

# How can strengthen the role of environmental education? Site-scale Ecological Virtual Laboratory enhance self-efficacy, which improve environmental information cognition and environmental awareness

Wei Gao, Pu Chen, Shengjie Hu, Yijun Liu and Lihua Xian \*

\* Corresponding author: xianlihua@scau.edu.cn

## Questionnaire : Exploring the Mechanisms of SEVL

### Part 1 Based Information

Age: \_\_\_\_\_ Grade: \_\_\_\_\_

Gender: \_\_\_\_\_ Major: \_\_\_\_\_

### Part 2 Instructions for the Scale

The following scale is designed to evaluate students' thoughts during their use of SEVL.

Please select the option that best matches your actual experience.

1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree

Dimension Questions		Questions' source
the Site-scale Ecological Virtual Laboratory (SEVL): The operation mechanism of the SEVL aligns with the framework of the "Game-Based Learning Model" , which consists of three stages: input, process, and output.		Garris, R., R. Ahlers and J.E. Driskell, Games, motivation, and learning: A research and practice model. Simulation & gaming, 2002. 33(4): p. 441-467.
SEVL1	The SEVL can transform abstract environmental knowledge into tangible interactive experiences through gamification.	
SEVL2	The SEVL's real-time data feedback mechanism can enhance your cognitive regulation via a visual interface.	
SEVL3	When adjusting virtual ecological parameters, the SEVL can validate strategy feasibility and guide scientific reasoning through instant feedback.	
SEVL4	The SEVL's ethics evaluation report can help you shift from in-depth environmental information cognition to enhanced ethical awareness.	
Dimension Questions		Questions' source
In-depth Cognitive of Environmental Information (EI): The EI dimension was measured from three aspects: granularity, precision, and depth of environmental information cognition. Problem formulated based on the objectives of the course.		Problem formulated based on the objectives of the course.
EI1	Granularity: I am able to further understand the site through practical experience in SEVL, identify and recognize specific landscape elements and details in the site, and use them as the basis for subsequent design.	
EI2	Accuracy: In sound environment control tasks, I am able to understand the corresponding ecological	

	relationships between landscape elements and ecological factors such as noise through simulation and data analysis in SEVL.
EI3	Accuracy: In air quality control tasks, I am able to understand the corresponding ecological relationships between landscape elements and ecological factors such as negative oxygen ion concentration and PM2.5 through simulation and data analysis in SEVL.
EI4	Accuracy: In the task of regulating thermal comfort, I am able to understand the corresponding ecological relationships between landscape elements and ecological factors such as temperature and wind cold index through simulation and data analysis in SEVL.
EI5	Depth: I am able to analyse, identify, and assess key ecological issues in the simulated garden in SEVL.
EI6	Depth: I am able to understand the relationship between landscape elements and ecological factors through simulation and data analysis in SEVL, and propose effective solutions to address ecological issues in garden.
EI7	Depth: I am able to design in SEVL for a single design goal, such as enhancing the thermal comfort of the garden, to shape the ecological relationships of the site and effectively express ecological design in the site.
EI8	Depth: I am able to simultaneously consider the impact of multiple landscape elements such as vegetation, hydrology, and soil on multiple ecological factors in SEVL, and integrate multiple design goals to form a comprehensive solution.
EI9	Depth: I am able to further grasp the concept, scope, and applicable scale of site ecology through the practice of in SEVL, and demonstrate the concept of ecological adaptability design, ensuring the feasibility and effectiveness of design schemes in practical applications.

Dimension Questions		Questions' source
Enhance Environmental Awareness (EA): The EA dimension assessed four core aspects: wholeness of nature, systemic interconnections, decoding of environmental order, and functional implementation mechanisms.		The four most relevant representatives of environmental ethics development applied their ideas to SEVL.
EA1	Using SEVL helps me see the site as an organic whole with interrelated elements.	Wulf, A., The invention of nature: Alexander von Humboldt's new world. 2015: Knopf.
EA2	SEVL enables me to view the site's formation as a process, understanding the interaction between landscape elements and ecological factors.	McHarg, I.L., Design with nature. 1969.
EA3	Through SEVL, I recognize the site as a combination of ecological order with internal dynamics.	Lyle, J.T., Can floating seeds make deep forms? Landscape Journal, 1991. 10(1): p. 37-47.
EA4	SEVL helps me realize the site needs to emulate natural systems to form self - organizing order and mechanisms.	Steiner, F.R., The living landscape: an ecological approach to landscape

		planning. 2012: Island Press.
<b>Dimension Questions</b>		
Learning Motivation (LM): in this study is adapted from Pintrich et al.'s (1991) "Motivated Strategies for Learning Questionnaire (MSLQ)", which includes three main aspects: value, expectancy, and affect.		Questions' source Pintrich, P. R. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire
LM1	During SEVL use, I engage actively due to my intrinsic interest in ecology.	
LM2	SEVL's experimental tasks enhance my understanding of site ecological design logic and procedures.	
LM3	I believe I can control the experimental process and achieve success while using SEVL.	
LM4	I don't feel anxious or nervous when facing experimental assessments in SEVL.	
<b>Dimension Questions</b>		
Self-efficacy (SE): Based on Bandura's (1997) self-efficacy theory, the part about learning self-efficacy can be divided into five aspects: attitude towards learning setbacks, achievement of learning goals, learning challenges, current learning status, and understanding of one's own learning conditions.		Questions' source Bandura, A. (1997). Self-efficacy: The exercise of control (Vol. 604). Freeman.
SE1	When encountering technical problems or experimental failures in SEVL, I am willing to maintain a positive attitude and continue trying to solve the problems.	
SE2	By using SEVL, I can clarify my learning objectives and am confident in achieving them through experimental activities.	
SE3	I am willing to accept challenging experimental tasks in SEVL and believe I can complete them successfully.	
SE4	I am confident that my current learning progress and abilities are sufficient to complete experimental tasks in SEVL.	
SE5	I understand my learning conditions, such as equipment, resources, and time, and believe these can support me in completing learning tasks in SEVL.	
<b>Dimension Questions</b>		
Cognitive Load (CL): John Sweller(1988) proposed the cognitive load theory in 1988, which includes three types: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load.		Questions' source Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive science, 12(2), 257-285.
CL1	I think the complexity and amount of information in experimental tasks in SEVL are moderate.	
CL2	The presentation of information in teaching materials in SEVL doesn't increase my learning burden.	
CL3	I think experimental tasks in SEVL help me build new knowledge structures.	