AKTIVITAS PEREKAYASAAN MOLEKUL PADA PERKULIAHAN KIMIA MATERIAL BERBASIS PENELITIAN UNTUK MENINGKATKAN LITERASI KEBERLANJUTAN MAHASISWA MELALUI PEMBELAJARAN BERPIKIR SISTEM

TESIS

Diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar
Magister Pendidikan Ilmu Pengetahuan Alam

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AKTIVITAS PEREKAYASAAN MOLEKUL PADA PERKULIAHAN KIMIA MATERIAL BERBASIS PENELITIAN UNTUK MENINGKATKAN LITERASI KEBERLANJUTAN MAHASISWA MELALUI PEMBELAJARAN BERPIKIR SISTEM

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PERNYATAAN KEASLIAN TESIS

Dengan ini, saya menyatakan bahwa tesis saya yang berjudul **"Aktivitas Perekayasaan Molekul pada Perkuliahan Kimia Material Berbasis Penelitian untuk Meningkatkan Literasi Keberlanjutan Mahasiswa Melalui Pembelajaran Berpikir Sistem"** ini beserta seluruh isinya adalah sepenuhnya karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung risiko atau sanksi yang dijatuhkan kepada saya apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

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ABSTRAK

Literasi keberlanjutan sangat penting bagi mahasiswa untuk memahami dan mengatasi masalah keberlanjutan. Hal ini melibatkan *molecular basis of sustainability* dari interaksi kimia dan transformasinya. Penelitian ini bertujuan merekonstruksi perkuliahan kimia material berbasis penelitian yang terintegrasi aktivitas perekayasaan molekul untuk meningkatkan literasi keberlanjutan melalui pembelajaran berpikir sistem. Aktivitas perekayasaan molekul yang dilakukan berupa seleksi cairan ionik eutektik untuk ekstraksi logam menggunakan COSMO-RS. Metode penelitiannya adalah *mixed method* dengan *exploratory sequential design* yang dipadukan dengan *Model of Educational Reconstruction* (MER). Instrumen penelitiannya adalah lembar analisis konten, pedoman wawancara prakonsepsi, *repertory grid*, peta konsep, soal tes, dan angket persepsi mahasiswa. Desain pembelajaran yang dikembangkan terdiri dari 4 tahapan utama dengan konten pembelajaran berdasarkan hasil analisis konten dan wawancara prakonsepsi yang menunjukkan pemahaman awal mahasiswa tentang topik daur ulang material masih rendah. Rancangan desain pembelajaran yang dihasilkan berbasis *Course-Based Undergraduate Research Experiences* (CUREs) dan diimplementasikan kepada mahasiswa kimia dan calon guru kimia. Profil berpikir sistem dapat dilihat pada bagaimana mahasiswa mengaitkan elemen-elemen menjadi suatu konstruk dan mengaitkan konsep-konsep menjadi peta konsep. Berdasarkan analisis *repertory grid*, keterampilan berpikir sistem mahasiswa berada pada tingkat analisis (77,54%), sintesis (19,32%), dan implementasi (3,14%), kemudian analisis klaster fokus menggunakan Rep Plus V.2.0 menunjukkan kategori tinggi (5,56%), sedang (58,33%), dan rendah (36,11%). Hasil analisis peta konsep menunjukkan mahasiswa mampu membuat konsep berupa komponen (72,71%) dan proses (27,29%). Keberhasilan implementasi pembelajaran juga dapat dilihat dari nilai N-Gain rata-rata. Keterampilan berpikir sistem mahasiswa berada pada kategori sedang dengan mahasiswa kimia memperoleh N-Gain lebih besar (0,63) daripada calon guru kimia (0,54). Literasi keberlanjutan mahasiswa juga berada pada kategori sedang dengan mahasiswa kimia memperoleh N-Gain lebih besar (0,68) daripada calon guru kimia (0,60). Hal ini mengindikasikan bahwa mahasiswa kimia lebih mampu mengembangkan kemampuan berpikir sistematis dalam menganalisis konsep daur ulang material sehingga dapat menghubungkannya dengan aspek-aspek keberlanjutan. Pendekatan ini berhasil meningkatkan literasi keberlanjutan mahasiswa.

Kata Kunci: Aktivitas Perekayasaan Molekul; Cairan Ionik Eutektik; Literasi Keberlanjutan; Perkuliahan Kimia Material Berbasis Penelitian; dan Pembelajaran Berpikir Sistem.

ABSTRACT

Sustainability literacy is essential for students to understand and address sustainability issues. This involves the molecular basis of sustainability from chemical interactions and their transformations. This study aims to reconstruct a research-based material chemistry course that is integrated with molecular engineering activities to improve sustainability literacy through systems thinking learning. The molecular engineering activity carried out was the selection of eutectic ionic liquids for metal extraction using COSMO-RS. The research method was a mixed method with exploratory sequential design combined with the Model of Educational Reconstruction (MER). The research instruments were content analysis sheets, preconception interview guidelines, repertory grids, concept maps, test questions, and student perception questionnaires. The learning design developed consisted of 4 main stages with learning content based on the results of content analysis and preconception interviews which showed that students' initial understanding of the topic of material recycling was still low. The resulting learning design was based on Course-Based Undergraduate Research Experiences (CUREs) and implemented to chemistry students and prospective chemistry teachers. The systems thinking profile can be seen in how students link elements into a construct and link concepts into a concept map. Based on the repertory grid analysis, students' systems thinking skills are at the level of analysis (77.54%), synthesis (19.32%), and implementation (3.14%), then focus cluster analysis using Rep Plus V.2.0 shows high categories (5.56%), medium (58.33%), and low (36.11%). The results of the concept map analysis show that students are able to create concepts in the form of components (72.71%) and processes (27.29%). The success of learning implementation can also be seen from the average N-Gain value. Students' systems thinking skills are in the medium category with chemistry students obtaining a greater N-Gain (0.63) than prospective chemistry teachers (0.54). Students' sustainability literacy is also in the medium category with chemistry students obtaining a greater N-Gain (0.68) than prospective chemistry teachers (0.60). This indicates that chemistry students are better able to develop systematic thinking skills in analyzing the concept of material recycling so that they can connect it to aspects of sustainability. This approach has succeeded in increasing students' sustainability literacy.

Keywords: Molecular Engineering Activity; Eutectic Ionic Liquids; Sustainability Literacy; Research-Based Material Chemistry Course; and Systems Thinking Learning.

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