

DEVELOPMENT OF MOODLE'S INTEGRATED MULTIMODAL-BASED ENTREPRENEURSHIP E-MODULE TO INCREASE CREATIVITY AND LEARNING INDEPENDENCE OF EQUIVALENCY PROGRAM STUDENTS IN SEMARANG REGENCY

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Abstract. Equality education in Indonesia faces challenges in providing interactive, contextual entrepreneurship teaching materials that support independent learning for adult learners. This research aims to develop a multimodal-based entrepreneurship e-module integrated with Moodle to increase the creativity and learning independence of Package C students in Semarang Regency. The research and development method, using the Design-Based Research (DBR) approach, comprises four stages: needs analysis; prototype design and development; validation and iterative feasibility testing; and reflection and determination of the final product. The research participants included five expert validators, three students in the one-to-one test, nine people in the small-group test, 30 students in the field test and the effectiveness test, and two tutors in the learning teacher. Data was collected through expert validation sheets, practicality questionnaires, creativity rubrics, learning independence scales, observations, interviews, Focus Group Discussions, and Moodle activity logs. Quantitative data were analyzed using descriptive statistics and differential tests (paired sample t-test or Wilcoxon signed-rank test), while qualitative data were analyzed thematically. The results of the study show that Moodle's integrated multimodal-based entrepreneurship e-module was deemed valid based on assessments by material experts, multimodal learning experts, LMS experts, linguists, and evaluation experts. The results of the practicality test indicated a very practical score from both tutors and students. The results of the effectiveness test showed a significant increase in entrepreneurial creativity and students' independence in learning after the use of e-modules. These findings contribute to the literature on the development of digital learning products in non-formal education and provide implications for strengthening entrepreneurship teaching materials that are contextual, flexible, and oriented towards the independence of equivalency program students.

Keywords: e-module, entrepreneurship, multimodal, moodle, equality education, creativity, learning independence

INTRODUCTION

Non-formal education plays a strategic role in expanding access and learning opportunities for people outside of formal education (Bagnall, 2009; Joseph & Said, 2020). In the Indonesian context, one of the most prominent forms of non-formal education institutions is the Community Learning Activity Center (PKBM) and other non-formal education units, including the Learning Activity Studio (SKB), which provides equality education services through Package A, Package B, and Package C Programs (Lukman, 2021; Tohani, 2015). Equality education is an important

pathway for adult learners and late adolescents who have not completed formal education, either due to economic constraints, work obligations, or family responsibilities.

SKB Ungaran, as the Technical Implementation Unit (UPTD) for Non-Formal Education in Semarang Regency, is the only state education unit serving as a reference for implementing equality education in the region. The Package C service at SKB serves adult and final adolescent students with heterogeneous characteristics in terms of age, work background, digital device ownership, and technological literacy. Face-to-face meetings are held on a limited basis, namely two to three times per week in the afternoon, so they require teaching materials that are flexible, contextual, and that support independent learning outside of face-to-face hours.

The real conditions in the Semarang Regency Decree show several interlocking problems. First, the teaching materials for entrepreneurship subjects in Package C are still dominated by print modules and static PDF documents that offer minimal interactivity, are difficult to update, and do not document the learning process. Second, tutors conveyed the need for entrepreneurship teaching materials that are contextual with the world of work and digital business opportunities in Semarang Regency, but are not yet available in a form that students can access independently. Third, monitoring students' learning progress is manual, making it difficult for tutors to identify participants' learning obstacles before the next face-to-face session. Fourth, most students access information through mobile phones, but there is no formal learning ecosystem that utilizes these access channels in a structured manner.

The problem of entrepreneurship is increasingly crucial, given the profile of Package C students: the majority do not continue to university after graduation, so entrepreneurship is a strategic avenue to improve their standard of living. Unfortunately, entrepreneurship learning today presents more basic theories, such as the definition of entrepreneurship, entrepreneurial characteristics, and types of businesses, without direct experience designing business ideas, analyzing local markets, or validating ideas with tutors and fellow participants. As a result, entrepreneurial creativity, namely the ability to produce, develop, and evaluate business ideas, as well as learning independence, namely the ability to initiate, organize, and evaluate one's own learning process, have not been optimally developed.

Theoretically, multimodal learning emphasizes the importance of presenting information through more than one mode of representation, namely text, visual, audio, and video, so that learners build comprehension with a lighter cognitive load and higher engagement (Mayer, 2020). It is important to distinguish multimodal from multimedia concepts: multimedia refers to a combination of technological media (audio, video, animation) as a means of delivery, while multimodal emphasizes the semiotic mode of representation of meanings that complement each other in the process of cognition, so that its scope is broader and pedagogical (Jewitt, 2009; Mayer, 2020). At the same time, Design-Based Research (DBR) provides the right methodological framework for developing technology-based learning products through cycles of needs analysis, design, repeated testing, revision, and reflection that are closely linked to the context of practice (Wang & Hannafin, 2005; Anderson & Shattuck, 2012). The outcome variables targeted by this study include creativity and learning independence. In the literature, it is necessary to distinguish between self-directed learning (SDL) and self-regulated learning (SRL): SDL emphasizes the autonomy of learners in determining their own learning goals, sources, and evaluations (Garrison, 1997), while SRL focuses more on cognitive, motivational, and behavioral regulation in the context of pre-defined learning goals (Zimmerman, 2002). This study uses SDL as the main framework for learning independence, with SRL as a complementary concept to explain students'

self-regulation mechanisms in the Moodle environment (Garrison, 1997; Zimmerman, 2002; Song & Hill, 2007).

Regarding the substance of entrepreneurship, recent research confirms that entrepreneurship education needs to shift from theoretical transfer to experiential, contextual, and action-oriented learning (Banha et al., 2022; Motta & Galina, 2023). However, studies on the development of multimodal entrepreneurship e-modules specifically designed for equality education and integrated into the Learning Management System (LMS) platform remain very limited. Previous research conducted by the research team in the context of equality education produced a multimodal print module that was found to be feasible; however, current SKB needs now demand a form of digital learning that is accessible, flexible, documented, and supports monitoring participants' learning progress.

The selection of Moodle as an LMS platform is based on its flexible, customizable, free (open source), and supports the implementation of learning through activity structures, forums, quizzes, assignments, assessments, and monitoring of learning progress (Gamage et al., 2022). The Moodle application also supports mobile access, audio and video uploads, and offline content access, making it relevant for students with limited access to devices and internet connections (Saikat et al., 2021). The integration of e-modules into Moodle enables the creation of a structured digital learning ecosystem while accommodating the diverse characteristics of equality education students.

Based on the real conditions in the SKB of Semarang Regency, the needs of tutors and students, and the identified research gaps, this study aims to develop a multimodal-based entrepreneurship e-module that integrates with Moodle to increase the creativity and learning independence of Package C students. (b) the product is designed based on multimodal and at the same time integrated with Moodle as a learning ecosystem; (c) outcome variables include creativity and learning independence; and (d) research is conducted with DBR at one location so that iterative cycles of testing and refinement can be displayed sharply and deeply.

METHODS

Research Design

This research uses a research and development method with a Design-Based Research (DBR) approach. This approach was chosen because the research aims to produce learning products that are developed directly from real problems in the field, then tested, revised, and refined through repeated cycles until a valid, practical, and effective product is obtained (Reeves, 2006; McKenney & Reeves, 2019). The research was conducted in a single authentic context, namely the Semarang Regency Decree. The selection of one location is intended to enable more focused product design, testing, and refinement, so that the core of DBR, in the form of iterative cycles of testing and refinement, can be carried out strictly.

The research stage adopts a model from McKenney and Reeves (2019) which consists of: (1) needs analysis, namely problem identification, student profiles, tutor needs, and learning context in the Semarang Regency SKB; (2) design and development of prototype e-modules and Moodle classrooms, including the preparation of materials, multimodal activities, quizzes, project assignments, and discussion forums; (3) expert validation, iterative feasibility tests (one-to-one and small groups), practicality tests (field tests), and effectiveness tests; and (4) reflection and determination of the final product. At the effectiveness stage, a one-group pretest-posttest design was used to determine changes in students' creativity and learning independence before and after using the e-module.

Research Participants

The research data sources include: (1) tutors/tutors learning entrepreneurship Package C at SKB Semarang Regency as the main collaborator; (2) Package C students as product users; (3) expert validators consisting of material experts, multimodal learning experts, LMS/media experts, linguists, and evaluation experts; and (4) learning documents, teaching materials, and Moodle activity logs.

To anticipate potential subjectivity in iterative feasibility tests and generalization limitations in single-site research, this study explicitly specifies the number of participants and the mitigation strategies at each stage of the test. The total minimum number of participants in the study was 49, with details: 5 validator experts; 3 students in the one-to-one test; 9 students in the small-group test; 30 students in the field test and the effectiveness test; and 2 tutors in the learning teacher. The selection of this number follows both DBR and educational R&D practices: validation involves a minimum of one expert per field to warrant cross-perspective assessments; One-to-one iterations ($n=3$) are sufficient to detect early usability issues in participants with diverse abilities; small group iterations ($n=9$) allow triangulation of observations, FGDs, and questionnaires; Meanwhile, field tests and effectiveness tests with a minimum N of 30 meet the statistical prerequisites for parametric tests and provide a strong empirical basis for claims of effectiveness.

Data Collection Techniques

The data collected includes both qualitative and quantitative data. Qualitative data were obtained through observation, interviews, Focus Group Discussions (FGDs), field notes, user reflections, and document review. Quantitative data were obtained through expert validation sheets, practicality questionnaires, learning independence scales, creativity rubrics, and pretest-posttest scores. Data collection is carried out in stages according to the DBR cycle, so that the results at each stage can be used as a basis for product revision and improvement.

Research Instruments

The instruments used include: observation guidelines, interview and FGD guides, expert validation sheets, tutor and student practicality questionnaires, digital entrepreneurship creativity rubrics, learning independence scales, and Moodle activity log documentation sheets, such as login frequency, task completeness, and forum participation. The expert validation instrument is designed using a 4-point Likert scale to assess the feasibility of the content, constructs, language, and media. The rubric for digital entrepreneurship creativity is developed around four aspects: originality of business ideas, flexibility in problem-solving, smoothness of ideas, and elaboration of action plans. The learning independence scale adapts the self-directed learning dimension from Garrison (1997), which includes initiation, planning, implementation, and evaluation. Before use, all quantitative instruments are tested for validity and reliability: content validity is verified through expert judgment (content validity ratio), construct validity is assessed using confirmatory factor analysis, and instrument reliability is calculated using Cronbach's alpha. Inter-rater reliability for the creativity rubric was determined using Cohen's Kappa coefficients before the field test.

Data Analysis and Validity

Qualitative data analysis is carried out thematically through the stages of data reduction, categorization, pattern tracing, and reflective conclusion drawing in each development cycle (Braun & Clarke, 2006). The results of this analysis are used to revise the prototype and formulate

the principles of product design. Quantitative data are analyzed using descriptive statistics to assess the product's feasibility and practicality. At the effectiveness test stage, a differential test analysis was used to see changes in students' creativity and learning independence before and after the use of e-modules. If the data are normally distributed, a paired-sample t-test is used; if not, the Wilcoxon signed-rank test is used.

The validity of the data is maintained through several strategies: triangulation techniques and source triangulation (Carter et al., 2014), member checking (Birt et al., 2016), peer discussions, and expert involvement in each important phase of development. This strategy is implemented to increase the credibility, consistency, and accuracy of research results in both qualitative and quantitative data. The limitations of generalization as a consequence of one-location research are recognized and answered through two strategies: first, detailed documentation of the context of the Semarang Regency SKB so that readers can assess the transferability of findings to similar contexts; Second, the formulation of design principles as a conceptual output that can be adapted to other equality education institutions.

RESULTS AND DISCUSSION

Table 1. Summary of Test Results at Each Stage of Development

Testing Phase	Participants	Method	Key Findings	Numerical Evidence
Expert Validation	5 experts	4-point Likert validation sheet	Valid on all aspects; revisions on Moodle instructions and mobile legibility	Red = 3.71/4.00; CVR = 0.87
One-to-one trial	3 learners	Observation, interview	Navigation and instruction revision; appreciation for local-context video	7 revision items
Small group trial	9 learners	FGD, observation, questionnaire	Effective forums; Project Task Most Meaningful	Practicality score = 3.74/4.00
Field Test & Effectiveness	30 learners	Pretest-posttest, practicality questionnaire, Moodle log	Significant pre-to-post improvement in creativity and learning independence; very practical rating	p < .001; d = 1.76 (creativity), 1.85 (independence); practicality = 3.78/4.00

Results

This section reports findings from each phase of the DBR cycle. All validation scores, practicality ratings, and effectiveness data were collected during the 2026 study period at SKB Semarang Regency.

Need Analysis Results

The needs analysis stage identified four key findings. First, the tutor stated that the current entrepreneurship teaching materials, in the form of print modules and static PDFs, are inadequate to support students' independent learning outside of face-to-face. Second, students are more comfortable accessing material on mobile phones than on computers, so e-module design needs to be responsive to mobile access. Third, tutors need an integrated learning-progress monitoring mechanism to identify learning barriers early. Fourth, entrepreneurship materials need to be contextualized with business opportunities and the local economic potential in Semarang Regency to make them more relevant and meaningful for students.

Expert Validation Results

The e-module was validated by five expert validators: a content expert, a multimodal learning expert, an LMS/media expert, a language expert, and an evaluation expert. All instruments were verified for content validity prior to use; the expert validation sheet yielded a content validity ratio (CVR) of 0.87, indicating adequate validity. Inter-rater reliability for the creativity rubric produced a Cohen's Kappa of 0.81, and the learning independence scale achieved an Alpha Cronbach reliability coefficient of 0.86. Validation results showed that the e-module attained a mean validity score of 3.71 out of 4.00 (category: valid) across all assessment aspects. The highest-scoring aspect was the content validity of the entrepreneurship material and its alignment with multimodal characteristics ($M = 3.85$). In contrast, the aspect requiring the most revision was the clarity of interactive activity instructions on Moodle and the legibility of the text on the mobile interface ($M = 3.52$). Revisions were carried out iteratively based on expert feedback before the product was trialed with learners.

Iterative Feasibility Test Results

The iterative feasibility test was carried out in two stages. The first stage, the one-to-one test, involved three students with diverse abilities and backgrounds. Key findings include: difficulty navigating the first module, the need for visual guidance for task-upload activities, and appreciation of entrepreneurship tutorial videos contextualized with local businesses. In the second stage, the small group test involved nine students and produced additional findings: the discussion forum on Moodle was effective in facilitating the sharing of business ideas between students, but required active moderation from the tutor; interactive quizzes helped with understanding basic concepts of entrepreneurship; and the project task of designing a business plan was considered the most meaningful by the students. Based on the two test stages, the e-module was revised to clarify instructions, add visual navigation guidance, enrich the variety of multimodal content, and improve the forum moderation mechanism.

Field Test Results

The practicality trial was conducted with 30 Package C learners at SKB Semarang Regency during the implementation period, in accordance with the equivalency curriculum. Practicality questionnaire results showed a mean score of 3.82/4.00 from supervising tutors (category: very practical) and 3.74/4.00 from learners (category: very practical). Tutors rated the e-module as supportive of progress monitoring and effective for managing out-of-class assignments. At the same time, learners appreciated the ease of mobile access, the diversity of content formats, and the relevance of the entrepreneurship material to their daily lives. Moodle activity logs recorded a mean login frequency of 8.3 sessions per learner, a task completion rate of 87%, and a forum participation rate of 79%, all of which were classified as active engagement.

Effectiveness Test Results

The effectiveness trial employed a one-group pretest-posttest design with 30 Package C learners. Entrepreneurial creativity scores showed a statistically significant pre-to-post increase (pretest $M = 61.43$, $SD = 8.27$; posttest $M = 76.87$, $SD = 7.54$; $t(29) = 9.63$, $p < .001$, effect size $d = 1.76$). The creativity dimensions showing the greatest gains were originality of business ideas and elaboration of action plans. Learning independence scores likewise increased significantly (pretest $M = 64.17$, $SD = 7.91$; posttest $M = 78.53$, $SD = 6.83$; $t(29) = 10.14$, $p < .001$, effect size $d = 1.85$), particularly on the initiation and evaluation dimensions. Given the one-group design without a control condition, these results indicate a meaningful pre-to-post improvement associated with e-module use; causal attribution to the e-module alone should be interpreted cautiously pending replication with a comparison group. Qualitative data from interviews and FGDs corroborated the quantitative findings: learners reported increased confidence in generating business ideas, improved ability to access learning materials independently, and stronger skills in evaluating their own business plans.

Discussion

The findings of this study show that the development of Moodle's integrated multimodal entrepreneurship e-module is a valid and practical solution to address the challenges of digital teaching materials in equality education, with early evidence of increased creativity and learning independence that needs to be further verified through a research design with a control group. Overall, these findings are in line with the multimodal learning literature that emphasizes that the integration of various modes of representation, namely text, visual, audio, and video, can improve learners' engagement and understanding (Mayer, 2020; Rahmanu & Molnár, 2024). In the context of adult learners in equality education, multimodality is not just an additional feature but a structural necessity due to the diversity of learning styles, digital literacy levels, and limited learning time.

In terms of entrepreneurial creativity, the increase observed after using e-modules indicates that learning designs that combine entrepreneurial theory with practical projects, local case studies, and authentic problem-based activities can build students' ability to generate and develop business ideas. These findings are consistent with the research by Banha et al. (2022) and Motta and Galina (2023), which affirm that entrepreneurship education needs to be experiential and action-oriented to produce a real impact on entrepreneurial competence. The integration of project assignments of designing a business plan, analyzing the local market, and presenting ideas to fellow students through the Moodle forum are the key mechanisms that drive the process.

Increased learning independence indicates that the design of the Moodle learning environment plays an important role in strengthening learners' capacity to manage their own learning process. This supports Kim et al.'s (2021) argument that learning independence is understood not only as an individual characteristic but also as a result of interactions among learners' characteristics, task demands, instructional support, and online learning system design. Moodle's organized activity structure, multimodal content combination, and automated feedback mechanism through quizzes create an environment that supports a self-regulated learning cycle including planning, monitoring, and evaluation (Zimmerman, 2002; Song & Hill, 2007).

The implementation of DBR in this study demonstrates that the cycle of needs analysis, design, testing, and revision yields products responsive to the field context. Findings from successive one-to-one, small-group, and field tests provide data that lead to gradual revisions, from improvements

to navigation and instructions to content refinements and forum moderation mechanisms. This approach aligns with the DBR principle, which emphasizes that learning products developed through iteration are of higher quality and more relevant than those from linear development (Wang & Hannafin, 2005; Barab & Squire, 2004; Anderson & Shattuck, 2012).

Implications for Policy and Practice

Three implications can be drawn from the findings of this study. First, for equality education policies, the development of LMS-integrated, multimodal e-modules can serve as a model for strengthening the development of contextual, responsive digital teaching materials for adult learners. Governments and non-formal educational institutions can adopt a similar approach for other subjects in the equality program. Second, in learning practices, the Moodle integration enables more systematic monitoring of learning progress and strengthens tutor-student interaction outside face-to-face sessions. Third, for entrepreneurship development, contextualizing the material with Semarang Regency's local economic potential demonstrates that entrepreneurial learning can be made meaningful and applicable for non-formal education students.

Limitations and Advanced Research

This research is limited to one location, namely the Semarang Regency SKB, so the findings map product patterns in a specific context rather than produce generalized claims. The one-group pretest-posttest design without a control group also has limitations in isolating the e-module's influence from confounding factors. Follow-up research is planned for: (a) replication of multiple SKBs in different regions; (b) the use of experimental designs with control groups to strengthen claims of effectiveness; (c) longitudinal studies to monitor the long-term impact on the economic independence of graduates; and (d) the development of adaptive learning features on Moodle to personalize entrepreneurial learning paths.

CONCLUSION

This research successfully developed a valid and highly practical Moodle-integrated, multimodal, entrepreneurship-based e-module and provided preliminary evidence of increased creativity and learning independence among Package C students in Semarang Regency. Through a Design-Based Research approach with four development cycles, the resulting e-modules met the eligibility criteria based on assessments by five experts, demonstrated high practicality according to tutors and learners, and led to a statistically significant increase in entrepreneurial creativity and learning independence in the one-group pretest-posttest design. Given the limitations of the design without a control group, the claims of effectiveness are presented on a measured basis and await confirmation through follow-up research with a more robust design. The integration of multimodal content, namely text, visual, audio, and video, with Moodle's activity structure creates a digital learning ecosystem that is flexible, documented, and responsive to the needs of adult learners in equality education. These findings contribute to the literature on the development of digital learning products in non-formal education and provide an evidence base for strengthening entrepreneurial teaching materials that are contextual, inclusive, and oriented towards student independence in supporting the achievement of SDG 4 and SDG 8.

REFERENCES

- Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, 41(1), 16–25. <https://doi.org/10.3102/0013189X11428813>
- Bagnall, R. G. (2009). The contribution of non-formal adult education to social sustainability: Policy implications from case studies in the Asia-Pacific region. In P. Willis, S. McKenzie, & R. Harris (Eds.), *Rethinking work and learning* (pp. 193–210). Springer. https://doi.org/10.1007/978-1-4020-8964-0_15
- Banha, F., Coelho, L. S., & Flores, A. (2022). Entrepreneurship education: A systematic literature review and identification of an existing gap in the field. *Education Sciences*, 12(5), 336. <https://doi.org/10.3390/educsci12050336>
- Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1), 1–14. https://doi.org/10.1207/s15327809jls1301_1
- Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, 26(13), 1802–1811. <https://doi.org/10.1177/1049732316654870>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, 41(5), 545–547. <https://doi.org/10.1188/14.ONF.545-547>
- Gamage, S. H. P. W., Ayres, J. R., & Behrend, M. B. (2022). A systematic review on trends in using Moodle for teaching and learning. *International Journal of STEM Education*, 9, 9. <https://doi.org/10.1186/s40594-021-00323-x>
- Garrison, D. R. (1997). Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly*, 48(1), 18–33. <https://doi.org/10.1177/074171369704800103>
- Jewitt, C. (Ed.). (2009). *The Routledge handbook of multimodal analysis*. Routledge.
- Joseph, C., & Said, R. (2020). Community-based education: A participatory approach to achieve the sustainable development goal. In W. Leal Filho, A. M. Azul, L. Brandli, P. G. Özuyar, & T. Wall (Eds.), *Quality education* (pp. 101–111). Springer. https://doi.org/10.1007/978-3-319-95870-5_67
- Kim, D., Jung, E., Yoon, M., Chang, Y., Park, S., Kim, D., et al. (2021). Exploring the structural relationships between course design factors, learner commitment, self-directed learning, and intentions for further learning in a self-paced MOOC. *Computers & Education*, 166, 104171. <https://doi.org/10.1016/j.compedu.2021.104171>
- Lukman, A. I. (2021). Community empowerment through non-formal education at PKBM Tiara Dezzy Samarinda. *Diklus: Journal of Out-of-School Education*, 5(2), 180–190. <https://doi.org/10.21831/diklus.v5i2.43669>
- Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press. <https://doi.org/10.1017/9781316941355>
- McKenney, S., & Reeves, T. C. (2019). *Conducting educational design research* (2nd ed.). Routledge.
- Motta, V. F., & Galina, S. V. R. (2023). Experiential learning in entrepreneurship education: A systematic literature review. *Teaching and Teacher Education*, 121, 103919. <https://doi.org/10.1016/j.tate.2022.103919>

- Rahmanu, I. W. E. D., & Molnár, G. (2024). Multimodal immersion in English language learning in higher education: A systematic review. *Heliyon*, 10(19), e38357. <https://doi.org/10.1016/j.heliyon.2024.e38357>
- Reeves, T. C. (2006). Design research from a technology perspective. In J. van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 52–66). Routledge. <https://doi.org/10.4324/9780203088364-13>
- Saikat, S., Dhillon, J. S., Wan Ahmad, W. F., & Jamaluddin, R. A. (2021). A systematic review of the benefits and challenges of mobile learning during the COVID-19 pandemic. *Education Sciences*, 11(9), 459. <https://doi.org/10.3390/educsci11090459>
- Song, L., & Hill, J. R. (2007). A conceptual model for understanding self-directed learning in online environments. *Journal of Interactive Online Learning*, 6(1), 27–42. Available from: ERIC.
- Tohani, E. (2015). A strategy for developing the capacity of community learning activity centers (PKBM) as service providers in the education sector. *Journal of Education Research*, 3(2). <https://doi.org/10.21831/jpipfip.v0i0.4636>
- Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, 53(4), 5–23. <https://doi.org/10.1007/BF02504682>
- Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64–70. https://doi.org/10.1207/S15430421TIP4102_2