Biner Journal of Social Science (BJSS)
Website: https://journal.leibnizbinernusantara.com/index.php/BJSS
Email: leibnizbinernusantara@gmail.com

Future Trends and Directions Innovation Digital Learning: A Systematic Review of the Integration of AI, Gamification, and Microlearning for Improving Self-Regulated Learning

INFO PENULIS

Deni Iriyadi
Sultan Maulana Hasanuddin State Islamic University
deni.iriyadi@uinbanten.ac.id

Ahmad Rustam
Banten Universities of Southeast Sulawesi
ahmad.rustam.1988@gmail.com

INFO ARTIKEL

ISSN: xxxx-xxxx
Vol. 1, No. 1, Oktober 2025
https://journal.leibnizbinernusantara.com/index.php/BJSS

Saran Penulisan Referensi:

Iriyadi, D., & Rustam, R. (2025). Future Trends and Directions Innovation Digital Learning: A Systematic Review of the Integration of AI, Gamification, and Microlearning for Improving Self-Regulated Learning. *Biner Journal of Social Science, 1* (1), 49-59.

Abstrak

Perkembangan teknologi digital telah mendorong lahirnya berbagai inovasi pembelajaran seperti Kecerdasan Buatan (AI), gamifikasi, dan pembelajaran mikro yang menjanjikan peningkatan mutu pendidikan yang tinggi. Namun, implementasi teknologi ini masih bersifat parsial dan belum diarahkan secara sistematis untuk mendukung pembelajaran mandiri (SRL) siswa. Penelitian ini bertujuan untuk mengkaji potensi integrasi ketiga pendekatan secara sistematis dalam memperkuat dimensi-dimensi utama SRL, termasuk regulasi kognitif, motivasional, dan perilaku-kontekstual. Dengan menggunakan metode Systematic Literature Review (SLR) berbasis protokol PRISMA pada 96 artikel internasional periode 2015–2025, dilakukan analisis bibliometrik dan tematik terhadap tren, pola, dan kontribusi teknologi pembelajaran. Hasil penelitian menunjukkan bahwa meskipun AI berbasis pembelajaran adaptif, gamifikasi, dan pembelajaran mikro masing-masing memiliki keunggulan dan kontribusi positif terhadap SRL, penelitian integratif yang menggabungkan ketiganya dalam satu desain pembelajaran masih sangat terbatas. Temuan ini juga menunjukkan adanya peluang besar untuk mengembangkan model pembelajaran digital yang adaptif, personal, dan bermakna melalui sinergi integrasi AI, gamifikasi, dan pembelajaran mikro. Penelitian ini menawarkan peta konseptual dan arah pengembangan inovasi pembelajaran digital yang lebih efektif dalam membentuk kemandirian belajar siswa di era Masyarakat 5.0.

Kata kunci: Kecerdasan Buatan, gamifikasi, pembelajaran mikro, pembelajaran mandiri, pendidikan tinggi, pembelajaran digital, studi pustaka sistematis.

Abstract

Development digital technology has push birth various innovation learning such as Artificial Intelligence (AI), gamification, and promising microlearning improvement quality education high. However, the implementation technology This Still nature partial and not yet directed in a way systematic for support students' self-regulated learning (SRL). Research This aim for study in a way systematic potential integration third approach the in strengthen dimensions SRL main, including regulations cognitive, motivational, and behavioral-contextual. With use method *Systematic Literature Review* (SLR) based PRISMA protocol on 96 articles international in 2015–2025 period, carried out analysis bibliometric and thematic to trends, patterns, and contributions technology learning the research results show that although AI based on adaptive learning, gamification, and microlearning each have their own advantages contribution positive towards SRL, research integrative that combines all three in One design learning is still very limited. The findings also indicate existence opportunity big for developing adaptive, personal, and meaningful digital learning models through integration synergy of AI, gamification, and microlearning. Research This offer map conceptual and direction development innovation more digital learning effective in form independence Study students in the Society 5.0 era.

Keywords: Artificial Intelligence, gamification, microlearning, self-regulated learning, education higher, digital learning, studies library systematic.

A. Introduction

Development digital technology in One decade final has bring change significant in practice learning in various level education, including education high. Various innovation-based technology like Artificial Intelligence (AI), gamification, and microlearning has Lots used in frame increase quality of the teaching and learning process (Hwang & Chen, 2023; Wang & Wang, 2022). At the level fact moment this (das Sein), although adoption technology This Already widespread, its implementation often Still nature partial, where each innovation the more Lots used in a way separated without synergy inter- technology learning AI -based tends to only focused on aspects adaptive learning For personalize material (Denden & Bouslama, 2023), gamification more directed For increase involvement learning (Alhammad & Moreno, 2022), while microlearning is more emphasize flexibility Study through material easy little understood and practiced (Maqbool & Maqbool, 2023).

However, in in practice, although technology This Already start utilized, challenges the main thing that still often found is low self-regulated learning (SRL) students, namely ability they for arrange motivation, strategy, and time Study in a way independent (Schnaubert & Grassinger, 2023). Conditions This show that just adoption technology No automatic increase quality learning If No designed in a way systematic for support SRL development. Therefore that, in a way normative (das Sollen), ideally innovation learning in this digital era No just utilize technology in a way separate but precisely must integrate the advantages of each technology the in One ecosystem mutual learning complete to form behavior independent and sustainable learning.

Literature show that AI-based adaptive learning capable facilitate personalization learning based on real-time data, improving accuracy material in accordance need individuals (Sungkur et al., 2023). Meanwhile gamification proven effective in increase motivation intrinsic through element competitive, rewarding, and engaging emotional (Yilmaz & Soyer, 2023). As for microlearning give excellence in aspects flexibility Study with concise, contextual, relevant material with need learners adults (Maqbool & Maqbool, 2023). Although thus, research the trend Still stand individually, not yet many of which are comprehensive study potential integration all three in one learning model whole, structured and measurable.

More continue, although There is studies that discuss involvement learning (engagement) and results academic based technology this, research that is specifically explicit study contribution AI, gamification, and microlearning simultaneous to strengthening self-regulated learning (SRL) is still very limited (Schnaubert & Grassinger, 2023; Hwang & Chen, 2023). The majority of study more results - oriented term short, like improvement mark academic, not on formation skills regulations self-term long. Real research gap is Not yet existence study library systematic mapping How combination third technology the in a way conceptual and empirical can contribute significant in build students' SRL capacity, especially in the context of education very demanding height independence Study.

Study this is deskman as answer over the gap, with novelty in the form of study library systematic (Systematic Literature Review/SLR) which maps trend integration AI, gamification and deep microlearning SRL strengthening. Not only identify trend study in a way bibliometrics,

studies this will also analyze in a way thematic How contribution integration technology This to SRL dimensions, such as regulations motivation, regulation time, and metacognitive strategies, as well as map direction future research. Research This expected give contribution scientific in enrich study theory innovation learning based technology and provide directions practical for developer system more digital learning effective, humanistic, and relevant with need learners in the Society 5.0 era.

B. Methodology

Study This use approach Systematic Literature Review (SLR) as method main in frame compile studies of a nature comprehensive, systematic, and structured about trends and directions development innovation learning based Artificial Intelligence (AI), gamification, and microlearning in support self-regulated learning (SRL) in education high. Selection SLR method is based on the objective study this is the focus for mapping, classifying, and identifying patterns, trends, and research gaps previously in a way systematic based on literature relevant, credible, and verified scientific approach. this also aims give map science that can become foundation for development research and practice future learning.

Study process systematic This implemented with referring to the procedure standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) as guide main. Procedure This covers stages identification, screening, determination eligibility, and inclusivity studies (included studies) in a way gradual and transparent. Stage identification done with browse article relevant scientific through several reputable databases international, namely Scopus, Web of Science, DOAJ, and Google Scholar. Search literature done with use combination of keywords that have been formulated in a way systematic, namely: ("Artificial Intelligence" OR "AI") AND ("gamification" OR " gamification ") AND ("microlearning") AND ("self-regulated learning" OR "self-directed learning" OR "self-regulation") AND ("higher education"). Range time search literature restricted from year 2015 to 2025 to be sure relevance findings with development latest in the field technology learning.

Criteria inclusion in study This set in a way strict, namely published articles in journal international indexed reputable (Q1-Q4 Scopus or DOAJ), containing discussion related to at least two of three element main study these (AI, gamification, microlearning), focus on context education, and linking discussion with aspects of self-regulated learning direct and No directly. The criteria are exclusion covers articles in the form of gray literature, articles that don't full-text available, or articles that are not relevant with focus study although in a way explicit contains the keywords used.

All over articles that have been fulfil criteria inclusion will analyzed in two stages, namely analysis bibliometrics and analysis thematic analysis bibliometrics done For map trend research, patterns collaboration between researchers or institutions, keyword co-occurrence, and map development field science through help device soft like VOSviewer. Whereas analysis thematic done in a way qualitative with grouping results studies previously to in themes big related with integration of AI, gamification, microlearning, as well his contribution to strengthening dimensions self-regulated learning (motivation, management) time and learning strategies). This data processing process aims No only For find pattern general but also identify research gap that has existed for This Not yet revealed in a way comprehensive.

Through method this research expected produce mapping scientifically accurate, comprehensive, and relevant related developments and future directions innovation learning based digital technology, in particular in strengthening self-regulated learning in education high. In addition to providing contribution for development theory, results study this is also expected give benefit practical for developer system digital learning, practitioners' education, and researchers furthermore.

C. Results and Discussion

General Findings of Research Trends (Bibliometric Analysis)

Based on results search literature through the Scopus, Web of Science, DOAJ, and Google Scholar databases with keywords that have been established, obtained as many as 1,237 articles related with themes of Artificial Intelligence, gamification, microlearning, and self-regulated learning (SRL) in context education high, in the range time 2015 to 2025. After through a screening process based on criteria inclusion and exclusion, 96 relevant articles were obtained For analyzed more carry on.

Analysis bibliometrics use device soft VOSviewer show that in period time ten year lastly, trend study about AI in learning experience improvement significant, especially since 2020 along with with acceleration digitalization education post-pandemic. The most frequently searched keywords appear Besides Artificial Intelligence, there are adaptive learning, personalized education, and learning analytics. Meanwhile, in research related gamification, the dominant keyword are engagement, motivation, and learning performance. Microlearning tends to appear in mobile learning context and flexible learning environments.

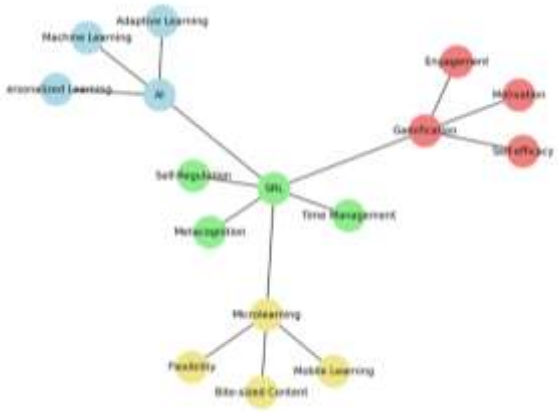

Figure 1. Visualization *Co-Occurrence Keyword*

The results of the keyword co-occurrence visualization show existence increasing interconnectedness strong between AI, gamification, and microlearning with the theme of self-regulated learning, although collaboration between topic the Still nature limited and tend to appear in separate studies, not in One integration system learning.

Research Study

Study results This disclose existence emptiness sufficient research gap significant, namely:

1. The lack of integrated study in a way Simultaneous AI, gamification, and deep microlearning One design learning integrated focused in a way explicit on strengthening self-regulated learning.
2. Most of the study Still results - oriented cognitive (values academic), not yet in a way comprehensive measure impact to aspect regulations self-learning, especially dimensions regulations motivation and management strategy time.
3. Lack of longitudinal research that observes change SRL behavior in general sustainable after implementation technology This.
4. Learning models that combine AI adaptive systems + dynamic gamification + SRL -based microlearning content are still very rare. developed, good in a way conceptual and practical.

Findings Thematic Analysis

Based on results study thematic from article selected, obtained a number of pattern findings that can be grouped to in three theme big following:

a. AI-based Adaptive Learning for SRL Strengthening

Majority study shows that application of AI in learning proven effective in give recommendation personalization content, customization speed learning, and adaptive feedback that has an impact positive to aspects of self-monitoring and goal setting in SRL (Denden & Bouslama, 2023; Wang & Wang, 2022). However, some big study Still focus self in aspects cognitive (learning achievement) and not yet Lots explore AI's contribution to dimensions affective or regulations motivation in SRL context. AI-based adaptive learning refers to systems capable digital learning adapt content, speed, and level difficulty material in real-time based on abilities and behavior users. Technology This depend on *machine learning algorithms* and *learning analytics* For map profile Study individual and provide bait come back appropriate adaptive with need learners (Denden & Bouslama, 2023). In the context of self-regulated learning, systems adaptive This gives benefit big on aspects regulations cognitive, in particular in help student compile objective learning (goal setting), monitoring understanding (self-monitoring), as well as choose the right learning strategy. Some studies show that personalization AI -based can increase efficiency learn, reduce burden cognitive, and improve perception control towards the

learning process, which is foundation from SRL (Wang & Wang, 2022). However, there are many shortcomings found in literature is focus too much research weight on achievement cognitive like mark academic, without explore in a way deep aspect affective like motivation and resilience learning (resilience) which is very crucial in the long term SRL long (Schnaubert & Grassinger, 2023).

In the era of digital transformation of education, the concept of AI-based adaptive learning (AI-based adaptive learning) is becoming increasingly popular. adaptive based intelligence artificial) has be one of approach many pedagogical get attention. System This in a way general refers to a digital learning model that is capable of adapt content, rhythm, and delivery strategy with the abilities, needs, and preferences of each participant educate in real-time. System This utilise machine learning algorithms, data mining techniques, as well principles of learning analytics for map behavior learn, measure performance, and recommend material as well as activity appropriate learning (Denden & Bouslama, 2023; Baker et al., 2021). Implementation approach This become very relevant especially in face challenge education modern high school, where students sued own ability Study in a way independent, flexible, and based on individual needs. One of them achievements important in the modern education process is formation self-regulated learning (SRL) abilities, namely ability student for planning, monitoring, and evaluating the learning process they itself (Zimmerman, 2002). In the context of this, learning adaptive AI - based becomes bridge potential between technology and achievement's ability regulations self-Study optimally.

Ways of working AI Adaptive Learning System

AI adaptive learning systems generally built based on modular structure which includes:

1. *User profiling module,* which identifies ability beginning, interests, and behavior Study student.
2. *Engine diagnosis,* which detects weaknesses and strengths based on performance data quizzes, interactions content, and patterns click.
3. *Recommendation engine,* which determines content or activity appropriate learning.
4. *Feedback engine,* which provides bait come back in real-time for strengthening students' self-monitoring and decision-making (Sungkur et al., 2023).

Technology This can implemented in various modern Learning Management Systems (LMS) or as system connected independent with curriculum adaptive. With ability For recognize need every individual, system This Not only facilitate efficiency learn, but also create experience learn more **humanistic and meaningful.**

Impact Positive against SRL

A number of studies mention that the use of AI-based adaptive learning has an impact direct to dimensions SRL main, in particular:

1. *Goal Setting* and *Self-Planning*
   Students who study through system adaptive tend own objective learn more directed Because system push, they For compile plan Study based on results assessment adaptive. This is reinforced by Wang & Wang's (2022) study which shows that student with access to adaptive AI system own awareness metacognitive taller compared to group control.
2. *Self-Monitoring* and *Real-Time Feedback*
   One of feature featured from system adaptive is his abilities provide direct and specific feedback to error or achievements students. Feed come back This facilitate self- monitoring skills and abilities correcting learning strategies that are not effective (Baker et al., 2021). This is in accordance with SRL framework from Pintrich (2000) who places monitoring as center activity regulations self.
3. Efficiency Cognition and Decision Making
   With serve appropriate content with level understanding students, system adaptive help reduce burden cognitive (cognitive overload) and optimizing capacity memory work. This result increase ability student in make decision Study in a way independent and improve efficiency learning (Hwang & Chen, 2023).

Challenges and Weaknesses Implementation

Although promising, a number of weakness important found in various studies that examine implementation of AI-based adaptive learning, especially in context SRL formation.

1. Domination Focus Cognitive
   Lots of research only evaluate system based on results academic or score cognitive, without notice change in aspect motivation, metacognition, or resilience learning (resilience). In fact,

SRL emphasizes the formation of habits and attitudes Study term long (Schnaubert & Grassinger, 2023).

2. Lack of Adaptation Affective
   Most of the system only adaptive to level difficulty material, not to emotions, motivations, or interest users. Not many yet capable system detect boredom, stress, or demotivation users and customize content based on condition psychological the.
3. Issues and Data Privacy
   Adaptive AI systems require personal data and history. interaction very detailed learning. This is causing challenge ethical related privacy, transparency algorithms, and potential bias in taking decision automatically (Holmes et al., 2019).
4. Limitations Infrastructure and Readiness Institution
   Many institutions education tall Not yet own infrastructure adequate technology or source Power competent human being For design and implement system This in a way full (OECD, 2021).

Comparison with Approach Traditional

When compared with approach learning conventional, adaptive learning systems offer more learning responsive and personal. On the other hand, the approach conventional Still tend put student as recipient passive and less give room For develop regulations self. Research show that students who study with adaptive model show an average increase of 18–30% in SRL indicators compared to with group conventional (Bouslama et al., 2022).

Implications Practical and Development Direction

1. Development Curriculum Adaptive
   Curriculum need designed modular and flexible For support AI systems. Learning materials must arranged in small units with clear metadata so that it can recommended in a way automatically by the system adaptive.
2. Collaboration Interdisciplinary
   The development of AI-based learning requires collaboration between educator, engineer device soft, expert psychology education, and data scientists for build adaptive system in a way pedagogical, technological, and ethical.
3. Integration with SRL Elements
   System should equipped with features that are explicit facilitate SRL, such as journal reflective, self-monitoring checklist, goal planner, and alerts for management time Study.
4. Longitudinal Evaluation
   Study to front need use longitudinal design for evaluate How system adaptive impact to formation habit regulations self in term long, not just see impact term short to mark academic.

b. Gamification in Increase Regulation Motivation Study

Related studies gamification in a way consistent find that use element gamification (points, badges, leaderboard) can increase intrinsic motivation, task persistence, and participant engagement education (Alhammad & Moreno, 2022; Yilmaz & Soyer, 2023). Research this also highlights role gamification in encourage self-efficacy, which is prerequisite important for self-regulated learning. However Thus, the use of gamification Still designed statically, not yet based real-time adaptation as enabled by AI.

Gamification is implementation element game like **points, badges, boards rankings,** challenges, and prizes in non-game environments such as education. In the context of SRL, gamification is very relevant close with **regulations motivation,** namely How student arrange internal and external motivation For Keep going learning. Elements like *progress bars* and *achievement badges* proven increase **task persistence,** engagement, and even *self-efficacy* (Alhammad & Moreno, 2022; Yilmaz & Soyer, 2023). Research This strengthen theory motivation intrinsic (Deci & Ryan, 2000) which states that achievements and competencies can increase encouragement learning that comes from from in myself. However thus, some big implementation gamification Still nature **static,** meaning rewards and challenges No adapt with dynamics abilities and preferences learners in real-time. This is cause potential gamification Not yet maximum, especially when compared to with system adaptive more AI -based dynamic in respond performance user. Gamification is implementation elements game to in non- game context like education, training, or online learning. Common elements used in gamification covering points, badges, boards leaderboards, levels, challenges, progress bars, and rewards. In the context of learning, goals main from gamification is For increase motivation, engagement, and

persistence Study with method utilise dynamics ordinary psychology happen in activity play (Deterding et al., 2011; Werbach & Hunter, 2012).
Gamification No identical with game That alone, but rather is a design strategy purposeful instructional For create environment learn more interesting and meaningful, and push participation active students. Within the framework this, gamification viewed as one of the approach pedagogical alignment with development digital education, especially on increasingly e-learning and mobile learning platforms general used in the post-pandemic era.

Connection Gamification and Self-Regulated Learning (SRL)

Self-Regulated Learning (SRL) includes three dimensions main, namely:

1. Regulation cognitive (learning strategies, planning)
2. Regulation motivational (self-efficacy, values) tasks, interests)
3. Regulation behavior and environment (management time, election source Study)

Gamification in a way special play a role in strengthen regulations motivational, namely ability student For control internal and external motivation they during the learning process. According to Self-Determination Theory (SDT) theory developed by Deci and Ryan (2000), motivation intrinsic develop when somebody feel own competence, autonomy, and connectedness social. Elements in gamification can fulfil third need psychological This:

1. Competence strengthened through feedback from achievement points and badges.
2. Autonomy supported with level system that allows student choose challenge in accordance ability.
3. Connectedness created through a leaderboard that compares performance between participant.

In other words, gamification provide motivational stimulus that encourages student For endure longer in the learning process, determining objective Study yourself, and evaluate results Study in a way reflective, all of which is SRL components.

Findings Empirical Latest

Studies literature in One decade final show that implementation gamification in education tall own impact positive towards SRL. As example:

1. Alhammad & Moreno (2022) in study systematically state that gamification in LMS capable increase motivation intrinsic, persistence, and retention material in a way significant.
2. Yilmaz & Soyer (2023) concluded that mobile learning application based gamification No only increase engagement, but also self-efficacy in learning in students.
3. Domínguez et al. (2013) showed that students who use system based gamification own higher completion rate and progress tracking tall compared to group control.

Weaknesses and Challenges Implementation

Although gamification offer Lots excellence, its implementation in the world of education No off from a number of weaknesses, especially in optimally support SRL:

1. Static Design
   Most of the system gamification moment This static, meaning rewards and challenges No changed along change performance students. System No capable detect whether student need challenge more tall or precisely difficulty at a certain level. This is make system gamification become not enough adaptive and potential lower motivation If No in accordance with need student.
2. Risk Motivation Extrinsic Dominant
   The use of external rewards (such as points and badges) which are too excessive can cause motivation extrinsic replace motivation intrinsic, which is precisely contradictory with objective term SRL length. This is known as effect overjustification in psychology education (Deci & Ryan, 2000).
3. Inequality Competition
   Leaderboard can become effective tool For trigger competition healthy, but also can lowering students ' self-efficacy with ability low, especially If they always be in position bottom.
4. Lack of Customization Contextual
   A number of system gamification No designed in accordance context cultural and social students, so that reward elements used No always own personal meaning or strong social.

Potential of Gamification Integration Adaptive

As it develops technology intelligence artificial intelligence (AI), appears opportunity For develop gamification adaptive, namely a system that can adjust levels, rewards, and challenges based on performance and emotion student in real-time. This is called as *Intelligent Gamification Systems* (IGS) and get started implemented in several learning platforms advanced.

1. AI can used For analyzing interaction patterns students, level persistence, and response emotions, then arrange repeat challenge or the reward given.
2. With thus, gamification No only become tool motivation, but also plays a role as mechanism bait adaptive feedback and reflection, which is very supportive SRL development.
3. Research by Chen et al. (2022) shows that system gamification adaptive capable increase SRL scores in significant more tall compared to gamification conventional. This is show that combination of AI and gamification open possibility new in create experience personal and meaningful learning.

Implications Practical and Recommendations

1. Designer learning need blend gamification in a way careful with SRL principles, for example with provide goal-setting features, reflective feedback, and progress tracking that support regulations self.
2. Institution education recommended adopt an LMS platform that has feature gamification dynamic and can customized based on profile Study student.
3. Developer technology can integrating AI for make system adaptive gamification, accordingly with preference learning, style learning and motivation user.
4. Researchers education recommended For evaluate effect term long from gamification, no only from in terms of engagement, but also in terms of formation character Study independent student.

c. Microlearning as a Learning Media Flexible and Contextual

Microlearning a lot used For support flexibility time and place learning, and provide content concise and contextual which makes it easy regulations time Study students (Maqbool & Maqbool, 2023). Study This show relatedness powerful microlearning with time-management strategies aspect in SRL. However Thus, the integration of microlearning with system learning adaptive AI -based and elements motivational from gamification still very rare found. Microlearning refers to delivery content learning in a short, focused, and modular format usually through digital media and mobile devices. This strategy is very supportive regulations contextual in SRL, especially in management time learning, taking decision when and how learning, and adjustment with rhythm Study individual (Maqbool & Maqbool, 2023). With fast, flexible, and easy access, microlearning allows student For arrange Alone time and duration Study in accordance need as well as preference they, so that facilitate very useful *just-in-time learning* in the era of everything fast this. Although Thus, the weaknesses found in part big study is Still lack of microlearning integration with AI system or element gamification. Frequent microlearning stand Alone as approach delivery content, without equipped feature adaptive or systematic rewards that can be increase involvement and independence Study in a way comprehensive. Microlearning is approach learning that emphasizes presentation content in a short, modular, and highly focused format, usually duration between 2 to 10 minutes per session. Microlearning content is designed for give information or specific skills, so that allows participant to educate For Study in a way flexible, precise time (just-in-time learning), and appropriate need personal They (Buchem & Hamelmann, 2010). The media used are very diverse, starting from from short videos, infographics, podcasts, quizzes interactive, up to mobile- based e-learning modules.

In context modern digital learning, microlearning becomes the more popular Because compatible with style Study digital generation (digital natives) and trends mobility tall in life academic and professional. The advantages lie in efficiency time, accessibility, and capabilities for used in a way contextual, for example moment student currently wait transportation general or moment pause between studying.

Microlearning and Connections with SRL

Self-Regulated Learning (SRL) emphasizes importance ability participant educate in arrange motivation, cognitive strategies, and behavior Study they in a way independent (Zimmerman, 2002). Microlearning provides strong contribution to aspect regulations time and context study, especially in three components following:

1. Time Management

Microlearning provides freedom to student For arrange time Study they in a way more flexible and personal. With duration short content, students can insert session study in between busy schedules, improve frequency Study daily, as well as share the learning process to in more pieces easy managed. This supports recognized time chunking strategies in SRL as technique management effective time (Cleary & Zimmerman, 2004).

2. Goal Setting and Self-Planning
   Modular content in microlearning makes it easier student For set learning targets term short in a way specific and measurable. This is in line with SRL principle that success Study independence is greatly influenced by ability set objective realistic and progressive small (Pintrich, 2000).
3. Self-Monitoring and Self-Evaluation
   Most microlearning platforms come with feature quizzes, reflections, or bait come back direct, which helps student carry out monitoring of understanding they. This allows student do evaluation self in a way fast, strengthening awareness metacognitive which is the main pillar of SRL.

Findings Empirical and Implementation Real

Various study empirical support effectiveness of microlearning in strengthen SRL aspects. Some findings important among others:

1. Dolasinski & Reynolds (2020) found that the use of microlearning videos in LMS platforms is encouraged improving student self-discipline and helping they in manage time Study more Good.
2. Leong et al. (2022) shows that mobile learning- based microlearning helps student still involved and maintaining focus in learning distance far away, which is No direct push they arrange schedule and progress Study in a way independent.
3. A study by Maqbool & Maqbool (2023) states that student tend finish more microlearning content consistent compared to with module Study long.

Weaknesses and Limitations of Microlearning in Support SRL

Although microlearning has Lots excellence, approach This No off from various limitations especially in support learning complete independence.

1. Lack of Adaptive Integration and Personalization
   Most of the microlearning systems still served in linear and non-linear format adaptive. Content arranged based on structure curriculum general, not based on performance or need unique students. As a result, no all student feel content the relevant or challenge.
2. Lack of Elements Gamification and Interactivity
   Microlearning often focuses on delivery content, without integrate mechanism motivational like common points, badges, or leaderboards in gamification. In fact, the elements This can strengthening student self-efficacy and engagement to learning independent.
3. Risk Fragmentation Knowledge
   If not designed with well, microlearning can cause fragmentation information Because lack of continuity concept. This is can bother development of learning strategies term required length in SRL.

Potential Integration with AI and Gamification

For maximize the potential of microlearning in support SRL, it is necessary developed a model that combines microlearning with AI-based adaptive learning and gamification technology motivational. This integration allows:

1. Microlearning content is adaptive, adjusted in a way automatic with style learning, level understanding and motivation student through AI.
2. Dynamic rewards and feedback, where every settlement microlearning modules provide points, badges, or feedback that can be push regulations self.
3. SRL's personal dashboard, which helps student set daily targets, monitor achievements, and analyze progress Study they.

Example system kind of This start appear, such as in research by Ali et al. (2023) which developed AI -based microlearning application and demonstrates significant improvement in self-monitoring and learning persistence aspects.

D. Conclusion

Study This conclude that third approach innovative (AI-based adaptive learning, gamification, and microlearning) has contribution significant to strengthening dimensions SRL's main, namely regulations cognitive, regulatory motivation and regulation contextual-behavioral. AI helps in personalization learning and decision-making decision Study data -driven that strengthens Goal setting and self-monitoring aspects. Gamification give encouragement important motivational for persistence and self-efficacy through giving challenges, rewards, and systems awards that trigger involvement active. While that, microlearning facilitates flexibility time and context learning, which is very crucial in management time and formation habit Study independent. All three in a way theoretical and empirical own point strong meeting with principles of modern SRL.

However, even though its potential big, research this also found that part big studies previously Still discuss third approach the in a way separate and tend to achievement - oriented cognitive term short. Integration between technology in One framework design comprehensive learning is still very limited. Therefore that, is necessary development of digital learning models that are **integrative and adaptive,** which is not only combine the power of AI, gamification, and microlearning, but also design in a way explicit For support formation and strengthening of SRL in general comprehensive approach This potential answer challenge education 21st century, with create experience learn more meaningful, personal, and empowering learners For become independent and reflective.

E. Reference

Alhammad, M., & Moreno, A. (2022). Gamification in education: A systematic review. *Education and Information Technologies,* 27(8), 10905–10939. https://doi.org/10.1007/s10639-021-10741-0

Ali, R., Razak, FZA, & Latip, N.A. (2023). Adaptive microlearning model using AI for SRL enhancement. *Computers & Education: Artificial Intelligence,* 5, 100078. https://doi.org/10.1016/j.caeai.2023.100078

Baker, R., Gowda, S. M., & Corbett, A. (2021). The impact of AI feedback systems on student learning outcomes. *Journal of Educational Data Mining,* 13(2), 1–16.

Buchem, I., & Hamelmann, H. (2010). Microlearning: A strategy for ongoing professional development. *eLearning Papers,* 21, 1–15.

Chen, C.H., Chou, Y.W., & Chen, Y.L. (2022). Adaptive gamification in personalized learning environments. *Journal of Educational Technology & Society,* 25(3), 15–28.

Cleary, T. J., & Zimmerman, B. J. (2004). Self-regulation empowerment program: A school-based program to enhance self-regulated and self-motivated cycles of student learning. *Psychology in the Schools,* 41(5), 537–550. https://doi.org/10.1002/pits.10177

Deci, E.L., & Ryan, R.M. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist,* 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Denden, M., & Bouslama, F. (2023). Artificial intelligence in education: A systematic literature review. *Education and Information Technologies,* 28, 519–543. https://doi.org/10.1007/s10639-022-11345-1

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference* (pp. 9–15). https://doi.org/10.1145/2181037.2181040

Dolasinski, M. J., & Reynolds, D. (2020). Using microlearning to improve student success. *Journal of Higher Education Theory and Practice,* 20(7), 134–143.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education,* 63, 380–392. https://doi.org/10.1016/j.compedu.2012.12.020

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning.* Boston: Center for Curriculum Redesign.

Hwang, G. J., & Chen, C. H. (2023). Research Trends in Digital Learning and AI. *Educational Technology Research and Development,* 71(3), 655–675.

Leong, LY, Hew, TS, & Tan, GWH (2022). Predicting learners' self-regulation in mobile microlearning. *Interactive Learning Environments.* https://doi.org/10.1080/10494820.2022.2036783

Maqbool, F., & Maqbool, A. (2023). Microlearning in higher education: A scoping review. *Education Sciences,* 13(3), 301. https://doi.org/10.3390/educsci13030301

OECD. (2021). *AI and the future of skills: A literature review.* OECD Publishing. https://doi.org/10.1787/b4e59b3b-en

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 451–502). Academic Press.

Schnaubert, L., & Grassinger, R. (2023). Self-Regulated Learning in Digital Environments: A Systematic Review. *Frontiers in Psychology,* 14, 1122365.

Schnaubert, L., & Grassinger, R. (2023). Self-regulated learning in digital environments: A systematic review. *Frontiers in Psychology,* 14, 1122365. https://doi.org/10.3389/fpsyg.2023.1122365

Sungkur, R.K., Panchoo, A., & Bhoyroo, V. (2023). Adaptive learning environments using AI for personalized education: A review. *Education and Information Technologies,* 28(4), 10541–10564. https://doi.org/10.1007/s10639-022-11315-7

Wang, J., & Wang, H. (2022). Personalized learning with AI in higher education: A review. *Computers & Education: Artificial Intelligence,* 3, 100064. https://doi.org/10.1016/j.caeai.2022.100064

Werbach, K., & Hunter, D. (2012). *For the win: How game thinking can revolutionize your business.* Wharton Digital Press.

Yilmaz, R. M., & Soyer, F. (2023). Gamified Mobile Learning Applications: Systematic Literature Review. *Interactive Learning Environments,* 31(2), 325–340.

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