PENERAPAN PROGRAM *BOTANICAL ECO-GAMIFICATION* PADA MATERI PEMBANGUNAN BERKELANJUTAN TERHADAP KOMPETENSI ESD, *TEAM WORK* DAN MOTIVASI MAHASISWA CALON GURU BIOLOGI

TESIS

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Program Studi Magister Pendidikan Biologi

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PENERAPAN PROGRAM *BOTANICAL ECO-GAMIFICATION* PADA MATERI PEMBANGUNAN BERKELANJUTAN TERHADAP KOMPETENSI ESD, *TEAM WORK* DAN MOTIVASI MAHASISWA CALON GURU BIOLOGI

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Dengan ini saya menyatakan bahwa tesis dengan judul "Penerapan Program *Botanical Eco-Gamification* pada Materi Pembangunan Berkelanjutan terhadap Kompetensi ESD, *Teamwork* dan Motivasi Mahasiswa Calon Guru Biologi" berserta seluruh isinya adalah benar-benar 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/sanksi apabila dikemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, Januari 2024

Asyah Dwi Hastika

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Penulis telah menyelesaikan tesis dengan judul “Penerapan Program *Botanical Eco-Gamification* pada Materi Pembangunan Berkelanjutan terhadap Kompetensi ESD, *Team work* dan Motivasi Mahasiswa Calon Guru Biologi”. Tesis ini diajukan sebagai salah satu syarat memperoleh gelar Magister Pendidikan Biologi di Prodi Pendidikan Biologi, Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia. Penulisan tesis ini memaparkan tentang pengaruh penerapan program pembelajaran *Botanical Eco-Gamification* terhadap kompetensi ESD, keterampilan bekerja sama (*team work*), dan motivasi belajar mahasiswa calon guru biologi.

Penulis sepenuhnya menyadari bahwa tesis ini masih jauh dari sempurna dikarenakan keterbatasan pengetahuan dan pengalaman penulis. Penulis berharap karya tulis ini dapat memberikan kontribusi positif bagi bidang ilmu pendidikan khususnya pendidikan di Indonesia, serta masyarakat luas. Semoga karya tulis ini dapat menjadi amal jariah bagi penulis. Aamiin.

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Penerapan Program *Botanical Eco-Gamification* pada Materi Pembangunan Berkelanjutan terhadap Kompetensi ESD, *Team Work*, dan Motivasi Mahasiswa Calon Guru Biologi

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ABSTRAK

Pendidikan untuk pembangunan berkelanjutan (ESD) bertujuan untuk mengembangkan kompetensi keberlanjutan sebagai kunci dalam menghadapi tantangan global. Pengembangan kompetensi ESD, kemampuan bekerja sama dan motivasi belajar diperlukan bagi calon guru biologi sebagai fasilitator pendidikan berkelanjutan. *Botanical Eco-Gamification* merupakan program pembelajaran yang menggabungkan unsur ekologi botani dan gamifikasi untuk meningkatkan minat dan keterlibatan mahasiswa dalam mempromosikan praktik pembangunan berkelanjutan. Penelitian ini bertujuan untuk menjelaskan pengaruh penerapan program pembelajaran *Botanical Eco-Gamification* terhadap kompetensi ESD, kemampuan *team work* dan motivasi belajar mahasiswa calon guru biologi. Penelitian ini menggunakan metode *pre-experimental* dengan *one group pretest-posttest* dan *one group posttest only design*. Subjek penelitian berjumlah 72 orang mahasiswa calon guru biologi yang mengontrak mata kuliah Biodiversitas, Pengetahuan Lingkungan dan Konservasi di salah satu Perguruan Tinggi di Bandung-Jawa Barat. Teknik sampling yang digunakan adalah *convenience sampling*. Pengumpulan data penelitian dilakukan dengan menggunakan beberapa instrumen yaitu: 1) instrumen tes (pilihan ganda dan uraian terbuka) pada kompetensi ESD (domain kognitif), 2) angket *self assesment* dan *peer assesment* pada kompetensi ESD (domain afektif), 3) lembar observasi pada kemampuan *team work*, dan 4) kuesioner pada motivasi belajar mahasiswa dan respon terhadap pembelajaran. Hasil penelitian menunjukkan bahwa: (1) Penerapan program *Botanical Eco-Gamification* memberikan pengaruh secara signifikan terhadap kompetensi ESD, kemampuan *team work* dan motivasi belajar mahasiswa calon guru biologi, (2) Peningkatan nilai rata-rata kompetensi ESD dengan capaian N-*Gain* dalam kategori sedang (0,57) dengan capaian nilai rata-rata awal sebesar 68,89 dengan kategori baik menjadi 83,63 dengan kategori sangat baik. (3) Capaian kemampuan *team work* mahasiswa dalam kategori baik (85,88), dan terdapat korelasi yang cukup kuat dan signifikan dengan kompetensi ESD pada domain afektif, (4) Peningkatan motivasi belajar mahasiswa dengan capaian N-*Gain* dalam kategori tinggi (0,70) dengan capaian awal pada kategori cukup termotivasi (69,43) menjadi sangat termotivasi (91,03), (5) Respon mahasiswa terhadap progam *Botanical Eco-Gamification* dalam kategori sangat baik (86,79), 6) Terdapat korelasi yang cukup kuat dan signifikan antara kompetensi ESD dengan kemampuan *team work*, dan motivasi belajar mahasiswa calon guru biologi.

Kata Kunci: Kompetensi ESD, *Team work*, Motivasi Belajar, *Botanical Eco-Gamification*, *Outdoor learning.*

Implementation of Botanical Eco-Gamification Program on Sustainable Development Materials for ESD Competence, Team Work, and Motivation of Undergraduate Biology Students

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ABSTRACT

Education for sustainable development (ESD) aims to develop competencies as a key in facing global challenges. The development of ESD competencies and the ability to work together as well as motivation to learn are necessary for prospective biology teachers as facilitators of sustainable education. Botanical Eco-Gamification is a learning program that combines elements of botanical ecology and gamification to increase student interest and involvement in promoting sustainable development practices. This study aims to explain the effect of implementing the Botanical Eco-Gamification learning program on ESD competencies, teamwork skills and learning motivation of prospective biology teacher students. This study used pre-experimental method with one group *pretest-posttest* and one group *posttest* only design. The subjects of this study were 72 prospective biology teacher students who contracted Biodiversity, Environmental Knowledge and Conservation courses at one of the Universities in Bandung-West Java. The data collection technique of the research conducted was netted by using several instruments, namely: 1) test instrument (multiple choice and open description) on ESD competence (cognitive domain), 2) self assessment and peer assessment questionnaire on ESD competence (affective domain), 3) observation sheet on team work ability, and 4) questionnaire on student learning motivation and response to learning. The results showed that: (1) The implementation of the Botanical Eco-Gamification program significantly influenced the ESD competence, teamwork skills and learning motivation of biology teacher candidates, (2) The increase in the average score of ESD competence with the achievement of N-Gain in the moderate category (0.57) with the achievement of the initial average score of 63.63 in the good category to 83.38 in the excellent category. (3) The achievement of students' teamwork skills in the good category (85.88), and there is a fairly strong and significant correlation with ESD competence in the affective domain, (4) Increased student learning motivation with N-Gain achievements in the high category (0.70) with initial achievements in the moderately motivated category (69, 43) to be very motivated (91.03), (5) Student response to the Botanical Eco-Gamification program in the very good category (86.79), (6) There is a fairly strong and significant correlation between ESD competencies with teamwork skills, and learning motivation of undergraduate biology students.

Keywords: ESD Competency, Teamwork, Learning Motivation, *Botanical Eco-Gamification*, Outdoor Learning

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DAFTAR PUSTAKA

Agusta, A. R., & Noorhapizah, D. (2018a). Improving the Student's Cooperation and Environmental Care Skill using Outdoor Learning Strategy Outbound Variation. *Advances in Social Science, Education and Humanities Research*, *274*, 10–17. https://doi.org/10.2991/iccite-18.2018.3

Agusta, A. R., & Noorhapizah, D. (2018b). Improving the Student's Cooperation and Environmental Care Skill using Outdoor Learning Strategy Outbound Variation. *Advances in Social Science, Education and Humanities Research*, *274*(1), 10–17. https://doi.org/10.2991/iccite-18.2018.3

Ali, A., Rasoolimanesh, S., & Cobanoglu, C. (2020). Technology in Tourism and Hospitality to Achieve Sustainable Development Goals (SDGs). *Journal of Hospitality and Tourism Technology*, *11*, 177–181.

Ali, M., Wahyuni, S., & Erwing, E. (2021). Persepsi Siswa Terhadap Pembelajaran Luar Ruangan Sebagai Proses Pendidikan Lingkungan. *Jurnal Ilmiah Mandala Education*, *7*(3), 366–372. https://doi.org/10.36312/jime.v7i3.2266

Alsawaier, R. S. (2017). Gamification: Motivation and Engagement. *The International Journal of Information and Learning Technology*, *35*(1), 1–50.

Alves, L., Faria, P. M., Cruz, E. F., Lopes, S. I., & Rosado da Cruz, A. M. (2023a). Eco-Gamification Platform to Promote Consumers' Engagement in the Textile and Clothing Circular Value Chain. *Sustainability*, *15*(5398), 1–31. https://doi.org/10.3390/su15065398

Alves, L., Faria, P. M., Cruz, E. F., Lopes, S. I., & Rosado da Cruz, A. M. (2023b). Eco-Gamification Platform to Promote Consumers’ Engagement in the Textile and Clothing Circular Value Chain. In *Sustainability* (Vol. 15, Issue 6). https://doi.org/10.3390/su15065398

Ariesandy, K. T. (2021). Pengaruh Pembelajaran Luar Kelas (Outdoor Learning) Berbentuk Jelajah Lingkungan Dan Motivasi Terhadap Hasil Belajar Biologi Siswa. *Wahana Matematika Dan Sains: Jurnal Matematika, Sains, Dan Pembelajarannya*, *15*(1), 110–120.

Arikunto, S. (2013). *Dasar-Dasar Evaluasi Pendidikan*. Rineka Cipta.

Arikunto, S. (2019). *Prosedur Penelitian*. Rineka Cipta.

Artobatama, I., Hastuti, W. S., Zubaidah, E., & Wibowo, S. E. (2023). STEM Learning Design with Literation-Based Pop-Up Book Media in Elementary Schools. *Jurnal Prima Edukasia*, *11*(2), 152–160. https://doi.org/10.21831/jpe.v11i2.56628

Assbeihat, J. M. (2016). The Impact of Collaboration among Members on Team's Performance. *Management and Administrative Sciences Review* , *5*(5), 248–259.

Avelar, A. B. A., Silva-Oliveira, K. D. da, & Pereira, R. da S. (2019). Education for advancing the implementation of the Sustainable Development Goals: A systematic approach. *The International Journal of Management Education*, *17*(3), 100322. https://doi.org/https://doi.org/10.1016/j.ijme.2019.100322

Bennett, L. M., & Gadlin, H. (2012). Collaboration and Team Science: From Theory to Practice. *National Institutes Health*, *60*(5), 768–775. https://doi.org/10.231/JIM.0b013e318250871d.Collaboration

Bouchrika, I., Harrati, N., Wanick, V., & Wills, G. (2021). Exploring the impact of gamification on student engagement and involvement with e-learning systems. *Interactive Learning Environments*, *29*(8), 1244–1257. https://doi.org/10.1080/10494820.2019.1623267

Brady, S. C., & Andersen, E. C. (2021). An escape-room inspired game for genetics review. *Journal of Biological Education*, *55*(4), 406–417. https://doi.org/10.1080/00219266.2019.1703784

Branch, R. M. (2009). Approach, Instructional Design: The ADDIE. In *Department of Educational Psychology and Instructional Technology University of Georgia* (Vol. 53, Issue 9).

Brookes, R. H. (2017). Developing Teamwork Skills In Undergraduate Science Students: The Academic Perspective And Practice. *Proceedings of the Australian Conference on Science and Mathematics Education*, 137–148. https://core.ac.uk/download/pdf/229410227.pdf

Burbules, N. C., Fan, G., & Repp, P. (2020). Five trends of education and technology in a sustainable future. *Geography and Sustainability*, *1*(2), 93–97. https://doi.org/10.1016/j.geosus.2020.05.001

Burns, H., Muñoz, M. C., & Sager, M. (2016). Engaging Change-Makers: A Profile of the Leadership for Sustainability Education Graduate Program. *Sustainability (United States)*, *9*(4), 178–184. https://doi.org/10.1089/SUS.2016.29054

Cebrián Bernat, G., Segalàs Coral, J., & Hernández Gómez, M. (2019). Assessment of sustainability competencies: A literature review and future pathways for ESD research and practice. *Central European Review of Economics and Management*, *3*(3), 19–44.

Chans, G. M., & Castro, M. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. *Computers*, *10*(10). https://doi.org/10.3390/computers10100132

Chapman, J. R., & Rich, P. J. (2018). Does educational gamification improve students' motivation? If so, which game elements work best? *Journal of Education for Business*, *93*(7), 314–321. https://doi.org/10.1080/08832323.2018.1490687

Costa, C. J., Aparicio, M., Aparicio, S., & Aparicio, J. T. (2017). Gamification usage ecology. *SIGDOC 2017 - 35th ACM International Conference on the Design of Communication*. https://doi.org/10.1145/3121113.3121205

Cottafava, D., Cavaglià, G., & Corazza, L. (2019). Education of sustainable development goals through students' active engagement: A transformative learning experience. *Sustainability Accounting, Management and Policy Journal*, *10*(3), 521–544. https://doi.org/10.1108/SAMPJ-05-2018-0152

Creswell, J. W. (2012). *Educational Research*.

Daumiller, M., Stupnisky, R., & Janke, S. (2020). Motivation of higher education faculty: Theoretical approaches, empirical evidence, and future directions. *International Journal of Educational Research*, *99*. https://doi.org/10.1016/j.ijer.2019.101502

de Haan, G. (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education*, *56*(2), 315–328. https://doi.org/10.1007/s11159-010-9157-9

de Prada Creo, E., Mareque, M., & Portela-Pino, I. (2021). The acquisition of teamwork skills in university students through extra-curricular activities. *Education and Training*, *63*(2), 165–181. https://doi.org/10.1108/ET-07-2020-0185

De Prada, E., Mareque, M., & Pino-Juste, M. (2022). Teamwork skills in higher education: is university training contributing to their mastery? *Psicologia: Reflexao e Critica*, *35*(1), 1–13. https://doi.org/10.1186/s41155-022-00207-1

Douglas, B. D., & Brauer, M. (2021). Gamification to prevent climate change: a review of games and apps for sustainability. *Current Opinion in Psychology*, *42*, 89–94. https://doi.org/10.1016/j.copsyc.2021.04.008

Edge, S. (2019). *Quasi-Experimental And Single-Case Experimental Designs* (pp. 333–370). Sage Publications, Inc.

Ernawati, T. (2016). Implementasi Scientific Approach pada Outdoor Learning Untuk Meningkatkan Motivasi Belajar Mahasiswa Pendidikan IPA. *Pijar MIPA*, *XI*(1), 34–38.

Fraenkel, J. R., Wallen, N., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education*. McGraw-Hill.

Galeote, D. F., Rajanen, M., Rajanen, D., Legaki, N. Z., Langley, D. J., & Hamari, J. (2021). Gamification for climate change engagement: Review of corpus and future agenda. *Environmental Research Letters*, *16*(6). https://doi.org/10.1088/1748-9326/abec05

Gericke, N., Boeve-de Pauw, J., Berglund, T., & Olsson, D. (2019). The Sustainability Consciousness Questionnaire: The theoretical development and empirical validation of an evaluation instrument for stakeholders working with sustainable development. *Sustainable Development*, *27*(1), 35–49. https://doi.org/10.1002/sd.1859

González, M., Arrocha, A., Bellido, E., Gonzalez, M. J., Espinosa, M., Peredo, A. V., Sancho-Galán, P., Álvarez-Saura, J. Á., Barbero, G. F., & Cejudo-

Bastante, C. (2019). Escape ClassRoom: Can You Solve a Crime Using the Analytical Process? *Journal of Chemical Education*, *96*(2), 267–273. https://doi.org/10.1021/acs.jchemed.8b00601

Groff, A., Lockhart, D., Ogden, J., & Dierking, L. D. (2005). An exploratory investigation of the effect of working in an environmentally themed facility on the conservation-related knowledge, attitudes and behavior of staff. *Environmental Education Research*, *11*(3), 371–387. https://doi.org/10.1080/13504620500081384

Guay, F., Chanal, J., Ratelle, C. F., Marsh, H., Larose, S., & Boivin, M. (2010). Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology*, *80*(4), 711–735. https://doi.org/10.1348/000709910X499084

Guilford, J. . (1956). *Fundamental Statistic in Psychology and Education* (3rd Editio). McGraw-Hill Education.

Guillén, A., Díez, R. M., Luján, L., & Gené, O. (2021). Educational hall escape: Increasing motivation and raising emotions in higher education students. *Education Sciences*, *11*(9). https://doi.org/10.3390/educsci11090527

Hake, R. R. (1999). Analyzing Change/ Gain Scores. *American Journal of Pshysics*, *4*(5).

Hanief, Y. N., & Himawanto, W. (2017). *Statistik Pendidikan*. Deepublish.

Harianto, S. P., Tsani, M. K., Santoso, T., Masruri, N. W., & Winarno, G. D. (2021). Penilaian Wisatawan Terhadap Komponen Destinasi Wisata: Atraksi, Amenitas, Aksesibilitas dan Pelayanan Tambahan Pada Objek Wisata Kebun Raya Liwa. *Jurnal Ilmu Kehutanan*, *15*(1), 13–27. https://doi.org/10.22146/jik.v15i1.1515

Harris, F. (2018). Outdoor learning spaces: The case of forest school. *Area*, *50*(2), 222–231. https://doi.org/10.1111/area.12360

Hastika, A. D., Fuadiyah, S., Darussyamsu, R., & Fitri, R. (2022). Kualitas Lembar Kerja Praktikum (LKP) Biologi Menggunakan Diagram Vee Pada Materi Sistem Respirasi. *Journal for Lesson and Learning Studies*, *5*(1), 19–25. https://doi.org/10.23887/jlls.v5i1.39720

Hastika, A. D., Saefudin, & Supriatno, B. (2023). Student Perceptions of Outdoor Learning : High School Biology Learning Activities in Botanical Gardens [Manuscript accepted]. *Journal of Research in Science Education*, *X*(5), 1–9.

Hastika, A. D., & Supriatno, B. (2023). Desain Lembar Kerja Praktikum (Worksheet) Alternatif : Uji Amilum pada Materi Fotosintesis. *Jurnal Ilmiah Ilmu Pendidikan*, *6*(12), 10927–10936.

Hernandez, M., Escobar Díaz, C. A., & Morales-Menendez, R. (2020). Educational experiences with Generation Z. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *14*(3), 847–859. https://doi.org/10.1007/s12008-020-00674-9

Herrera, C. C., Carrizosa, A., Yunes-Rojas, J. A., & Gómez, M. A. (2019). Design of an app based on gamification and storytelling as a tool for biology courses. *International Journal on Interactive Design and Manufacturing*, *13*(4), 1271–1282. https://doi.org/10.1007/s12008-019-00600-8

Hobson, C. J., Strupeck, D., Griffin, A., Szostek, J., Selladurai, R., & Rominger, A. S. (2013). Field testing a behavioral teamwork assessment tool with US undergraduate business students. *Business Education & Accreditation*, *5*(2), 17–27.

Högberg, J., Hamari, J., & Wästlund, E. (2019). Gameful Experience Questionnaire (GAMEFULQUEST): an instrument for measuring the perceived gamefulness of system use. In *User Modeling and User-Adapted Interaction* (Vol. 29, Issue 3). Springer Netherlands. https://doi.org/10.1007/s11257-019-09223-w

Irianto, T., Arifin, R., & Firmansyah, M. (2021). The Relationship of Physical Activities and Student Learning Outcomes of Physical Education. *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*, *5*(2), 318–325. https://doi.org/10.33369/jk.v5i2.16376

Jeronen, E., Palmberg, I., & Yli-Panula, E. (2017). Teaching methods in biology education and sustainability education including outdoor education for promoting sustainability—a literature review. *Education Sciences*, *7*(1), 1–19. https://doi.org/10.3390/educsci7010001

Khairunnisa, R., Putri, M. Z., Siregar, D. P., Miftahul, F., Zafira, S. D., Dalina, D., Fariha, K. L., Farida, M., Sari, R., Putri, S., Efendi, F., Aji, F. I., Raranditha, A., & Fardana, A. (2022). Internet Addiction Disorder Pada Generasi-Z Di Era Modernisasi. *N Proceeding Conference On Psychology and Behavioral Sciences*, *1*(1), 73–77. http://proceedings.dokicti.org/index.php/CPBS/index%0AInternet

Kulik, C. L. C., Kulik, J. A., & Bangert-Drown, J. (1990). Effectiveness of Mastery Learning Programs: A Meta Analysis. *Review of Educational Research*, *60*(2), 265–299.

Lange, E. A. (2023). *Transformative Sustainability Education: Reimagining Our Future*.

Leich, A; Heiss, J; Byun, W. . (2018). Issues and trends in education for sustainable development. In *UNESCO*. https://doi.org/10.54675/yelo2332

LIbao, N. J. P., Sagun, J. J. B., Tamangan, E. A., Pattalitan, A. P., Dupa, M. E. D., & Bautista, R. G. (2016). Science learning motivation as correlate of students' academic performances. *Journal of Technology and Science Education*, *6*(3), 209–218. https://doi.org/10.3926/jotse.231

Lismaya, L. (2018). Improving Student'S Naturalist Intelligence Through Outdoor Activities on Plant Morphology Learning. *Indonesian Journal of Learning and Instruction*, *1*(1). https://doi.org/10.25134/ijli.v1i1.1283

Lo, C. K., & Hew, K. F. (2020). A comparison of flipped learning with gamification, traditional learning, and online independent study: the effects on students' mathematics achievement and cognitive engagement. *Interactive Learning Environments*, *28*(4), 464–481. https://doi.org/10.1080/10494820.2018.1541910

Mahdzar, M., Jaapar, A., & Zain, W. Z. W. M. (2022). *High School Students' Motivation Needs and Their Intentions to Pursue Tertiary Education*. 37. https://doi.org/10.3390/proceedings2022082037

Mahyatun, B., Neviyarni, Nirwana, H., & Khaidir, A. (2020). Development of Outbound Learning Models to Improve Students' Caring Characters on the Social Environment. *Advances in Social Science, Education and Humanities Research*, *504*, 346–352. https://doi.org/10.2991/assehr.k.201209.247

Marasi, S. (2019). Team-building: Developing Teamwork Skills in College Students Using Experiential Activities in a Classroom Setting. *Organization Management Journal*, *16*(4), 324–337. https://doi.org/10.1080/15416518.2019.1662761

Martin, S., Martin, E., Rey, A., Cubillo, J., Pulido, A., & Castro, M. (2018). Analysis of new technology trends in education: 2010-2015. *IEEE Access*, *6*, 36840–36848. https://doi.org/10.1109/ACCESS.2018.2851748

Mcewan, D., Ruissen, G. R., Eys, M. A., Zumbo, B. D., & Beauchamp, M. R. (2017). The effectiveness of teamwork training on teamwork behaviors and team performance: A systematic review and meta-Analysis of controlled interventions. *PLoS ONE*, *12*(1), 1–23. https://doi.org/10.1371/journal.pone.0169604

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268. https://doi.org/10.1119/1.1514215

Moleong, L. J. (2013). *Metodologi Penelitian Kualitatif*. PT. Remaja Rosdakarya.

Mufid, A., Fatimah, S., Abdullahi Umar, J., & Mawere, D. (2022). Efforts to Improve the Development of Naturalistic Intelligence through Outbound Methods at RA Muslimat NU XVII Keser Tunjungan District, Blora Regency. *Al-Hijr: Journal of Adulearn World*, *1*(3), 125–131. https://doi.org/10.55849/alhijr.v1i3.26

Mystakidis, S., Cachafeiro, E., & Hatzilygeroudis, I. (2019). Enter the Serious E-scape Room: A Cost-Effective Serious Game Model for Deep and Meaningful E-learning. *10th International Conference on Information, Intelligence, Systems and Applications, IISA 2019*, 1–6. https://doi.org/10.1109/IISA.2019.8900673

Nedovic, S., & Morrissey, A. M. (2013). Calm active and focused: Children's responses to an organic outdoor learning environment. *Learning Environments Research*, *16*(2), 281–295. https://doi.org/10.1007/s10984-

013-9127-9

Nicholson, S. (2015). Peeking Behind the Locked Door: A Survey of Escape Room Facilities. *White Paper*, 1–35.

Nur'aini, K. D., Werang, B. R., & Suryani, D. R. (2020). *Student's Learning Motivation and Learning Outcomes in Higher Education*. *473*(Icss), 463–466. https://doi.org/10.2991/assehr.k.201014.101

Ordov, K., Madiyarova, A., Ermilov, V., Tovma, N., & Murzagulova, M. (2019). New trends in education as the aspect of digital technologies. *International Journal of Mechanical Engineering and Technology*, *10*(2), 1319–1330.

Orion, N. I. R., Hofstein, A. V. I., Tamir, P., & Giddings, G. J. (1997). Development and Validation of an Instrument for Assessing the Learning Environment of Outdoor Science Activities. *John Wiley & Sons*, *81*, 161–171.

Pintrich, P. R., & Groot, E. V. De. (1990). Motivational and Self-Regulated Learning Components of Classroom Academic Performance. *Journal of Educational Psychology*, *82*(1), 33–40.

Purnamasari, S., & Nurawaliyah, S. (2023). Studi Literatur : Penilaian Kompetensi Keberlanjutan dan Hasil Belajar Education for Sustainable Development (ESD). *Jurnal Pendidikan Universitas Garut*, *17*(1), 686–698.

Purwanto, M. N. (2008). *Prinsip-Prinsip dan Teknik Evaluasi Pengajaran*. PT. Rosdakarya.

R. Kelley, T., Geoff Knowles, J., Han, J., & Sung, E. (2019). Creating a 21st Century Skills Survey Instrument for High School Students. *American Journal of Educational Research*, *7*(8), 583–590. https://doi.org/10.12691/education-7-8-7

Rahman, S. (2021). Pentingnya Motivasi Belajar Dalam Meningkatkan Hasil Belajar. *Merdeka Belajar*, *November*, 289–302.

Ramos, G., & Schleicher, A. (2018). Preparing our Youth for an Inclusive and Sustainable World. In *The OECD PISA Global Competence Framework*. https://www.oecd.org/education/Global-competency-for-an-inclusive-world.pdf

Riduwan. (2015). *Dasar-dasar Statistika* (Ed. Rev.). Alfabeta.

Rieckman, M. (2018). Issues and trends in education for sustainable development. In *UNESCO*. https://doi.org/10.54675/yelo2332

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures*, *44*(2), 127–135. https://doi.org/10.1016/j.futures.2011.09.005

Rudawska, A. (2017). Students' team project experiences and their attitudes towards teamwork. *Journal of Management and Business Administration.*

Central Europe, *25*(1), 78–97. https://doi.org/10.7206/jmba.ce.2450-7814.190

Saefudin, Kusnadi, Hastika, A. D., & Zidan, Z. (2023). Development of a Gamification-Based Program to Support ESD Competency Improvement in Botanical Gardens [Manuscript submitted for Publication]. *Jurnal Bioedukatika*, *11*.

Saxena, M., & Mishra, D. K. (2021). Gamification and gen Z in higher education: A systematic review of literature. *International Journal of Information and Communication Technology Education*, *17*(4), 1–22. https://doi.org/10.4018/IJICTE.20211001.oa10

Scherak, L., & Rieckmann, M. (2020). Developing ESD competences in higher education institutions—Staff training at the University of Vechta. *Sustainability (Switzerland)*, *12*(24), 1–19. https://doi.org/10.3390/su122410336

Seibert, S. A. (2021). Problem-based learning: A strategy to foster generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing*, *16*(1), 85–88. https://doi.org/https://doi.org/10.1016/j.teln.2020.09.002

Sekarwinahyu, M. (2019). Sejarah dan Konsep Dasar Pendidikan Lingkungan Hidup. In *Pendidikan Lingkungan Hidup* (pp. 1.1-1.42). http://www.pustaka.ut.ac.id/lib/wp-content/uploads/pdfmk/PEBI4223-M1.pdf

Sesliokuyucu, O. S. (2022). Eco-Gamification and Sustainable Behavior in Service Systems-An Exploratory Study. *Fiscaoeconomia International Congress on Social Sciences, December 2022*, 16–17.

Sinakou, E., Donche, V., Pauw, J. B. De, & Van Petegem, P. (2019). Designing powerful learning environments in education for sustainable development: A conceptual framework. *Sustainability (Switzerland)*, *11*(21). https://doi.org/10.3390/su11215994

Sogunro, O. A. (2014). Motivating Factors for Adult Learners in Higher Education. *International Journal of Higher Education*, *4*(1), 22–37. https://doi.org/10.5430/ijhe.v4n1p22

Souza, V. S., & Marques, S. R. B. de V. (2022). Factors influencing urban tourists' receptivity to ecogamified applications: a study on transports and mobility. *International Journal of Tourism Cities*, *8*(4), 820–843. https://doi.org/10.1108/IJTC-08-2021-0165

Souza, V. S., Marques, S. R. B. de V., & Veríssimo, M. (2020). How can gamification contribute to achieve SDGs? : Exploring the opportunities and challenges of ecogamification for tourism. *Journal of Hospitality and Tourism Technology*, *11*(2), 255–276. https://doi.org/10.1108/JHTT-05-2019-0081

Ssossé, Q., Wagner, J., & Hopper, C. (2021). Assessing the impact of ESD: Methods, challenges, results. *Sustainability (Switzerland)*, *13*(5), 1–26.

https://doi.org/10.3390/su13052854

Su, C., & Cheng, C. (2015). *A mobile gamification learning system for improving the learning motivation and achievements*. *2005*, 268–286. https://doi.org/10.1111/jcal.12088

Sudijono, A. (2011). *Pengantar Statistik Pendidikan*. PT Raja Grafindo Persada.

Sugiyono, D. (2010). Metode penelitian kuantitatif kualitatif dan R&D. In *Penerbit Alfabeta*.

Taimur, S., & Sattar, H. (2019). Education for Sustainable Development and Critical Thingking Competency. In *Quality Education* (Issue September, pp. 1–12). Spinger Nature Switzerland. https://doi.org/10.1007/978-981-13-2369-0_3

Tarricone, P., & Luca, J. (2002). Successful Teamwork: A Case Study. *25th Herdsa Annual Conference, July 2002*, 641–646.

Teaching and Learning Services. (2020). *Using Peer Assessment to Make Teamwork Work : A Resource Document for Instructors*. https://www.mcgill.ca/tls/files/tls/tls-group-peer-assessment-resource-doc-may-2018_0.pdf

Tetep, Murdiati, A. R., Mulyana, E., & Widyanti, T. (2021). Cooperation Skills Based on Students ' Perceptions Through Integration of the Group Discussion and Group Project Method. *Proceedings of the 1st International Conference on Research in Social Sciences and Humanities (ICORSH*, *584*(Icorsh 2020), 475–481.

Tim Pengembang Kebun Botani. (2021). *Rencana Pengembangan Kebun Botani Universitas Pendidikan Indonesia*. Universitas Pendidikan Indonesia (Tidak diterbitkan).

UN. (2018). *The 2030 Agenda and the Sustainable Development Goals An opportunity for Latin America and the Caribbean Thank you for your interest in this ECLAC publication*. https://repositorio.cepal.org/bitstream/handle/11362/40156/25/S1801140_en.pdf

UNDP, FAO, PPC, & PDR, L. (2021). *OYSTER MUSHROOMS PRODUCTION STEPS*.

UNECE. (2012). Learning for the future: Competences in Education for Sustainable Development. In *Vormgeving Smidswater Publicatienummer* (p. 18). https://doi.org/10.7748/ns.13.4.58.s49

UNESCO. (2014). *UNESCO Roadmap Education for Sustainable Development*. https://en.unesco.org/sites/default/files/roadmap_1.pdf

UNESCO. (2017). Education for Sustainable Development Goals: learning objectives. In *UNESCO*. https://doi.org/10.54675/cgba9153

UNESCO. (2018). Issues and trends in education for sustainable development. In *Issues and trends in education for sustainable development*. https://doi.org/10.54675/yelo2332

UNESCOSST. (2023). *ESD competences in Curriculum-Activated Handprint Action Learning*. Fundisa For Change. https://www.youtube.com/watch?v=ZDG0YNapgnQ

United Nation. (2016). Transforming Our World: The 2030 Agenda For Sustainable Development. In *Arsenic Research and Global Sustainability - Proceedings of the 6th International Congress on Arsenic in the Environment, AS 2016* (pp. 1–41). https://doi.org/10.1201/b20466-7

United Nations. (2015). The 2030 Agenda for Sustainable Development's 17 Sustainable Development Goals (SDGs). In *SDG Resource Document* (pp. 1–19). https://sustainabledevelopment.un.org/content/documents/21252030 Agenda for Sustainable Development web.pdf

United nations, international institute for sustainable development. (2016). UN Sustainable Development Goals; 2030 Agenda for Sustainable Development. *Journal for International Institute For Sustainable Development*, *1*(1), 1–35.

UPI. (2022). *Pedoman Penyelenggaraan Pendidikan*.

UU RI No.32 Tahun 2009, 1 (2009).

Vance, K., Kulturel-Konak, S., & Konak, A. (2014). Assessing teamwork skills and knowledge. *ISEC 2014 - 4th IEEE Integrated STEM Education Conference, March 2014*. https://doi.org/10.1109/ISECon.2014.6891052

Veldkamp, A., Daemen, J., Teekens, S., Koelewijn, S., Knippels, M. C. P. J., & van Joolingen, W. R. (2020). Escape boxes: Bringing escape room experience into the classroom. *British Journal of Educational Technology*, *51*(4), 1220–1239. https://doi.org/10.1111/bjet.12935

Verhelst, D., Vanhoof, J., Boeve-de Pauw, J., & Van Petegem, P. (2020). Building a conceptual framework for an ESD-effective school organization. *Journal of Environmental Education*, *51*(6), 400–415. https://doi.org/10.1080/00958964.2020.1797615

Vero, E., & Puka, E. (2017). The Importance of Motivation in an Educational Environment. *Formazione & Insegnamento*, *15*(1), 57–66. https://core.ac.uk/download/pdf/322532474.pdf

Vilmala, B. K., Karniawati, I., Suhandi, A., Permanasari, A., & Khumalo, M. (2022). A Literature Review of Education for Sustainable Development (ESD) in Science Learning: What, Why, and How. *Journal of Natural Science and Integration*, *5*(1), 35. https://doi.org/10.24014/jnsi.v5i1.15342

Wahyuni, S., Indrawati, I., Sudarti, S., & Suana, W. (2017). Developing science process skills and problem-solving abilities based on outdoor learning in junior high school. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 165–169. https://doi.org/10.15294/jpii.v6i1.6849

Wals, A. E. J. (2015). Beyond unreasonable doubt. Education and learning for socio-ecological sustainability in the anthropocene. In *Wagening University* (Issue December). https://library.wur.nl/WebQuery/wurpubs/fulltext/365312

Watt, H. M. G., & Richardson, P. W. (2020). Motivation of higher education faculty: (How) it matters! *International Journal of Educational Research*, *100*(December 2019). https://doi.org/10.1016/j.ijer.2020.101533

Widodo, A. (2021). Pembelajaran Ilmu Pengetahuan Alam Dasar-Dasar untuk Praktik. In *UPI Press*.

Widodo, A., Riandi, Sriyati, S., Purwaningsih, W., Rochintawati, D., Solihat, R., & Siswandari, P. (2023). *Pengembangan Nilai-Nilai Keberlanjutan Melalui Pelajaran Sains*. UPI Press.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, *6*(2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

Xyrichis, A., & Ream, E. (2017). Teamwork : a concept analysis. *Theoritical Paper*, *61*(2), 232–241. https://doi.org/10.1111/j.1365-2648.2007.04496.x

Youth Workers 4 global goals. (2020). *MODULE 1: What are the Sustainable Development Goals? Youth Workers 4 Global Goals CAPACITY BUILDING IN THE FIELD OF YOUTH Module 1: What are the Sustainable Development Goals?*

Zainuddin, Z., Farida, R., Keumala, C. M., Kurniawan, R., & Iskandar, H. (2022). Synchronous online flip learning with formative gamification quiz: instruction during COVID-19. *Interactive Technology and Smart Education*, *19*(2), 236–259. https://doi.org/10.1108/ITSE-01-2021-0002

Zainuddin, Z., Shujahat, M., Chu, S. K. W., Haruna, H., & Farida, R. (2019). The effects of gamified flipped instruction on learner performance and need satisfaction: A study in a low-tech setting. *Information and Learning Science*, *120*(11–12), 789–802. https://doi.org/10.1108/ILS-07-2019-0067

Zhansen, L. (2021). *The Technology of Oyster mushroom Cultivation with JUNCAO* (pp. 1–44).