

**PENGEMBANGAN MODEL PERKULIAHAN *6E LEARNING BY DESIGN*
BERORIENTASI ESD UNTUK MENINGKATKAN KEMAMPUAN
BERPIKIR SISTEM DAN PROSES KOGNITIF
PADA MATERI HIDROSFER**



DISERTASI

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Doktor
Pendidikan Ilmu Pengetahuan Alam (IPA)

**Oleh:
SYAIFUL ROCHMAN
NIM. 2106695**

**PROGRAM STUDI PENDIDIKAN ILMU PENGETAHUAN ALAM
FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
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2025**

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PADA MATERI HIDROSFER**

Oleh
Syaiful Rochman

S.Pd. Universitas Bengkulu, 2012
M.Pd. Universitas Negeri Yogyakarta, 2015

Sebuah Disertasi yang diajukan untuk memenuhi salah satu syarat memperoleh
gelar Doktor Pendidikan (Dr.) pada Fakultas Pendidikan Matematika dan Ilmu
Pengetahuan Alam

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Disetujui dan disahkan oleh panitia disertasi,

Promotor,



Prof. Dr. Hj. Nurvani Rastaman, M.Pd.

NIP. 920220119501231201

Ko-Promotor,



Prof. Dr. Winni Liliawati, S.Pd., M.Si.

NIP. 197812182001122001

Anggota,



Dr. Khairul Amri, S.T., M.T.

NIP. 197202121998021002

Ketua Program Studi Pendidikan Ilmu Pengetahuan Alam
Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam
Universitas Pendidikan Indonesia



Prof. Dr. phil. Ari Widodo, M.Ed.

NIP. 196705271992031001

PERNYATAAN KEASLIAN DISERTASI

Dengan ini saya menyatakan bahwa disertasi yang berjudul "**Pengembangan Model perkuliahan *6E Learning By Design* Berorientasi *ESD* Untuk Meningkatkan Kemampuan Berpikir Sistem dan Proses kognitif pada materi Hidrosfer**" beserta seluruh isinya adalah benar-benar karya saya sendiri dan saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan tersebut, saya siap menanggung resiko yang dijatuhkan kepada saya apabila dikemudian hari ditemukan adanya pelanggaran terhadap etika keilmuan dalam karya saya ini atau ada klaim dari pihak lain terhadap karya saya ini.

Bandung, Agustus 2025

Yang membuat pernyataan,



Syaiful Rochman

**PENGEMBANGAN MODEL PERKULIAHAN *6E LEARNING BY DESIGN*
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ABSTRAK

Bencana banjir yang dipicu oleh curah hujan ekstrem dan perubahan tata guna lahan menunjukkan pentingnya pemahaman sistemik terhadap masalah lingkungan. Pendidikan mahasiswa IPA berperan dalam membentuk kemampuan berpikir sistem untuk menangani isu kompleks seperti perubahan iklim dan tata guna lahan. Penelitian ini bertujuan untuk mengembangkan dan mengimplementasikan model perkuliahan *6E Learning by Design* yang berorientasi *Education for Sustainable Development (ESD)* guna meningkatkan kemampuan berpikir sistem dan proses kognitif materi hidrosfer pada mahasiswa IPA. Penelitian ini menggunakan metode pengembangan, pendekatan *Educational Developmental Research (EDR)* dengan model 4D (*Define, Design, Develop, Disseminate*). Proses implementasi penelitian ini menggunakan *mix method embedded experimental design*. Pengumpulan data kualitatif melalui kajian literatur, observasi, wawancara, analisis kurikulum, dan tes awal untuk merancang perangkat pembelajaran yang relevan. Setelah validasi ahli, uji coba dilakukan terhadap 27 mahasiswa menggunakan *pretest* dan *posttest* untuk mengukur kemampuan berpikir sistem dan proses kognitif. Analisis data dilakukan secara kualitatif, selanjutnya menggabungkan data kualitatif dan kuantitatif untuk mengevaluasi efektivitas model perkuliahan *6E Learning by design*. Hasil penelitian menunjukkan bahwa model perkuliahan ini memiliki karakteristik yang unik pada bagian *engineer* menuju *enrich* untuk memfasilitasi keterampilan *engineering* mahasiswa lebih mendalam. Hasil penelitian juga menunjukkan efektif untuk meningkatkan kemampuan berpikir sistem, kemampuan proses kognitif, dan memfasilitasi keterampilan *engineering* mahasiswa IPA. Uji statistik menunjukkan peningkatan yang signifikan pada kemampuan berpikir sistem ($*p < 0,05$) dan proses kognitif hidrosfer, dengan korelasi positif yang signifikan antara keduanya ($r = 0,736$). Model pembelajaran ini memfasilitasi keterlibatan aktif mahasiswa melalui tahapan pembelajaran yang terstruktur dan reflektif, didukung teknologi seperti *ArcGIS* dan masalah kontekstual. Penelitian ini menyarankan pengembangan model ini pada topik geosains lainnya, penerapannya di jenjang pendidikan yang lebih rendah, serta uji longitudinal untuk menilai keterampilan yang diperoleh.

Kata Kunci: *6E Learning by Design*, *ESD*, Kemampuan Berpikir Sistem, Proses Kognitif, Keterampilan *Engineering*, Hidrosfer

**DEVELOPMENT OF THE 6E LEARNING BY DESIGN CURRICULUM
MODEL ORIENTED ESD TO ENHANCE SYSTEM THINKING
SKILLS AND COGNITIVE PROCESSES
IN THE HYDROSPHERE TOPIC**

ABSTRACT

Flood disasters triggered by extreme rainfall and land-use change highlight the importance of a systemic understanding of environmental problems. Science education plays a crucial role in shaping students' systems thinking skills to address complex issues such as climate change and land-use dynamics. This study aims to develop and implement the *6E Learning by Design* model oriented toward *Education for Sustainable Development (ESD)* to enhance systems thinking skills and cognitive processes in the hydrosphere topic among science students.

The research employed a development method with the *Educational Developmental Research (EDR)* approach, using the 4D model (Define, Design, Develop, Disseminate). The implementation process followed a mixed-method embedded experimental design. Qualitative data were collected through literature review, observation, interviews, curriculum analysis, and preliminary tests to design relevant learning instruments. After expert validation, the trial was conducted with 27 students using pretests and posttests to measure systems thinking and cognitive processes. Data were analyzed qualitatively and further integrated with quantitative results to evaluate the effectiveness of the 6E Learning by Design model.

The findings reveal that this instructional model possesses unique characteristics, particularly in the *engineer-to-enrich* phase, which deepens students' engineering skills. The results also demonstrate the model's effectiveness in improving systems thinking abilities, cognitive processes, and fostering engineering skills among science students. Statistical tests indicated a significant improvement in systems thinking skills ($p < 0.05$) and hydrosphere cognitive processes, with a significant positive correlation between the two ($r = 0.736$). The model further facilitated active student engagement through structured and reflective learning stages, supported by technologies such as ArcGIS and contextual problem-solving.

This study recommends further development of the model for other geoscience topics, its implementation at lower levels of education, and longitudinal testing to assess the sustainability of the acquired skills.

Keywords: 6E Learning by Design, ESD, System Thinking Skills, Process Cognitive, Engineering Skills, Hydrosphere

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Puji syukur penulis panjatkan ke hadirat Allah SWT atas segala limpahan rahmat, taufik, dan hidayah-Nya sehingga penulis dapat menyelesaikan disertasi yang berjudul **“Pengembangan Model Perkuliahan *6E Learning By Design* Berorientasi *ESD* Untuk Meningkatkan Kemampuan Berpikir Sistem dan Proses kognitif pada Materi Hidrosfer”** ini dengan baik.

Disertasi ini disusun sebagai salah satu syarat untuk memperoleh gelar doktor dalam bidang pendidikan. Bencana banjir yang dipicu oleh curah hujan ekstrem dan perubahan tata guna lahan menunjukkan pentingnya pemahaman sistemik terhadap masalah lingkungan. Pendidikan mahasiswa IPA berperan dalam membentuk kemampuan berpikir sistem untuk menangani isu kompleks seperti perubahan iklim dan tata guna lahan. Penelitian ini bertujuan untuk mengembangkan dan mengimplementasikan program perkuliahan berbasis model *6E Learning by Design* yang berorientasi *Education for Sustainable Development (ESD)* guna meningkatkan kemampuan berpikir sistem dan proses kognitif hidrologi pada mahasiswa IPA. Penulis menyadari bahwa disertasi ini masih memiliki kekurangan. Oleh karena itu, kritik dan saran yang membangun sangat penulis harapkan demi penyempurnaan di masa mendatang. Semoga karya ini dapat memberikan kontribusi nyata dalam pengembangan pendidikan berkelanjutan, khususnya bidang pedagogi di Indonesia.

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