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I LOVE ECOSISTEAM IN CIRCULAR FACTORY (IMPLEMENTATION OF ECONOMY CIRCULAR IN VOCATIONAL EDUCATION THROUGH ECOSISTEAM LEARNING STRATEGY IN CIRCULAR FACTORY)

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ABSTRACTS
This study aims to develop an implementative learning model based on the Circular Economy through the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach at the Circular Factory unit at SMK Negeri Pringkuku. The background of this study is based on the high amount of textile waste from fashion practice activities, as well as the urgent need for vocational education oriented towards sustainability. The method used is Research and Development (R&D) with modifications to the Borg & Gall model in six stages. Data was collected through observation, interviews, questionnaires, documentation, and project evaluations. The research results indicate that integrating the circular economy concept with the STEAM approach can create deep learning, foster 21st-century skills (4C), competent teachers in implementing the circular economy in education, savings in practice materials.and enhance environmental awareness and entrepreneurial spirit (ecopreneurship). This innovation supports the achievement of SDGs points 4, 12, and 13, and drives the transformation of vocational education toward green skills and green jobs through the strengthening of a sustainable Teaching Factory model.

INTRODUCTION

Vocational education plays a strategic role in preparing skilled workers who are ready to face the challenges of the industry. Innovation in learning is key to producing outstanding, adaptive, and relevant graduates who meet the needs of the business and industry al worlds, thereby contributing to Indonesia's sustainable economic progress. Vocational schools emphasize the competencies of skilled and job-ready graduates, so their learning processes are dominated by practical activities and skill development (Barkah et al., 2024). Practical learning activities involve experimentation and training, which often result in failure, including in the Fashion Design and Production program at SMK Negeri Pringkuku. Practical learning often generates waste, which not only impacts the efficiency of practical costs but also affects the environment.

Fashion waste is the second-largest type of waste after plastic waste. Approximately 92 million tons of textile industry waste end up in landfills each year. Textile dyes are discharged into rivers without treatment, amounting to 40,000–50,000 tons per year. This is because 15 percent of fabric is wasted during cutting in every clothing production process (Fadhilah et al., 2025). In fashion production, there needs to be wisdom in the use of materials and tools to make the process more effective and efficient. According to the Copenhagen Fashion Summit (2015), the fashion industry produces 92 million tons of waste per year that ends up in landfills. This accounts for approximately 0.92–1.32% of the reported 7–10 billion tons of global annual solid waste generation (Global Waste Management Conference, 2021). In Indonesia, textile waste accounts for 2.6% of the total 33 million tons of waste per year, amounting to 866,000 tons per year (National Waste Management Information System, 2020). Meanwhile, data from the Central Statistics Agency (BPS) in 2014 indicates that Indonesians consume 308.4 tons of clothing per year. This means that people discard more than twice what they purchase in a single year, even though a piece of clothing can last for years (Riyadi et al., 2025).

From this phenomenon, there is a relevance that vocational schools, as educational institutions, play a role in preparing the younger generation to be more adaptive to the developments of the times and global issues. One of the global issues that has emerged recently is the issue of sustainable development goals (SDGs), which aim to promote responsible consumption and sustainability (Malcheni, 2022).

Schools, as educational institutions, should reinforce their role in supporting the achievement of the SDGs through structured efforts, taking concrete actions, and collaborating with various parties to address various challenges in development. Quality education is undoubtedly essential for a nation's progress. Education is not merely a tool for “change agents” for the younger generation who will become the nation's successors, but it must also serve as an “agent of production” to create tangible transformation (Elvira et al., 2022).

From this, there is a need for a habit or learning process that can shape the character of the younger generation to be wiser in production, including in fashion products. One strategy in shaping wise production character is to implement the concept of a circular economy in learning. The circular economy emphasizes the need to re-examine traditional production and consumption chains, where the circular economy is defined as “a general term for activities aimed at reducing, reusing, and recycling in production, circulation, and consumption” through the preservation of

product value, materials, and resources within the economy for as long as possible, thereby minimizing waste production. (Arsy & Syamsulrizal, 2021).

The concept of the circular economy in educational practice can be implemented in a teaching factory or TEFA, where the circular concept or reuse of production waste becomes another valuable product, or can be integrated into a circular factory learning concept. For its implementation, a STEAM (science, technology, engineering, art, and mathematics) approach is needed to facilitate the process.

A. METHOD

This research is a research and development (R&D) study aimed at producing an implementative learning model based on the Circular Economy through the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach at the Circular Factory unit. Research and Development (R&D) is the process or steps involved in developing a new product or improving an existing one. Development research is one type of research that can bridge or bridge the gap between basic research and applied research (Sugiyono, 2013).

The stages of the development model according to Borg & Gall include: research and information collection, planning, development of a preliminary form of the product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination, and implementation (Sugiyono, 2013).

The development model used is a modified version of the Borg & Gall model, simplified into six main stages: (1) preliminary study, (2) planning and model design, (3) development of tools, (4) limited testing, (5) product revision, and (6) limited implementation.

The research was conducted at SMK Negeri Pringkuku, Pacitan Regency, East Java, focusing on the Fashion Design program, which has initiated the Circular Factory initiative. The research subjects consisted of productive teachers from the Fashion Design program, 11th-grade students participating in practical activities at the production unit, the school principal, and industry partners, who served as key informants in strengthening the context of circular economy-based learning.

Data was collected using the following techniques: 1) Participatory observation, to understand the implementation of STEAM learning and student involvement in circular fashion projects, 2) In-depth interviews, conducted with teachers, students, and the school principal to explore perceptions of the learning model and the application of the circular economy, 3) Response questionnaires, given to students and teachers to assess the usefulness, sustainability, and meaningfulness of learning, 4) Project documentation, in the form of recycled products, educational posters, and project reports, 5) Project assessment rubrics, used to assess aspects of creativity, collaboration, material sustainability, and the environmental impact of learning outcomes.

C. RESULT AND DISCUSSION

This innovation is the development of implementative learning based on the Circular Economy, which is a strategic step in responding to global sustainability challenges and the needs of the industrial world. SMK Negeri Pringkuku has

introduced an educational innovation that integrates circular economy principles with a STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach, aiming to produce graduates who are not only technically competent but also adaptable, creative, and environmentally conscious (Dewi & Sutriyani, 2024).

This learning approach aligns with the mandate of Ministry of Education and Culture Regulation No. 34 of 2018 on Graduation Competency Standards for Vocational High Schools (SMK/MAK), which emphasizes the importance of fostering entrepreneurial character, social responsibility, and environmental awareness. Additionally, this innovation is an implementation of the deep learning approach, where the learning outcomes aim to achieve the 8 dimensions of graduates (with a focus on developing various dimensions of graduate profiles, such as faith and piety, citizenship, critical thinking, creativity, collaboration, independence, health, and communication).

The implementation of the circular economy concept is applied through the STEAM approach to achieve deep learning, while the production process at the Teaching Factory (TEFA) is focused on the 5R principles (Reduce, Reuse, Recycle, Repair, Rethink), particularly in the expertise competencies of Design and Apparel Production. Textile waste is processed into new marketable products, the use of natural dyes is developed, and digitalization systems are implemented for production efficiency. This innovation directly contributes to the achievement of the SDGs, particularly Goal 4 (quality education), Goal 12 (responsible consumption and production), and Goal 13 (climate action) (Febriansari et al., 2022).

This innovation is an effort to provide in-depth learning for students specializing in Fashion Design and Production by applying the circular economy concept in teaching factory learning, making it more effective, efficient, and environmentally friendly.

Concept

This innovation implements the Circular Economy concept in teaching factory learning using a STEAM approach to develop circular production principles (not the linear model of raw materials –> production process –> use –> waste). which uses the pattern: materials → production process → waste = materials → production process → product → use → waste = materials → production process → product (Ajir et al., 2025).

The main concepts are: 1) Circular Economy: Sustainable production and consumption principles by applying the 5R principles (Reduce, Reuse, Recycle, Repair, Rethink). 2) Teaching Factory (TEFA): A learning model based on real-world production that integrates the education sector with the workforce. The TEFA (Teaching Factory) program approach combines the CBT (Competency-Based Training) learning approach, where training is based on the work performed by students at the workplace and emphasizes what an individual can do as a result of the training (output) rather than the quantity of training. 3) STEAM: An integrative approach based on Science, Technology, Engineering, Art, and Mathematics to sharpen students' creativity, logic, and innovation. The STEAM approach has many advantages. When applied in learning, the STEAM approach can develop critical thinking skills, creativity, as well as students' moral and ethical values. 4) Sustainable Fashion: The production and design of clothing that considers environmental, social, and economic impacts. Sustainable fashion is a fashion trend that prioritizes the

values of those involved, particularly in the fields of the environment and humanity (Shafira, 2021).

Methods

The implementation methods in learning use several approaches (NENENG & MULYAWAN, 2023), including: 1) Project-Based Learning (PjBL): Students work on real projects related to waste management, recycling, and product innovation based on the Circular Economy, 2) Design Thinking: A creative process to design solutions to environmental problems using critical and innovative thinking approaches, 3) Collaborative Learning: Collaboration among students across disciplines to integrate science, engineering, art, and mathematics aspects into Circular Economy projects, 4) Problem-Based Learning: Students are encouraged to identify environmental issues in their surroundings (e.g., plastic waste, organic waste) and design solutions based on Circular Economy principles, 5) Entrepreneurship Education: Integrating entrepreneurship based on recycled products (ecopreneurship)

Technology

The technologies used to support this innovation include 1) Android fashion design applications, 2) Google platforms for digital portfolios.

Products

The implementation of the Circular Economy through the STEAM approach at the Circular Factory has produced various economically valuable works.

Tabel 1. Circular Factory Product

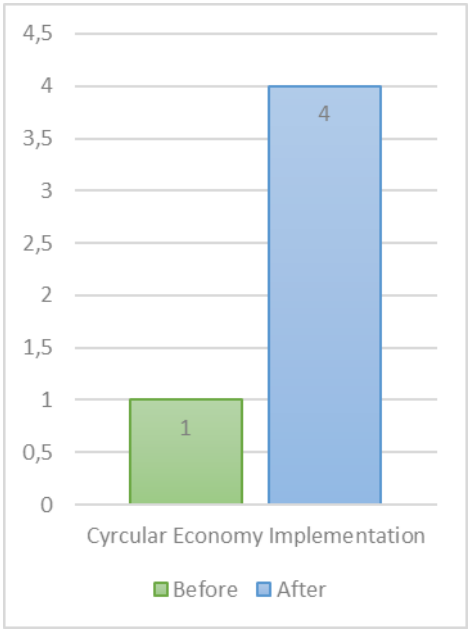
Picture	Product	Circular
	Vest	Recycle
	Men's Shirt	Redesign
	Coctail Dress	Repair

	Tote Bag	Reuse
	Digital Disign	Reduse

Teacher Competence

Before imparting knowledge about the application of the circular economy in fashion design education at SMK Negeri Pringkuku, the four teachers applied a linear system in the use of practical materials. However, with the implementation of the circular economy system, the four fashion design teachers were able to apply circular principles in the learning process (Mu'minah, 2020).

Table 1. Teachers Who Apply the Circular Principle



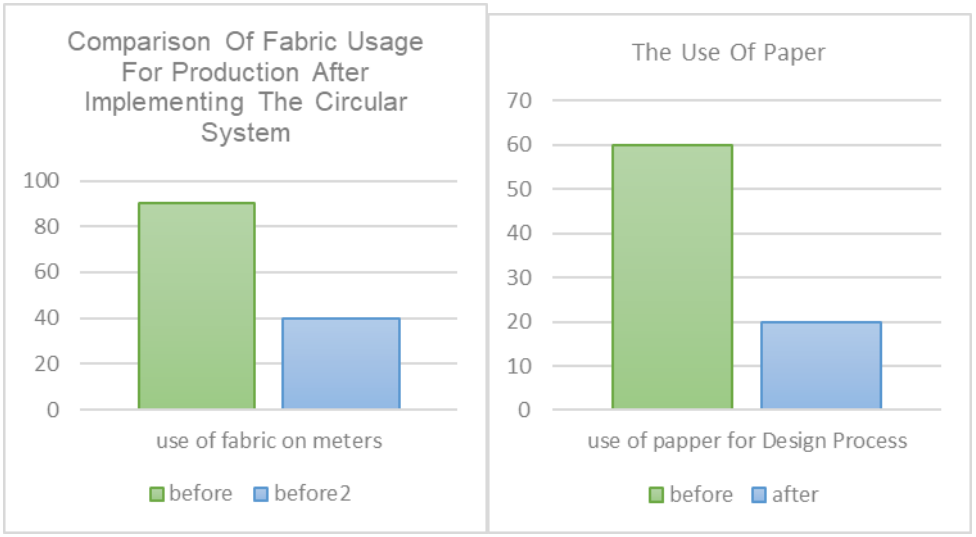
Practical Material Savings

Before implementing the STEM system in learning, the use of practical materials was inefficient, including the use of paper and fabric for practical work. However, after implementing STEM in the design process using digital applications for fashion design, paper usage decreased. Previously, each of the 20 students in the class needed three sheets of paper, but when using digital applications, only one sheet of

paper was needed per student. This process is included in the rethink process (Rosiani, 2023).

Additionally, by using the circular system, students are more economical in using fabric for practical materials because fabric that is incorrect or inappropriate in the practical process is discarded and reused for practical purposes until it is appropriate. This process is part of the reuse, rethink, redesign, and recycle process.

Table 2. Practical Material Savings



Impact

The impact of this innovation can improve 21st Century Skills: Critical thinking, creativity, collaboration, communication (4C), improve STEAM Literacy: Students are able to apply knowledge of Science, Technology, Engineering, Arts, and Mathematics to solve real problems, foster an Entrepreneurial Spirit (Ecopreneurship): Students are able to create products from waste with economic value (creative recycling), as well as increasing Environmental Awareness: Students are more concerned about environmental issues and behave in an environmentally friendly manner (Zubaidah, 2019).

Additionally, this innovation also impacts school performance, where the school becomes a center for Circular Economy innovation and a model for Circular Economy-based schools. Strengthening the Link and Match between the Business and Industrial World (DUDI) is also achieved through collaboration with recycling and green business industry partners. Additionally, it impacts the enhancement of the Pancasila Student Profile through the practical implementation of values such as cooperation, independence, and critical thinking.

By applying the circular economy system to every student's work, it also impacts the community and empowers the community through environmental education. Practically, students become agents of change who spread the Circular Economy mindset in their surroundings. The implementation of this innovation in the learning process also reduces waste volume in the local environment, directly impacting the Circular Economy-based waste management project. Additionally, recycled products can be marketed as creative products, supporting local SMEs and automatically boosting the local economy.

This innovation also has a sustainable impact aligned with the SDGs (Sustainable Development Goals): specifically Goal 4 (quality education), Goal 12 (responsible consumption and production), and Goal 13 (climate action). It also helps build a circular economy culture in the education sector, facilitating the transformation of vocational education toward green skills and green jobs (Sari & Ekayanti, 2021).

D. CONCLUSION

This study concludes that Circular Economy-based learning innovation integrated with the STEAM approach through the Teaching Factory (TEFA) unit in the Fashion Design and Production competency at SMK Negeri Pringkuku has proven effective in developing contextual, sustainable, and relevant learning that meets the needs of the future industry. This approach not only equips students with technical skills but also fosters critical thinking, creativity, collaboration, communication, and environmental awareness—all of which align with 21st-century skills (4C) and the Pancasila learner profile.

By implementing Project-Based Learning, Design Thinking, Problem-Based Learning, Collaborative Learning, and Entrepreneurship Education methods, this innovation provides deep learning experiences focused on real-world solutions to textile waste issues. The use of digital technology in design, portfolio documentation, and marketing of recycled products further strengthens digital skills and sustainable entrepreneurship (ecopreneurship). The Circular Economy concept, implemented through the 5R principles (Reduce, Reuse, Recycle, Repair, Rethink), successfully transforms waste into new raw materials with market value. This not only reduces waste volume in the local environment but also opens up creative business opportunities that can support the local economy and community empowerment.

Another positive impact is the increased role of schools as centers of circular economy innovation and green learning models that bridge the gap between the education sector and the business and industrial sectors (link and match). Strategically, this innovation supports the achievement of sustainable development goals (SDGs), particularly point 4 (quality education), point 12 (responsible consumption and production), and point 13 (action against climate change). Thus, this innovation not only impacts the improvement of vocational education quality but also drives educational transformation toward green skills and green jobs, while fostering a sustainable circular economy culture in the education sector.

REFERENCES

Ajir, B., Salmawati, S., & Ishak, S. (2025). Literature review: Inovasi pembelajaran STEAM (Science, Technology, Engineering, Art, and Mathematics) pada mata pelajaran matematika di sekolah dasar. *Jurnal Ilmiah Matematika (JIMAT)*, *6*(1), 219–226.

Arsy, I., & Syamsulrizal, S. (2021). Pengaruh pembelajaran steam (science, technology, engineering, arts, and mathematics) terhadap kreativitas peserta didik. *Biolearning Journal*, *8*(1), 24–26.

Barkah, E. S., Awaludin, D., & Bahtiar, M. (2024). Implementasi model pembelajaran steam (science, technology, engineering, art and mathematics): Strategi peningkatan kecakapan abad 21. *Jurnal Syntax Admiration*, *5*(9), 3501–3511.

Dewi, S. N., & Sutriyani, W. (2024). Efektivitas model pembelajaran STEAM (science, technology, engineering, art, and mathematics) terhadap hasil belajar matematika sekolah dasar. *Jurnal Syntax Admiration*, *5*(7), 2752–2759.

Elvira, M., Aprilia, E., & Sainuddin, S. (2022). Model Pembelajaran STEAM (Science, Technology, Engineering, Art, and Mathematics) di Kota Malang. *Preschool: Jurnal Perkembangan Dan Pendidikan Anak Usia DIni*, *4*(1), 13–20.

Fadhilah, M. N., Ahmad Fawaid, M. P. I., Yuliati, I., & Rahmah, N. (2025). *Model pembelajaran steam berbasis kearifan lokal Madura*. Cahya Ghani Recovery.

Febriansari, D., Sarwanto, S., & Yamtinah, S. (2022). Konstruksi model pembelajaran STEAM (Science, Technology, Engineering, Arts, and Mathematics) dengan pendekatan design thinking pada materi energi terbarukan. *JINoP (Jurnal Inovasi Pembelajaran)*, *8*(2), 186–200.

Mu'minah, I. H. (2020). Implementasi STEAM (science, technology, engineering, art and mathematics) dalam pembelajaran abad 21. *Bio Educatio*, *5*(1), 377702.

NENENG, N., & MULYAWAN, S. N. (2023). Implementasi model pembelajaran STEAM dalam meningkatkan kreativitas peserta didik di RA Al-Manshuriyah Kota Sukabumi. *Jurnal Arjuna: Publikasi Ilmu Pendidikan, Bahasa Dan Matematika Учредители: Asosiasi Riset Ilmu Manajemen Dan Bisnis Indonesia*, *1*(5), 73–93.

Riyadi, R., Sarwanto, S., Triyani, S., & Saddhono, K. (2025). *STEAM-A (Science, Technology, Engineering, Arts, Mathematics, Animation) Berbasis Kearifan Lokal di Sekolah Dasar*. Tren Digital Publishing.

Rosiani, M. (2023). Pengaruh Model Pembelajaran Steam (Science, Technology, Engineering, Art, And Mathematics) Terhadap Prestasi Belajar Siswa Pada Pembelajaran Ipa Kelas V Sekolah Dasar: Meilina Rosiani1, Pamujo2. *EduTeach: Jurnal Edukasi Dan Teknologi Pembelajaran*, *4*(2).

Sari, P. N., & Ekayanti, A. (2021). Penerapan model pembelajaran STEAM (science, technology, engineering, art, and math) untuk penguatan literasi-numerasi siswa. *Jurnal Abdimas Indonesia*, *1*(2), 89–96.

Sugiyono, D. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D*.

Zubaidah, S. (2019). *STEAM (science, technology, engineering, arts, and mathematics): Pembelajaran untuk memberdayakan keterampilan abad ke-21*. 1–18.