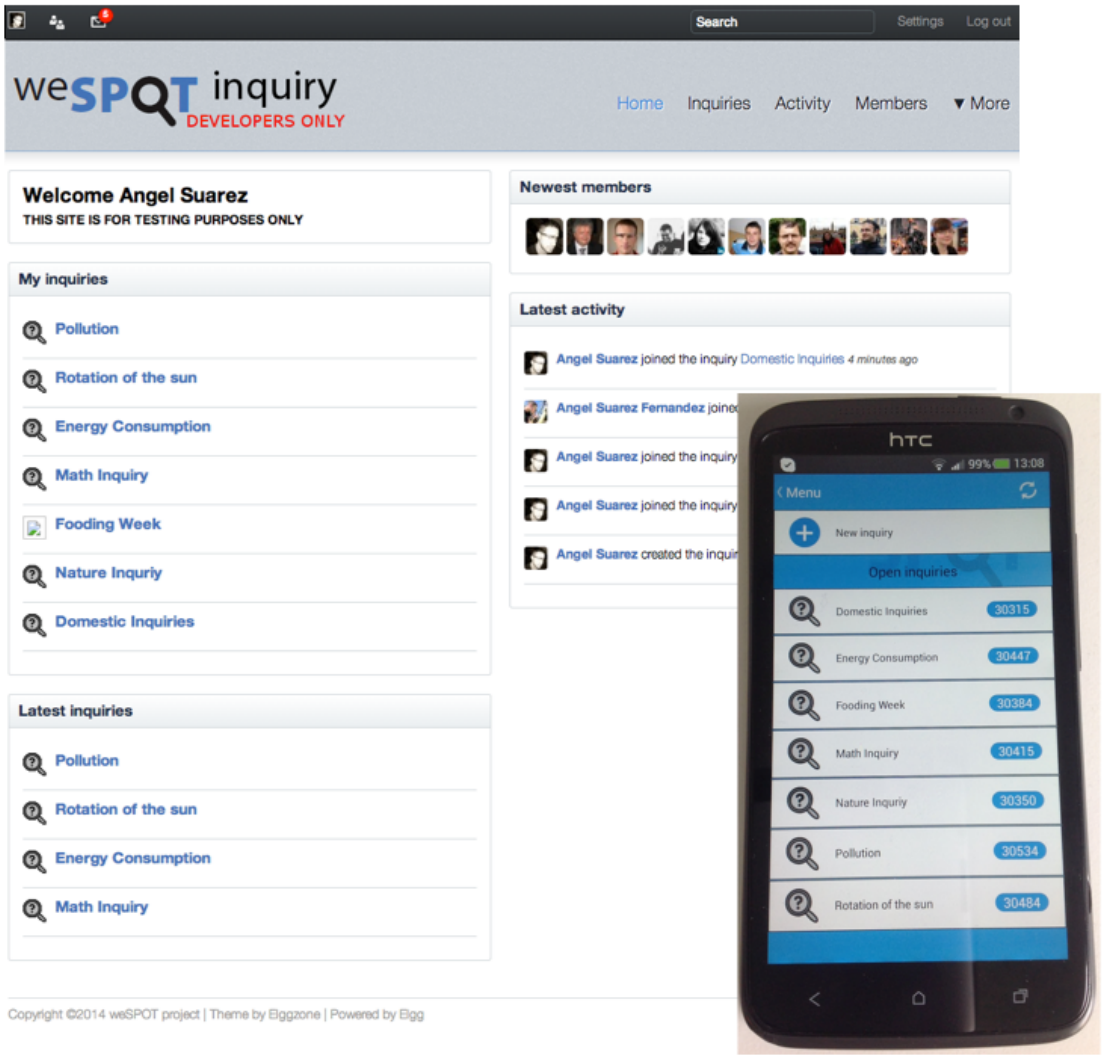

Figure 9: Personal Inquiry Manager (PIM)

7.3 Mobile Inquiry Coordination Interface (MICI)

The Inquiry coordination interface will give inquiry coordinators access to the current on-going inquiries and the contributions of all participants. It will allow central dispatching of messages and management of tasks and data. Envisaged main functionalities:

- To track students during an inquiry
- To broadcast messages to the inquiry participants
- To show data collected by inquiry participants
- Badges' awarding

MICI is under development and due by month 24 of the project.

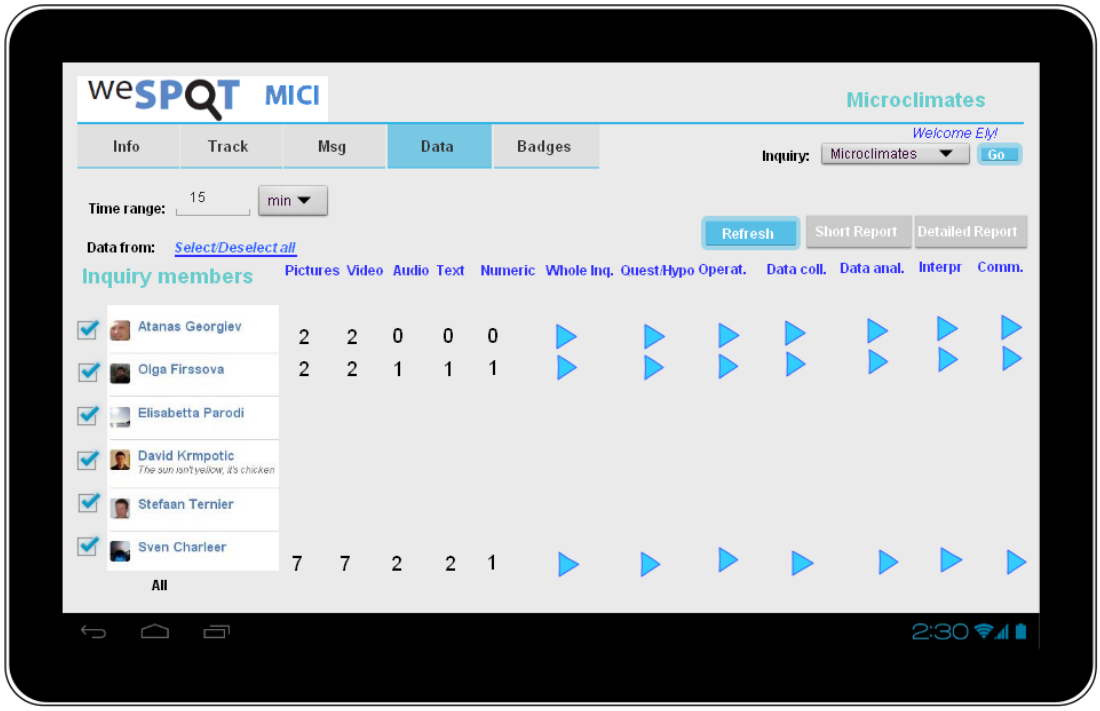

Figure 10: Mobile Inquiry Coordination Interface

7.4 Domain Modelling and Resource Recommendations

To model a content domain, the Formal Concept Analysis plugin can be found within the Elgg system. It provides teachers with an interface to model a content domain in terms of objects and attributes. The instructor can then assign learning resources to objects and attributes. The resulting concept graph forms the basis for our learner model that will be updated according to a learner's performance in questionnaires and additionally by considering a learner's interaction with the system (log data). Learning resources will be recommended that are tailored to the learner's learning progress.

The tutorial for the FCA tool can be found at the following address: https://www.youtube.com/watch?v=yrjsM_X0u5s&list=UUoy04HtVkunK_cuVJgovTsQ.

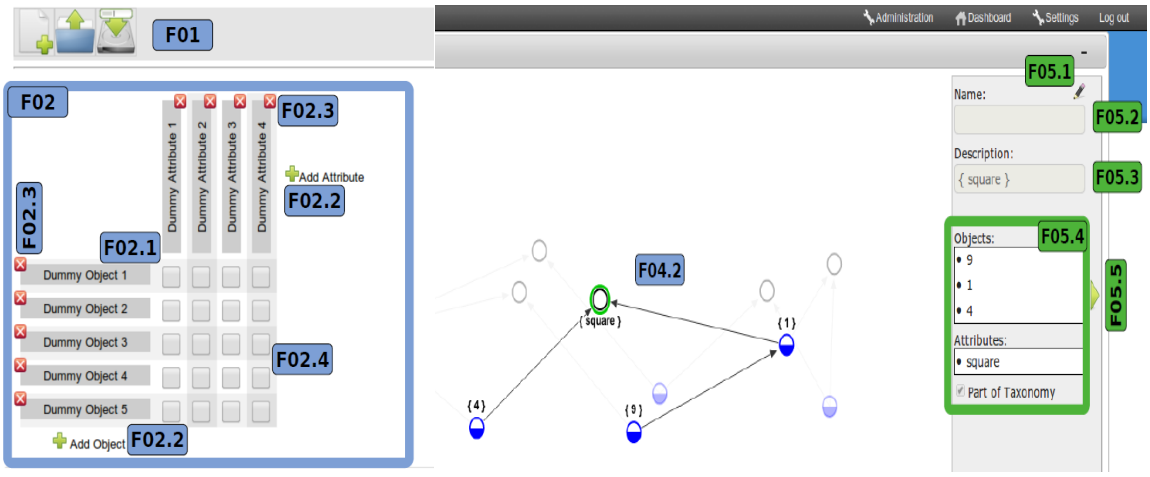

Figure 11: Formal Concept Analysis tool

7.5 Analytics StepUp, Navi, LARAe

Supplementary, the learner model, visualized as a graph is provided for a learner to reflect on. This application is not assigned to a phase but available throughout the entire inquiry.

To assist students in getting a better understanding of their learning behaviors and that of their peers, StepUp, Navi and LARAe (http://ariadne.cs.kuleuven.be/wespot/inquiryDashboard) provide dashboards that visualize the student's learning activities, using mobile devices, desktop computers, interactive tabletops and large displays. Every action on a widget in Elgg that a student performs can be tracked, stored and used to provide interesting visualizations, not only to students but also to teachers. These visualizations give a better insight into their learning process e.g. what and how widgets are used, how they move from one phase to another etc. Students can get a better understanding of their own activities but also of their peers. This can provide them with new ideas on how to tackle problems.

A quick example: Using his mobile phone, a student notices more activity in a specific phase by his fellow students. More specifically, their data collection activities are much higher. He invites some students around an interactive table top where they dig deeper into the analytics data, go through their collected data and discuss their progress. He concludes that his data collection is lacking and should spend more time on this.

A comprehensive tutorial about the use of LARAe is available the following url: https://www.youtube.com/watch?v=8UPaRyHF_FM&list=UUoy04HtVkunK_cuVJgovTsQ.

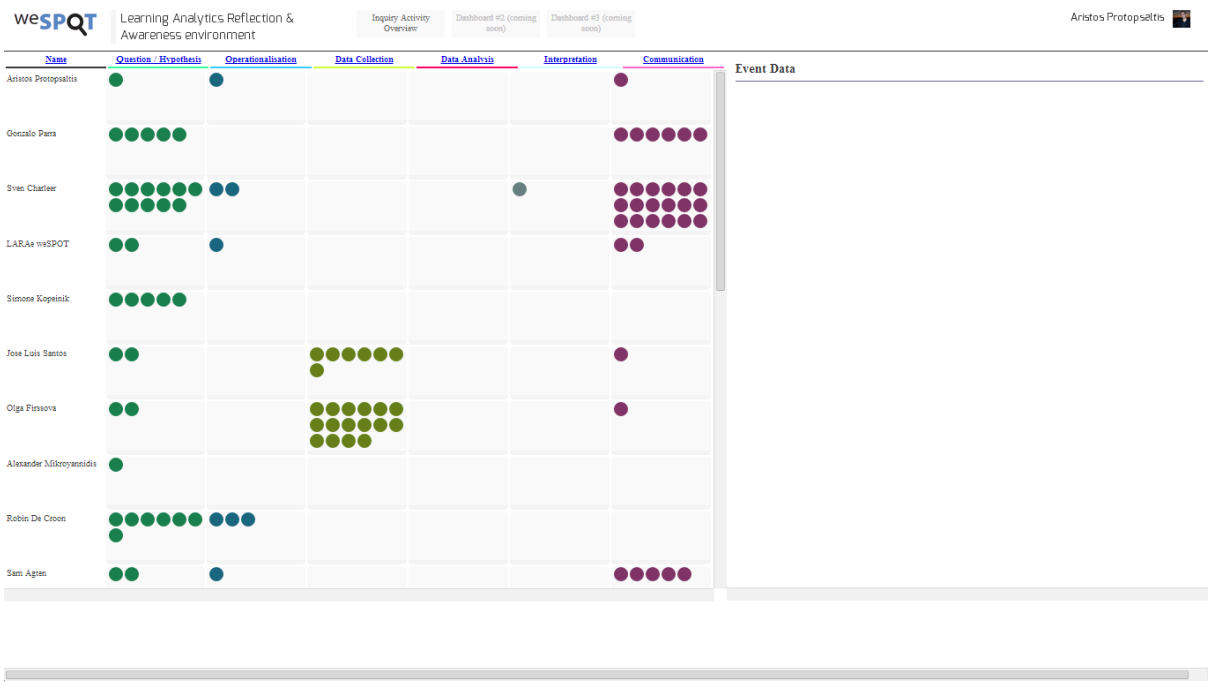

Figure 12: LARAe environment

8. The use of weSPOT IBL toolkit

To show case the weSPOT IBL model and the weSPOT tool-set the same microclimate scenario is used. The document shows how to use the weSPOT IBL model with the developed tools and how these tools can be utilised in the classroom. The teachers can find this description as a separate

document on the projects website, at teachers section (http://portal.ou.nl/web/wespot/teachers). This document will be best use by the teachers together with the screen casts and video tutorials (https://www.youtube.com/user/ProjectWeSPOT) that explain the functionalities of the tools.

9. weSPOT diagnostic assessment guidance

The diagnostic instrument will provide a questionnaire version for creating a baseline assessment as also a non-invasive continuous tracking tool, which collects and processes the relevant indicators, which are able to measure the impact of the weSpot approach. This will also lead to an Inquiry Guidance and Assessment Tutorial, which will be used by students and teachers in order to work with the weSPOT diagnostic tools and procedures. The assessment tutorial shows how to use the taxonomy (see D2.3.1), and the assessment components in educational settings.

9.1 weSPOT Inquiry Skills Taxonomy

The IBL Model consists of 45 specific tasks (e.g. *Systematic Observation*) which are assigned to more generic IBL phases (e.g. *Data collection*). To carry out these IBL tasks, a student requires certain skills (e.g. *Computer / Technical skills* such as the ability to apply search engines or word processing software). A skill – as a psychological construct - is not directly observable. However, we can infer about a student´s skills when observing the student´s performance while carrying out a task or by evaluating the outcome of a task for which certain skills are required. In this sense, the associations between the IBL tasks and a set of skills may serve as valuable input for assessment purposes in an educational setting. In weSPOT, students are encouraged to engage in and complete their own inquiries, or in other words: weSPOT favors a "learning by doing" approach where *students learn IBL skills by doing IBL tasks*. This is how the associations between IBL tasks and IBL skills provide guidance on how to train certain skills.
The following table provides the set of IBL tasks from the weSPOT IBL model, a set of skills and the associations between them (indicated by the grey cells). The set of skills and their associations to the tasks have been defined by pedagogical experts of the weSPOT consortium. The table can be read from both perspectives, i.e. an "assessment" and a "guidance" perspective, respectively. As an example, a student who has shown that he or she is able to carry out *information foraging* has (at least to some extend) *Learning skills*, *Computer / Technical skills* and *Research skills*. From a guidance or instructional perspective, if we would like to teach a student *Research skills,* we can suggest him or her to engage with *information foraging tasks* (e.g. searching through the web for articles and pictures for a particular domain).
IBL-skills, IBL-tasks and associations between them, can also be represented in a graphical way. Table 3 shows a graphical representation of a so called lattice that is a labeled line-diagram in which combinations of IBL-tasks and IBL-skills are shown as nodes. Hierarchical dependencies between these combinations are indicated by connected lines.
The weSPOT IBL lattice (Table 3) can be "read" as follows: The labels of the IBL-tasks are in white boxes, the labels for the IBL-skills are in grey boxes. Let's look at the node with the label "Writing Skills" (highlighted in red) at the left-hand side of the lattice. When "collecting" all labels in the white boxes from descending paths of this node, we know all the IBL-tasks, which are associated to *Writing skills*. In this case the associated IBL-tasks are *Writing up*, *Dissemination* and *Documentation*. On the other hand, we can see all IBL-skills, which are associated to a particular IBL-task when identifying all labels in the grey boxes from ascending paths of the node. As an example, look at the node labeled as "Language / definitions" (highlighted in green) just right of the "Writing skills node": The IBL-skills in the ascending paths are *Language skills*, *Learning skills*, and *Comprehension skills*.

		Skills																								
IBL Phases	IBL Tasks	Critical thinking skills	Comprehension skills	Observation skills	Learning skills	Metacognitive skills	Language skills	Analytical skills	Inferring skills	Search skills	Evaluation Skills	Computer / Technical Skills	Research Skills	Experimentation Skills	Problem Solving Skills	Writing Skills	Quantitative analysis skills	Statistics Skills	Mathematical Skills	Qualitative analysis skills	Existing Knowledge	Classification	Planning Skills	Organisation Skills	Presentation Skills	Communication Skills
Question/Hypothesis	Embedding	■	■																							
	Context			■																						
	Existing knowledge				■																					
	Mental representation		■			■																				
	Language/definitions		■		■		■																			
	Field of research		■		■		■	■																		
	Empirical meaning	■						■																		
	Reflection (Question)					■																				
Operationalisation	Indicators				■																					
	Predictions	■						■	■																	
	Resources				■					■																
	Methodology	■			■																					
	Ethics				■																					
	Reflection (Operationalization)	■				■					■															
Data collection	Information foraging				■							■	■													
	Systematic observation			■										■												
	Experimentation													■	■											
	Tools (Data Collection)											■														
	Simulation											■														
	Data storage											■														
	Data security											■														
	Documentation						■					■				■										
	Classification	■						■																		
	Reflection (Data Collection)	■				■					■															
Data Analysis	Quantitative analysis																■	■	■							
	Qualitative analysis																	■	■	■						
	Tools (Data Analysis)											■														
	Visualisation		■									■														
	Noise reduction							■			■															
	Reflection (Data Analysis)	■				■					■															
Interpretation	Embedding		■		■				■												■	■				
	Confirmation/falsification										■			■				■	■							
	Significance							■										■	■							
	Relevance	■						■																		
	Threshold							■										■	■							
	Exhaustion	■						■			■															
	Reflection (Interpretation)	■				■					■															
Communication	Writing up						■									■										
	Strategy																						■	■		
	Audience							■															■	■		
	Tools (Communication)											■														
	Dissemination						■									■									■	■
	Discussion																									■
	Feedback (Receiving and Reacting)																									■
	Reflection (Communication)	■				■					■															

Table 3: IBL-Tasks, IBL-Skills and how they are associated

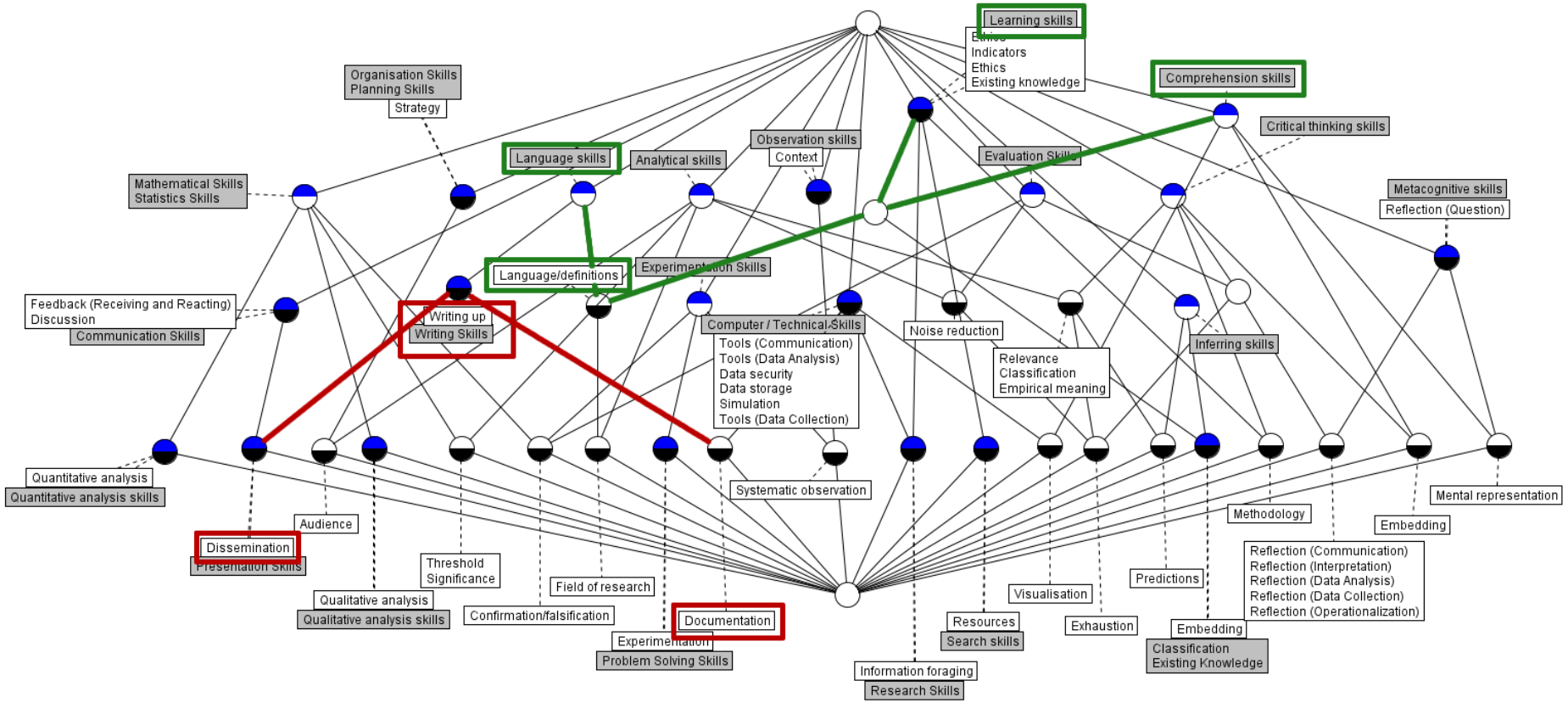

Figure 13: weSPOT IBL lattice

This graphical representation provides additional information such as hierarchical dependencies between IBL-skills and IBL-tasks that are often hard to read from the matrix representation. Skills which are located above others (connected by lines) are more "complex", because they are associated to more IBL-tasks. As an example, let´s go back to the node labeled with "Writing Skills". This node is located above, and thus is "more complex" than, *Presentation skills*. As elaborated on in the previous paragraph, *Writing Skills* are associated to the IBL-tasks *Writing up*, *Dissemination* and *Documentation*, whereas *Presentation skills* are only associated to *Dissemination*. We find another example looking at *Writing Skills that* are "less complex" than *Language Skills,* which node is located above: *Language Skills* are additionally associated to the IBL-tasks *Language / definitions* and *Field of Research*. The hierarchical dependencies between skills are the focus of Figure14 which doesn´t include the labels of the IBL-tasks.

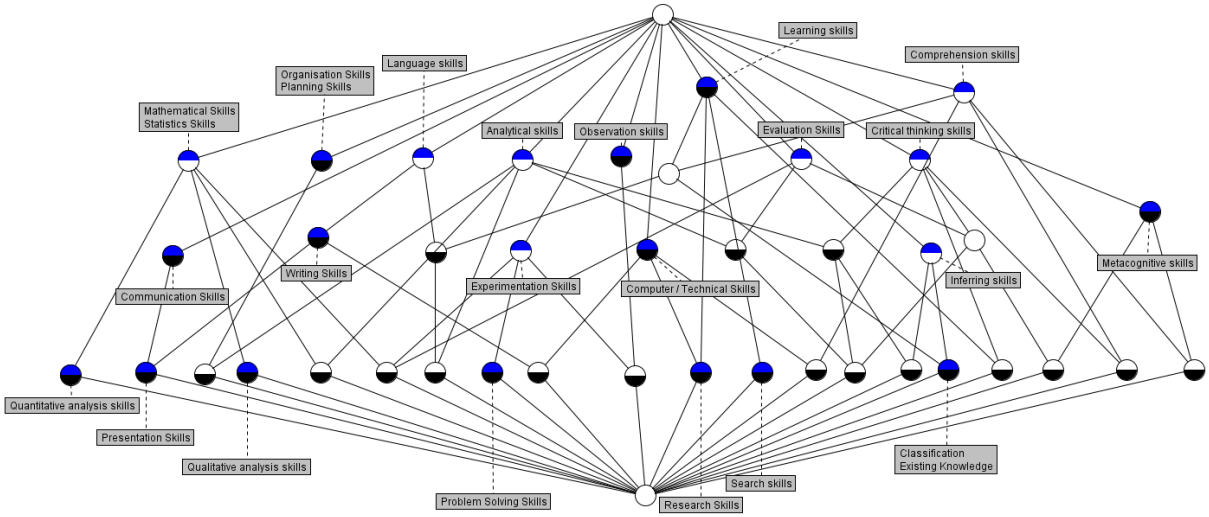

Figure 14: weSPOT IBL-skills lattice

If you are only interested in hierarchical dependencies between skills we recommend using the following Figure15. This weSPOT IBL skills taxonomy brings some valuable insights on how to guide students through inquiry projects: less complex skills should be taught, trained or learned before complex ones.

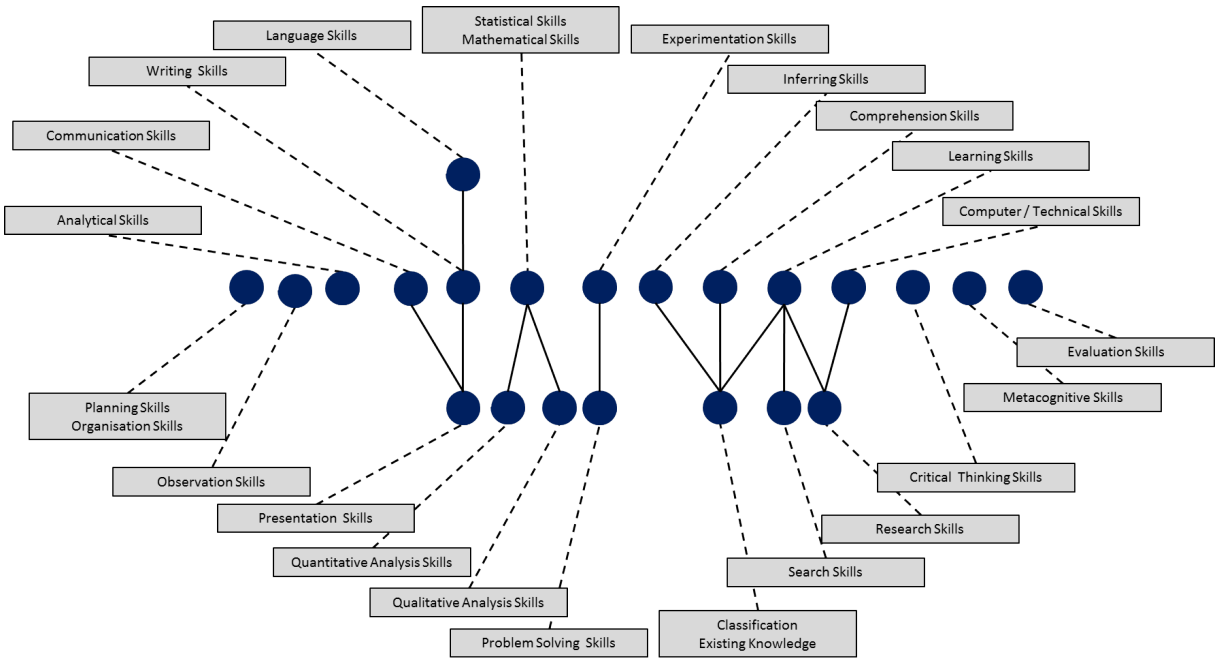

Figure 15: weSPOT IBL-skills taxonomy

6. Conclusions

Deliverable D2.4 has introduced the guidance and assessment tutorials of the weSPOT project.
The aim of the inquiry guidance tutorial framework is to provide all the necessary guidance to the teachers to use the weSPOT IBL model and the tools and support them in their quest to assist "young researchers" in exploring "scientifically" specific aspects of their physical environment. The inquiry guidance tutorial describes the weSPOT IBL model and explains its use with examples. Additionally provide thorough tutorials of all the developed tools.
The assessment tutorial explains the associations between the weSPOT IBL tasks and a set of skills that may serve as valuable input for assessment purposes in an educational setting. The set of skills and their associations to the tasks will allow teachers to assess the required skills for a given task.
The theoretical framework for the pedagogical diagnosis is tailored to the ambitious aim of inferring students' inquiry and meta-cognitive skills as well as domain-specific knowledge from observational data tracked within the weSPOT environment.
This deliverable is strongly related to the technical design and development WPs (3, 4, and 5) to the integration and piloting in different test-beds WP (6), and the evaluation framework WP (7).

7. References

AAAS. (2009). "The Nature of Science." Retrieved 20/04/13, from http://www.project2061.org/publications/bsl/online/index.php?chapter=1.

Abbott, A. (2001). Chaos of Disciplines. Chicago, University Of Chicago Press.

Anderson, R. D. (2002). "Reforming science teaching: What research says about inquiry?" Journal of Science Teacher Education **13**(1): 1-12.

Barstow, D., Ed. (2001). Blueprint for change: Report from the national conference on the revolution in earth and space science education. Cambridge, MA: TERC. Cambridge, MA, TERC.

Bell, T., D. Urhahne, et al. (2010). "Collaborative inquiry learning: Models, tools, and challenges." International Journal of Science Education **3**(1): 349-377.

Britannica, E. (2013). "Encyclopaedia Britannica." Retrieved 13/03/13, from http://www.britannica.com/EBchecked/topic/429927/operationalism.

Colombo, A. (2006). "Prediction. The SAGE Dictionary of Social Research Methods." Retrieved 20/04/13, from http://srmo.sagepub.com/view/the-sage-dictionary-of-social-research-methods/n155.xml.

Corno, L. (1986). "The metacognitive control components of selfregulated learning." Contemporary Educational Psychology **11**(4): 333-346.

Corno, L. and M. Rohrkemper (1985). The intrinsic motivation to learn in classrooms. Research on motivation: The classroom milieu. C. Ames and R. Ames. New York, Academic Press. **2:** 53-90.

Crawford, S. and L. Stucki (1990). "Peer review and the changing research record." Journal of the American Society for Information Science **41**(3): 223-228.

de Jong, T. (2006). "Computer simulations - Technological advances in inquiry learning." Science **312**(5773): 532-533.

Dewey, J. (1989). The Later Works 1925-1953. Carbondale and Edwardsville, Southern Illinois University Press.

Edelson, D., D. Gordin, et al. (1999). "Addressing the challenge of inquiry-based learning through technology and curriculum design." Journal of the Learning Sciences **8**(3/4): 391-450.

Gale, S. T. F. (2007). Generative Instruction and Learning: Strategies for Increasing Student Achievement in Low Performing and At-risk Students. South Carolina, ProQuest.

Graham, S., K. R. Harris, et al. (1992). "Developing self-regulated learners." Focus on Exceptional Children **24**(6): 1-16.

Grandy, R. and R. Duschl (2007). "Reconsidering the Character and Role of Inquiry in School Science: Analysis of a Conference." Science & Education **16**(2): 141–166.

Hunt, F. E. and D. C. Colander (2010). Social Science: An Introduction to the Study of Society. Boston, MA, Pearson Education.

Irny, S. I. and A. A. Rose (2005). "Designing a Strategic Information Systems Planning Methodology for Malaysian Institutes of Higher Learning (isp- ipta)." Issues in Information System **6**(1): 325-331.

Krajcik, J., R. W. Marx, et al. (2000). Inquiry based science supported by technology: Achievement among urban middle school students. American Educational Research Association Spring Meeting. Ann Arbor, Michigan.

Kubicek, P. J. (2005) "Inquiry-based learning, the nature of science, and computer technology: New possibilities in science education." Canadian Journal of Learning and Technology **Volume**, DOI:

Mikroyannidis, A., A. Okada, et al. (2013). "weSPOT: A Personal and Social Approach to Inquiry-Based Learning." Journal of Universal Computer Science Special Issue on Cloud Education Environments **19**(14): 2093-2111.

Miller, D. (1985). Popper Selections. Princeton, Princeton University Press.

Mulholland, P., S. Anastopoulou, et al. (2012). "nQuire: technological support for personal inquiry learning." IEEE Transactions on Learning Technologies **5**(2): 157–169.

Novak, A. M. and C. I. Gleason (2001). Incorporating portable technology to enhance an inquiry, project-based middle school science classroom. Portable technologies – Science learning in context. F. R. Tinker and S. J. Krajcik. New York, N.Y, Kluwer Academic/Plenum Publishers.

NRC (1996). National science education standards. Washington, DC, National Academic Press.

NSTA. (2004). "NSTA Position Statement: Scientific Inquiry." Retrieved 22/03/13, from http://www.nsta.org/about/positions/inquiry.aspx.

Osborne, J., S. A. Simon, et al. (2005). Enhancing the Quality of Argument in Science Lessons, ESRC.

Pirolli, P. and S. K. Card (1999). "Information Foraging." Psychological Review **106**: 643-675.

Reid, R. and K. R. Harris (1993) "Self-monitoring of attention versus self-monitoring of performance: Effects on attention and academic performance." Exceptional Children **Volume**, 1-13 DOI:

Sapsford, R. (2006). "Indicators. The SAGE Dictionary of Social Research Methods." Retrieved 19/03/13, from http://srmo.sagepub.com/view/the-sage-dictionary-of-social-research-methods/n98.xml.

Schuster, J. W. and P. D. Powers (2005). Translational and Experimental Clinical Research, Lippincott Williams and Wilkins.

Shadish, R. W., D. T. Cook, et al. (2002). Experimental and Quasi- Experimental Designs for Generalized Casual Inference. Boston-New York, Houghton Mifflin Company.

Shields, P. and H. Tajalli (2006). "Intermediate Theory: The Missing Link to successful Student Scholarship." Journal of Public Affairs Education **12**(3): 313-334.

Spronken-Smith, R. and R. Walker (2010). "Can inquiry-based learning strengthen the links between teaching and disciplinary research?" Studies in Higher Education **35**(6): 723-740.

Sternberg, J. R. (2009). Cognitive Psychology. Australia; Belmont, CA, Wadswoth Cengage Learning.

Tafoya, E., D. Sunal, et al. (1980). "Assessing inquiry potential: A tool for curriculum decision makers." School Science and Mathematics **80**(1): 43-48.