

Bridging Science, Sustainability and Digital Learning: A Multi-Level Educational Model Using Natural Cosmetic Abrasives as a Case Study

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Abstract

*This study presents a multi-level educational model that integrates environmental science, sustainability education, and digital literacy by investigating natural cosmetic abrasives. Microplastics pose a global environmental challenge, and the ban on cosmetic microbeads has prompted the use of natural abrasive alternatives, both of which raise important environmental questions with scientific and pedagogical value. The model integrated conceptual preparation, digital learning activities, laboratory work, and an inquiry-based experiment. Fifty students used digital resources from two Erasmus+ projects to build foundational knowledge, apply digital materials in study and research, and develop critical evaluation skills. Students conducted a germination assay using *Lepidium sativum* to assess the ecotoxicological effects of four natural abrasives, which revealed inhibitory effects on early plant growth and underscored the importance of carefully evaluating their environmental implications and practical use. The findings demonstrate that authentic environmental questions effectively foster digital, green, and scientific competencies in higher education.*

Keywords: Natural abrasive, Microplastics, Ecotoxicology, Higher Education, Digital learning, Inquiry-based learning