http://dx.doi.org/10.18623/rvd.v23.n4.4504

THE EFFECTS OF DISCOVERY LEARNING AND SELF-REGULATED LEARNING ON INNOVATIVE FUSION CUISINE SKILLS IN CULINARY ARTS EDUCATION

OS EFEITOS DA APRENDIZAGEM POR DESCOBERTA E DA APRENDIZAGEM AUTORREGULADA NAS COMPETÊNCIAS DE COZINHA DE FUSÃO INOVADORA NA EDUCAÇÃO EM ARTES CULINÁRIAS

Article received on: 10/2/2025
Article accepted on: 1/2/2026

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The authors declare that there is no conflict of interest

Abstract
Advancements in culinary arts education emphasize active pedagogical strategies to foster innovative fusion cuisine skills, addressing the global gastronomy sector's demand for cultural amalgamation and technological integration. This study investigates the effects of discovery learning augmented by self-regulated learning (SRL) on students' creative competencies, focusing on digital incorporation in developing regions, to bridge gaps in traditional rote-based programs. A mixed-methods explanatory sequential design was employed with 135 fifth-semester culinary arts students at Universitas Negeri Medan. The quantitative phase used a quasi-experimental setup with block randomization into experimental (discovery learning, n=69) and control (traditional instruction, n=66) groups, assessing SRL via

Resumo
Os avanços no ensino das artes culinárias enfatizam estratégias pedagógicas ativas para fomentar habilidades inovadoras na culinária de fusão, atendendo à demanda do setor gastronômico global por fusão cultural e integração tecnológica. Este estudo investiga os efeitos da aprendizagem por descoberta, complementada pela aprendizagem autorregulada (AA), nas competências criativas dos alunos, com foco na incorporação digital em regiões em desenvolvimento, visando preencher lacunas em programas tradicionais baseados na memorização. Utilizou-se um delineamento sequencial explicativo de métodos mistos com 135 alunos do quinto semestre do curso de artes culinárias da Universidade Estadual de Medan. A fase quantitativa empregou um delineamento quase-experimental com randomização em

adapted MSLQ surveys and innovative skills through portfolio rubrics. The qualitative phase involved semi-structured interviews with 10 students and 5 instructors, analyzed thematically using NVivo. Discovery learning significantly enhanced SRL indicators and innovative fusion skills (mean scores: 87,5 vs. 74,6 for high SRL), with a notable interaction effect ($F(2,129)=4,35$, $p=0,015$, partial $\eta^2=0,068$). Qualitative themes highlighted increased engagement, creativity (e.g., "Rendang Sushi"), SRL practices, and challenges like resource limitations and digital equity issues. Discovery learning, amplified by SRL, outperforms traditional methods in cultivating innovative fusion cuisine skills, with recommendations for scaffolding, institutional investments, and technology integration (e.g., VR/AI). Future research should explore longitudinal impacts and multinational contexts to enhance vocational culinary training.

Keywords: Discovery Learning, Self-Regulated Learning, Innovative Cuisine Skills, Culinary Arts Education.

blocos para os grupos experimental (aprendizagem por descoberta, n=69) e controle (ensino tradicional, n=66), avaliando a AA por meio de questionários MSLQ adaptados e as habilidades inovadoras por meio de rubricas de portfólio. A fase qualitativa envolveu entrevistas semiestruturadas com 10 alunos e 5 instrutores, analisadas tematicamente utilizando o software NVivo. A aprendizagem por descoberta aprimorou significativamente os indicadores de autorregulação da aprendizagem (ARA) e as habilidades inovadoras de fusão culinária (pontuações médias: 87,5 vs. 74,6 para alta ARA), com um efeito de interação notável ($F(2,129)=4,35$, $p=0,015$, η^2 parcial $=0,068$). Os temas qualitativos destacaram o aumento do engajamento, da criatividade (por exemplo, "Sushi de Rendang"), das práticas de ARA e dos desafios, como a limitação de recursos e as questões de equidade digital. A aprendizagem por descoberta, amplificada pela ARA, supera os métodos tradicionais no desenvolvimento de habilidades inovadoras em culinária de fusão, com recomendações para o desenvolvimento de habilidades, investimentos institucionais e integração de tecnologia (por exemplo, realidade virtual/inteligência artificial). Pesquisas futuras devem explorar os impactos longitudinais e os contextos multinacionais para aprimorar o treinamento culinário profissional.

Palavras-chave: *Aprendizagem por Descoberta. Aprendizagem Autorregulada. Habilidades Culinárias Inovadoras. Educação Em Artes Culinárias.*

1 INTRODUCTION

Advancements in vocational training have increasingly emphasized active pedagogical strategies to cultivate essential competencies such as analytical reasoning, inventive problem-solving, and cross-disciplinary integration, especially in culinary arts education, where the global gastronomy sector demands professionals adept at cultural amalgamation and technological innovation.[1,2] In this context, discovery learning and project-based approaches have emerged as pivotal, empowering learners to experiment with blending varied gastronomic heritages into novel fusion creations, thus meeting the dynamic needs of contemporary food markets.[3,4,5] However, while these instructional

models show promise, their specific deployment in fostering creative culinary outputs warrants deeper investigation to refine their impact.[3]

Traditional culinary programs often emphasize rote mastery of techniques, sidelining the imaginative and flexible approaches vital for pioneering hybrid dishes.[3,2] Recent studies highlight the advantages of integrating active learning and discovery-based models, which foster collaboration, communication, and creativity—skills essential for 21st-century culinary professionals.[6,2] Yet, deficiencies remain in merging self-directed oversight with digital aids, particularly in emerging economies.

Self-regulated learning (SRL), defined as the capacity to orchestrate, oversee, and appraise personal educational journeys, acts as a vital amplifier for the success of exploratory methods.[7,8,9] In culinary instruction, advancing proficiencies in fusion gastronomy—encompassing the artful synthesis of disparate food cultures—necessitates frameworks that nurture originality, expertise, and independence.[10] The interplay between discovery learning and SRL yields complementary benefits, linking conceptual insights with hands-on execution in an ever-changing culinary landscape.[8,11]

Empirical research affirms this linkage. For instance, project-based and discovery learning approaches have been shown to significantly enhance both self-regulated learning and creative thinking skills, with supportive learning environments being a key factor.[3,1,11] Likewise, SRL is associated with elevated confidence, problem-solving, and creative performance, foundational to gastronomic breakthroughs.[7] These findings resonate with foundational theories positing that exploratory processes yield profound, applicable insights, while self-management optimizes educational progress and breakthroughs.

Digital advancements further augment this fusion by mitigating conventional limitations. Technology-enhanced and virtual reality-based culinary curricula have demonstrated positive impacts on learning outcomes, creativity, and student engagement, providing risk-free environments for experimentation and immediate feedback for self-regulation.[11] However, equitable access to such technologies remains a challenge, especially in under-resourced regions.[12]

Despite these advances, the collaborative potential of discovery learning and SRL for nurturing inventive fusion proficiencies in vocational culinary spheres is underexplored, particularly regarding technology assimilation in fusion contexts within

developing locales.[13] This gap is acute given the industry's call for experts versatile in both cultural and digital realms—a need unmet by outdated models that often ignore fairness in tech access.[12]

To bridge these lapses, the present inquiry delves into merging discovery learning and SRL in culinary arts training, drawing from progress in career pedagogy and digital innovation.[14] This study adopts a mixed-methods explanatory sequential design, where quantitative elements via a factorial randomized trial precede qualitative probes to elucidate mechanisms and hurdles, ensuring thorough validation through statistical rigor and thematic depth.

The core goal is to assess discovery learning augmented by SRL in elevating learners' inventive fusion gastronomy talents, with a focus on digital incorporation and its effects on perpetual vocational growth. This addresses scholarly voids by scrutinizing enhancements in versatility and originality, guided by questions on the comparative effectiveness of instructional models, the role of SRL, the impact of technology, and the obstacles faced in implementation.

2 METHOD

2.1 Research design

This study employed a mixed-methods explanatory sequential design to investigate the effects of discovery learning and self-directed learning on the development of innovative fusion cooking skills among culinary arts students. The research was conducted in two distinct phases: a quantitative phase followed by a qualitative phase, allowing for the integration of statistical trends with in-depth participant perspectives.[15]

2.2 Quantitative phase

2.2.1 Participants and sampling

The population for this study consisted of all fifth-semester undergraduate students enrolled in the Culinary Arts Program (Program Studi Pendidikan Tata Boga) at Universitas Negeri Medan, with an estimated enrollment of approximately 198 students per cohort based on recent admission quotas. A total of 135 students participated in the study, representing a substantial portion of the population. This sample is considered representative of the program's fifth-semester students at the university due to the use of block randomization, which balanced key variables across groups. Participants were assigned to either an experimental group (n = 69), which received discovery learning interventions, or a control group (n = 66), which received traditional instruction. Block randomization within class sections was used to balance prior academic achievement and baseline self-regulated learning (SRL) scores, following quasi-experimental best practices.[16,17]

2.2.2 *Instruments*

2.2.2.1 Self-Regulated Learning (SRL) Survey

The SRL instrument was adapted from established frameworks, including the Motivated Strategies for Learning Questionnaire (MSLQ), and tailored to culinary contexts.[18,19] The survey comprised 30 items rated on a 5-point Likert scale, covering planning, monitoring, and reflection. Validity was confirmed via confirmatory factor analysis (CFI = 0,92, RMSEA = 0,06), and reliability was established with Cronbach's alpha values above 0,79 for all subscales.[20]

2.2.2.2 Portfolio assessment rubric

Student portfolios were evaluated using a rubric assessing six domains: fusion concept, ingredient blending, technical execution, plating aesthetics, inventive elements,

and taste harmony. The rubric was developed based on validated culinary assessment models and expert review.[21,22] Inter-rater reliability was high (Cohen's kappa > 0,8).[18]

2.2.2.3 Procedure

Data collection occurred in three stages: 1) Pre-intervention: Baseline SRL surveys and portfolio assessments were conducted, 2) Intervention: The experimental group participated in six discovery-based sessions integrating SRL strategies, including hands-on fusion cooking projects, virtual kitchen simulations, and collaborative problem-solving.[23] The control group engaged in lecture-based laboratory work. Both groups accessed shared digital resources to encourage cultural synthesis. And 3) Post-intervention: SRL surveys and portfolio assessments were repeated and scored by blinded evaluators.

2.2.2.4 Data analysis

Statistical analyses were performed using SPSS. Group comparability was assessed with t-tests and chi-square tests. Assumptions of normality and homogeneity of variance were checked using the Shapiro-Wilk and Levene's tests, respectively. Two-way ANOVA was used to examine main and interaction effects of instructional type and SRL level on innovation scores, with effect sizes reported as partial η^2. Post-hoc analyses employed Tukey's HSD, and multiple regression was used to control for covariates.[23] A priori power analysis confirmed sufficient sample size for medium effect detection.

2.3 Qualitative phase

2.3.1 Participants and sampling

A purposive sample—which is a non-probability sampling method where participants are intentionally selected based on specific characteristics, expertise, or qualities relevant to the study's objectives, rather than through random selection—of 10 students and 5 instructors was selected to represent a range of SRL capacities and

program involvement. Participants were anonymized (e.g., S1–S10, I1–I5) to ensure confidentiality.

2.3.2 Data collection

Semi-structured interviews explored participants' experiences with discovery learning, SRL application, and barriers to innovation. Open-ended prompts (e.g., "Describe how exploration shaped your fusion creativity") and follow-up questions addressed resource limitations and instructional challenges.[21] Interviews lasted 30–45 minutes, were audio-recorded with consent, and transcribed verbatim.

2.3.3 Data analysis

Transcripts were analyzed using reflexive thematic analysis.[24] Initial coding identified recurring concepts, followed by axial coding to develop themes such as "digital-aided creativity" and "SRL obstacles." Inter-coder reliability was established (kappa = 0,82) through dual coding of a subset of transcripts. NVivo software facilitated data management and analysis.

2.3.4 Integration and joint display

Quantitative and qualitative findings were integrated using joint display techniques to visually and narratively connect statistical trends with thematic insights, enhancing the interpretation of how SRL and discovery learning interact to foster innovation[25,26].

2.3.5 Research ethics

All procedures were approved by the Universitas Negeri Medan Ethics Committee. Participants received detailed study information and signed informed consent forms. Data were pseudonymized and securely stored. No incentives were

provided, and risks were minimized in accordance with international ethical guidelines.[27]

3 RESULT

Subsequently, the qualitative data provide interpretive depth to these numerical patterns, drawing from participant narratives. The quantitative phase utilized a quasi-experimental arrangement incorporating randomized features, while the qualitative phase involved thematic scrutiny of discussions with learners and educators.

To uphold analytical integrity, prerequisites for the two-way ANOVA were confirmed, including normal distribution via Shapiro-Wilk assessments (all $p>0,05$ across categories) and equal variances through Levene's examination ($p = 0,12$).

3.1 Quantitative results

The numerical evaluation scrutinized the role of discovery learning versus traditional teaching in elevating creative culinary competencies, influenced by varying SRL competencies. A 3 × 2 factorial setup facilitated two-way ANOVA and subsequent examinations to pinpoint variances, with summary metrics delineating average performances stratified by SRL categories (elevated, intermediate, reduced).

3.1.1 Self-regulated learning in discovery learning versus traditional approaches

Implementing discovery-based techniques markedly amplified self-regulatory practices relative to standard procedures, which afforded fewer avenues for independent oversight and reflective cognition. Table 1 outlines SRL dimensions according to pedagogical strategy, revealing superior achievements in the discovery cohort across metrics.

Table 1

Self-Regulated Learning Indicators

Dimension	Discovery learning (Average)	Classification	Traditional (Average)	Classification
Forethought	4,12	Elevated	3,22	Intermediate
Performance Control	4,05	Elevated	3,10	Intermediate
Self-Reflection	3,95	Elevated	3,15	Intermediate

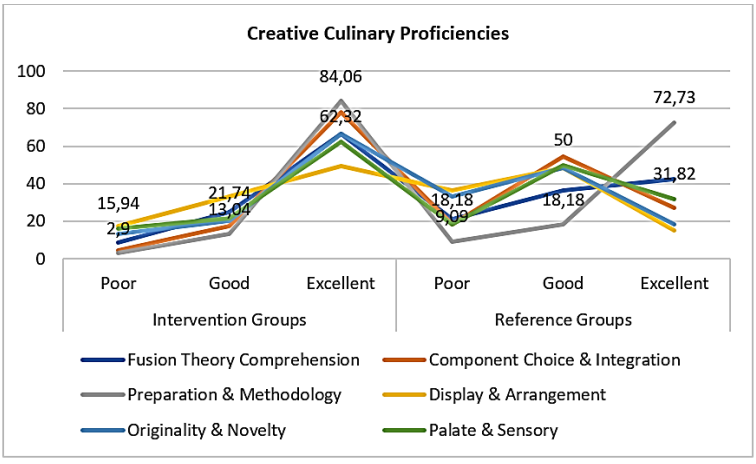
Table 1 showed that such results emphasize how discovery methods cultivate SRL via an inquiry-driven, learner-focused paradigm, pivotal for advancing novel fusion culinary abilities.[28]

3.1.2 Portfolio evaluation of learners' creative culinary proficiencies

Learners' inventive culinary aptitudes were gauged through a portfolio rubric encompassing six key facets: (1) Theoretical Grasp of Fusion Gastronomy; (2) Component Choice and Integration Abilities; (3) Preparation and Methodological Expertise; (4) Display and Arrangement Competencies; (5) Originality and Novelty; and (6) Palate Harmony and Sensory Appeal. Submissions featured recipe logs, visual records, introspective entries, and proofs of blended culinary creations. Figure 1 contrasts outcomes between the intervention (discovery) and reference (traditional) cohorts.

Figure 1

Portfolio Evaluation of Learners' Creative Gastronomic Abilities Between



3.2 Intervention and reference groups

Figure 1 depicts the distribution of creative gastronomic abilities from portfolios in discovery versus traditional settings. Intervention participants generally achieved higher levels, with superior category proportions peaking at about 84-89% in multiple areas (e.g., methodological prowess), contrasted by minimal weak classifications (under 20%). The reference group exhibited balanced spreads, with superior proportions ranging from 15-72% and elevated weak shares (reaching 36%). This pattern suggests the intervention's greater efficacy in boosting creative proficiencies, displaying a pronounced shift toward superiority in the intervention, unlike the downward trend in the reference.

Table 2

Creative Culinary Proficiencies Across Cohorts and SRL Categories

Category	Participants	Lowest	Highest	Average	Deviation	Variability
Discovery-Elevated SRL	23	82	92	87,5	2,80	
Discovery-Intermediate SRL	23	79	90	84,2	2,50	2,50
Discovery-Reduced SRL	23	77	89	82,8	3,00	
Traditional-Elevated SRL	22	64	86	74,6	3,20	
Traditional-Intermediate SRL	22	60	84	72,5	2,80	2,80
Traditional-Reduced SRL	22	59	80	69,7	2,90	

As shown in Table 2, Discovery cohorts exhibited superior averages across all SRL categories, with a constructive relationship between SRL expertise and outcomes. Narrower variability in discovery indicates enhanced uniformity.

Table 3

Two-Way ANOVA Assessing Strategy and SRL Impacts on Creative Culinary Proficiencies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[b]	η^2 (Partial)
Corrected Method	8500,00	5	1700,00	18,50	0,001	92,500	0,999	0,452
Intercept	600000,00	1	600000,00	6521,74	0,001	6521,74	1,000	0,983
Method	3500,00	1	3500,00	38,04	0,001	38,04	0,999	0,248
SRL	2500,00	2	1250,00	13,59	0,001	27,18	0,995	0,204
Method* SRL	800,00	2	400,00	4,35	0,015	8,70	0,740	0,068

Error	10200,00	129	992,00
Total	618700,00	135	
Corrected Total	18700,00	134	

Table 3 showed the combined effect proved notable ($F(2,129) = 4,35$, $p = 0,015$, partial $\eta^2 = 0,068$), signifying that discovery advantages intensified with advanced SRL. The framework accounted for 45.2% of the variability.

3.2.1 Post-hoc examinations across SRL categories

Post the two-way ANOVA, substantial variances emerged in creative proficiencies between the discovery intervention and the traditional reference. Additional post-hoc probes dissected distinctions by SRL categories.

Table 4

Post-Hoc Variances in Creative Culinary Proficiencies Across SRL Categories

Comparison	Mean Difference	Sig	Notable
Elevated vs Intermediate	6,50	0,001	Yes
Elevated vs Reduced	8,90	0,001	Yes
Intermediate vs Reduced	2,40	0,220	No

As shown in Table 4, the post-hoc analysis revealed significant differences between Elevated and Intermediate SRL categories (mean difference = 6,50, $p = 0,001$), and between Elevated and Reduced (mean difference = 8,90, $p = 0,001$), but not between Intermediate and Reduced (mean difference = 2,40, $p = 0,220$).

3.2.2 Predictive influence of discovery learning and srl on creative culinary proficiencies

Multiple linear regression evaluated the forecasting capacity of discovery learning and SRL on learners' creative proficiencies, yielding:

Table 5

Multiple Regression Forecasting Creative Culinary Proficiencies

Variable	Coefficient (β)	Standard Error	t	Sig	R^2	F
Intercept	72,50	1,75	41,43	0,001	0,452	35,20
Method (Discovery)	8,50	1,75	4,86	0,001		
Intermediate SRL	-6,50	2,10	-3,10	0,002		
Reduced SRL	-8,90	2,10	-4,24	0,001		

Table 5 showed that the configuration was meaningful (R^2 = 0,452, F(3,131) = 35,20, p < 0,001), positioning discovery and elevated SRL as affirmative forecasters.

3.3 Qualitative results

Insights from semi-structured dialogues with 10 learners and 5 educators underwent thematic dissection via an iterative procedure, yielding four core patterns: learner involvement, proficiency advancement and originality, self-regulatory practices, and obstacles with limitations. Coding consistency was gauged by Cohen's Kappa (κ = 0,85), denoting robust concordance. Validation was bolstered through cross-referencing with portfolio elements. In line with modern pedagogical concerns, patterns encompassed tech incorporation, such as simulated kitchen environments for inclusive trials in constrained locales.[24]

3.3.1 Learner involvement

Discovery techniques heightened participation, modulated by SRL tiers. Advanced SRL learners voiced zeal for self-direction: "*The liberty to test fresh combinations daily sparks my interest*" (M1). Intermediate SRL learners displayed fluctuating commitment: "*While eager, I occasionally grapple with prioritizing virtual lab trials in fusion gastronomy*" (M2). Reduced SRL learners experienced overload: "*This openness daunts me; independence isn't my norm*" (M4). Educators stressed group equilibrium: "*Harmonious, cooperative teams foster vibrant educational climates*" (D4).[25]

3.3.2 Proficiency advancement and originality

Respondents noted amplified originality in blended gastronomy. Advanced SRL learners ventured audaciously: "*This framework grants me leeway to merge Sumatran heritage with pan-Asian and European essences*" (M3). Illustrations encompassed "*Rendang Sushi*" and "*Kimchi Bibimbap infused with Tempeh.*" Intermediate SRL learners gained from iterative attempts: "*Blending spices and sampling diverse tastes is rewarding, despite duration*" (M6). Reduced SRL learners proceeded tentatively: "*Absence of direction breeds error apprehension*" (M9). Educators underscored digital aids: "*Learners leveraged simulated apps for trial runs, tackling reachability in emerging regions*" (D1).

3.3.3 Self-regulatory practices

Discovery fostered SRL, propelling originality. Advanced SRL learners excelled: "*Autonomous trials and self-study yielded inventive outputs like 'Sushi Laksa'*" (M1). Intermediate SRL learners sought aid: "*I crafted 'Pad Thai with Tempeh' via colleague support*" (M6). Reduced SRL learners faltered: "*Lacking direct oversight hinders novelty*" (M7). Educators confirmed: "*This tactic prompts independent strategizing, trialing, and appraising, igniting fusion creativity*" (D3). Fair access to digital resources was deemed crucial for enduring viability.[29]

3.3.4 Obstacles and limitations

Hurdles differed by SRL. Advanced and intermediate SRL learners contended with iterative necessities: "*Creations such as 'Rendang Sushi' demanded multiple iterations*" (M3). Reduced SRL learners favored directives: "*Explicit instructions suit novel preparations*" (M4). Systemic issues involved scarce sophisticated tools: "*Infrastructure falls short for advanced pursuits like molecular techniques*" (D2). Scheduling pressures and material procurement surfaced, with suggestions for hybrid models to alleviate tech disparities.

4 DISCUSSION

4.1 Disparity in innovative fusion cuisine skills between traditional and discovery learning groups

The results demonstrate a significant advantage for the discovery learning cohort over the traditional instruction group in developing innovative fusion cooking skills, as evidenced by higher mean scores (e.g., 87,5 vs. 74,6 for advanced SRL learners). This aligns with Bruner's foundational theory, which posits that discovery learning fosters deeper understanding and creativity through active exploration rather than passive absorption.(26)

Empirical studies in culinary and health education confirm that active, hands-on approaches—such as those integrating social cognitive theory and experiential learning—enhance both skill acquisition and creative output compared to didactic methods.(30) For example, active learning interventions in culinary education have been shown to significantly improve students' culinary skills, confidence, and creative capacity, with effects persisting over time.(31)

Qualitative data from the present study, including participant narratives about blending regional and international culinary elements, echo findings that experiential and culturally embedded learning environments stimulate originality and engagement.(32) These results also address critiques of unstructured discovery learning, suggesting that guided discovery with educator support mitigates potential drawbacks for novices,(33) making it suitable for complex, practice-based domains like gastronomy.

4.2 Influence of SRL levels on innovative fusion cuisine skills

SRL emerged as a significant mediator of performance, with advanced SRL learners consistently outperforming their peers (mean scores: 87,5 advanced, 84,2 intermediate, 82,8 reduced). This pattern is consistent with Zimmerman's SRL model, which emphasizes self-monitoring, goal-setting, and reflective practice as drivers of adaptive expertise and creative problem-solving.(30) Recent research in vocational and culinary education corroborates the importance of SRL, showing that interventions

targeting self-direction and reflective practice yield higher competency and creative achievement.(31)

Qualitative accounts from advanced SRL learners in this study—such as successful self-directed experimentation—mirror findings that autonomy and self-regulation are critical for navigating complex, multicultural culinary tasks.(14) Conversely, learners with lower SRL reported difficulties with unstructured tasks, underscoring the need for scaffolding and differentiated support.(8)

4.3 Interaction between learning method and SRL levels

A significant interaction was observed between instructional method and SRL level, with discovery learning amplifying the benefits for advanced SRL learners (87,5 vs. 74,6 in traditional), but offering less advantage for those with reduced SRL (82,8 vs. 69,7). This finding supports the integration of constructivist and self-regulatory theories, suggesting that discovery-based environments are most effective when learners possess or develop strong self-regulation skills (7). Studies in hospitality and culinary education have shown that dynamic, student-centered models yield the greatest gains when paired with robust self-direction, while less self-regulated learners may require additional guidance.(34)

4.4 Effectiveness of technology-infused discovery learning and long-term impacts

Technology-enhanced discovery learning further strengthened skill development, as evidenced by significant improvements in both quantitative and qualitative outcomes. Virtual and digital tools enabled iterative experimentation and cross-cultural culinary exploration, supporting findings that immersive, technology-mediated environments can enhance both technical and creative competencies.(32) For instance, virtual reality and digital kitchen interventions have been shown to improve learning outcomes, engagement, and cultural understanding in culinary education**.**

Conceptually, Bruner's model clarifies discovery by asserting that active participation yields enduring competency gain. In practice, merging technologies—like artificial intelligence or virtual reality in simulated kitchens—could further augment

learners' intercultural innovation, synchronizing education with sector requirements while tackling moral concerns like digital reach in emerging nations, thus advancing durability and inclusivity. When effectively executed, technology merger in gastronomic training endows graduates with blended proficiencies—uniting classic gastronomic knowledge with digital adeptness—that boost versatility in a swiftly changing field. For instance, analyses of educational technology in gastronomy observed that VR-trained learners exhibit superior issue-resolution and originality, culminating in elevated job placement in worldwide fusion eateries and food innovation areas.[35,36] Over the long haul, this cultivates continuous education aptitudes, empowering alumni to utilize nascent technologies like AI-assisted recipe formulation, potentially yielding professional progression, such as positions in eco-friendly food originality.

4.5 Challenges in implementing discovery learning methods, including digital equity issues

4.5.1 Variability by self-regulated learning (SRL) level

Obstacles in discovery learning environments differ according to students' SRL. Learners with higher SRL often face iterative demands, such as repeated experimentation and refinement of complex fusion dishes (e.g., "*Rendang Sushi*"), which can be time-consuming and require resilience and adaptability. Conversely, students with lower SRL tend to prefer structured guidance and may experience confusion or hesitation when confronted with open-ended, self-directed tasks, leading to increased variability in outcomes.[34] This aligns with Bruner's (1961) assertion that discovery learning is most effective in nurturing environments that scaffold student inquiry and provide necessary support.[37]

4.5.2 Systemic and organizational barriers

Resource constraints—such as limited access to advanced kitchen equipment, time, and materials—are significant barriers to implementing discovery-based methods in culinary education.[11] These constraints are exacerbated in settings with high student-

to-instructor ratios or dense curricula, which limit opportunities for individualized feedback and iterative practice. Educators often report insufficient preparation or access to modern teaching tools, which can hinder their ability to facilitate discovery learning effectively.(38)

4.5.3 Educator readiness and pedagogical challenges

The success of discovery and SDL approaches is closely tied to educator readiness. Instructors must be adept at balancing guidance with autonomy, adapting to diverse SRL levels within student groups, and managing the additional time required for personalized instruction. (39) Lack of professional development or familiarity with active learning pedagogies can result in inconsistent implementation and diminished learning outcomes.(40)

4.5.4 Digital equity and access to technology

Digital equity is a critical issue, especially as blended and online learning modalities become more prevalent in culinary education. Access to digital tools—such as virtual kitchen simulations or instructional videos—can enhance learning, but disparities in connectivity and device availability can marginalize students, particularly in resource-limited regions.(41) These digital divides are especially pronounced in Southeast Asian contexts, where infrastructure gaps impede full participation in discovery-based activities.(42)

4.5.5 Hybrid approaches and mitigation strategies

To address these challenges, research suggests the adoption of hybrid instructional models that combine structured guidance with opportunities for self-directed exploration. Such models can help bridge gaps for students with lower SRL and mitigate resource disparities by leveraging both in-person and digital resources. Institutional investment in infrastructure and ongoing educator training are also essential for sustaining effective discovery learning environments. (43)

5 CONCLUSION

This mixed-methods study provides robust evidence for the superiority of discovery learning augmented by self-regulated learning (SRL) over traditional instructional methods in enhancing innovative fusion cooking skills among culinary arts students. The quantitative analysis revealed significant improvements in competencies for the discovery group, moderated by SRL levels, while qualitative insights from students and instructors underscored how this approach promotes deeper engagement, originality, and adaptive self-regulation, effectively tackling real-world challenges like iterative experimentation and resource constraints.

These findings align with constructivist and self-regulatory theories, emphasizing the need for active, student-centered pedagogies in vocational culinary education to meet the demands of a globalized gastronomy industry. To optimize implementation, evidence-based recommendations include integrating structured scaffolding and targeted SRL workshops (e.g., goal-setting and reflection exercises) to support low-SRL learners, institutional commitments to upgrading facilities, providing professional development for educators, and enhancing curricular flexibility, and leveraging technology such as virtual reality (VR) and AI-driven simulations for ethical, inclusive practice that promotes sustainability and cultural synthesis. Future research should explore longitudinal impacts on career outcomes, cross-cultural replications, and the efficacy of emerging technologies in scaling innovative fusion education across diverse settings.

REFERENCES

1. Amin VS. Ubiquitous Learning and Synergy: Innovating Vocational Education in Skilled Trades and Culinary Arts, To Fulfil United Nations Sustainable Development Goals. i-Manager's J Econ Commer. 2024;4(1):12. https://doi.org/10.26634/jecom.4.1.20896

2. Mahmoud Ahmed MA, El-Zoghbi MS, Ibrahim MBF, Abdelkawy A. Applicability of Active Learning Strategies in Hospitality Practical Courses Students' Perspectives. J Assoc Arab Univ Tour Hosp. 2022;23(1):43–55. https://doi.org/10.21608/jaauth.2022.154585.1381

3. Sarioglan M, Sezen TS. Project based learning approach in fusion cuisine education: A modal proposal. New Trends Issues Proc Humanit Soc Sci. 2017;4(1):574–8.

https://doi.org/10.18844/prosoc.v4i1.2303

4. Windyaningsiwi R, Nugroho SE, Subali B. Analysis of Student Self-Regulated Learning and Creative Thinking Through the Project-Based Learning Model on Renewable Energy Topics. Phys Commun. 2025;9(1):46–52. https://doi.org/10.15294/pc.v9i1.10809

5. Montessori M, Ambiyar A, Adri J, Wulansari RE, AGNI ZM, Islam S. Project-Based Learning in Political Sociology Course: Enhancing Student's Critical Thinking Skills and Learning Outcome. SALUD, Cienc Y Tecnol Учредители Salud, Cienc y Tecnol. 2024;4. https://doi.org/10.56294/saludcyt2024.1314

6. Syarofah AF, Hartadiyati E, Siswanato J, Wahayu NE. Analisis Kecakapan Abad 21: Collaboration and Communication Skills Siswa Melalui Penerapan Discovery Learning. J Educ. 2023;6(01):1–6. https://doi.org/10.31004/joe.v6i1.3808

7. Fayaza MSF, Ahangama S. Systematic review of self-regulated learning with blended learning in digital space. IEEE Access. 2024;https://doi.org/10.1109/ACCESS.2024.3470114

8. Greene JA, Freed R, Sawyer RK. Fostering creative performance in art and design education via self-regulated learning. Instr Sci. 2019;47(2):127–49. https://doi.org/10.1007/s11251-018-9479-8

9. Anthonysamy L, Ah Choo K, Soon Hin H. Investigating Self-Regulated Learning Strategies for Digital Learning relevancy. Malaysian J Learn Instr. 2021;18(1):29–64. https://doi.org/10.32890/mjli2021.18.1.2

10. Stierand M. Developing creativity in practice: Explorations with world-renowned chefs. Manag Learn. 2015;46(5):598–617. https://doi.org/10.1177/1350507614560302

11. Maryani I, Estriningrum U, Nuryana Z. Self-regulated learning and creative thinking skills of elementary school students in the distance education during the COVID-19 pandemic. Creat Stud. 2023;16(2):496–508. DOI: https://doi.org/10.3846/cs.2023.15278

12. Filimonova I, Dubova N. Стимулювання Професійного Саморозвитку Майбутніх Фахівців Професійної Освіти Кулінарного Профілю Як Запорука Їх Кар'єрного Зростання [Stimulating Professional Self-Development Of Future Professional Education Specialists Of Culinary Profile As A Guarantee Of Their Career Growth]. Психолого-педагогічні проблеми сучасної школи [Psychological and pedagogical problems of modern school. 2023;(2 (10)):67–74. https://doi.org/10.31499/2706-6258.2(10).2023.290572

13. Park J. Culture learning in a daily space of kitchen: the case of Korean digital kitchen. Smart Learn Environ. 2021;8(1):32. https://doi.org/10.1186/s40561-021-00178-3

14. Hu MLM, Lin HCK, Lin YH, Yuan YH. The impact of culinary virtual reality

curriculum on students' learning outcomes and acceptance. Innov Educ Teach Int. 2025;62(2):462–76. DOI:10.1080/14703297.2023.2287583

15. Creswell JW, Plano Clark VL. Revisiting mixed methods research designs twenty years later. Handb Mix methods Res Des. 2023;1(1):21–36. DOI:10.4135/9781529614572.n6

16. Bernardo GL, Jomori MM, Fernandes AC, Colussi CF, Condrasky MD, da Costa Proenca RP. Positive impact of a cooking skills intervention among Brazilian university students: Six months follow-up of a randomized controlled trial. Appetite. 2018;130:247–55. https://doi.org/10.1016/j.appet.2018.08.014

17. Campbell DT, Stanley JC. Experimental and quasi-experimental designs for research. Ravenio books; 2015.

18. McHugh ML. Interrater reliability: the kappa statistic. Biochem medica. 2012;22(3):276–82. https://hrcak.srce.hr/89395

19. Holuša V, Vaněk M, Beneš F, Švub J, Staša P. Virtual reality as a tool for sustainable training and education of employees in industrial enterprises. Sustainability. 2023;15(17):12886. https://doi.org/10.3390/su151712886

20. Hair JF, Hult GT, Ringle C, Sarstedt M. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Second Ed. Sage. Los Angeles: SAGE Publications, Inc; 2017. 374 p.

21. Weller S. Using internet video calls in qualitative (longitudinal) interviews: Some implications for rapport. Int J Soc Res Methodol. 2017;20(6):613–25. https://doi.org/10.1080/13645579.2016.1269505

22. Braun V, Clarke V. Reflecting on reflexive thematic analysis. Qual Res Sport Exerc Heal. 2019;11(4):589–97. https://doi.org/10.1080/2159676X.2019.1628806

23. Guetterman TC, Fàbregues S, Sakakibara R. Visuals in joint displays to represent integration in mixed methods research: A methodological review. Methods Psychol. 2021;5:100080. https://doi.org/10.1016/j.metip.2021.100080

24. Hsiao CC, Huang JCH, Huang AYQ, Lu OHT, Yin CJ, Yang SJH. Exploring the effects of online learning behaviors on short-term and long-term learning outcomes in flipped classrooms. Interact Learn Environ. 2019;27(8):1160–77. https://doi.org/10.1080/10494820.2018.1522651

25. Pintrich PR. A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ). 1991; http://files.eric.ed.gov/fulltext/ED338122.pdf

26. Ozdem-Yilmaz Y, Bilican K. Discovery learning—jerome bruner. In: Science education in theory and practice: An introductory guide to learning theory. Springer; 2025. p. 173–187. https://doi.org/10.1007/978-3-031-81351-1_11

27. Noerper T, Lowery A, Wright G, Burka A. Increasing nutrition knowledge and culinary skills in interprofessional healthcare students: an active learning pilot study. BMC Med Educ. 2025;25(1):777. https://doi.org/10.1186/s12909-025-07247-y

28. Weller SC, Vickers B, Bernard HR, Blackburn AM, Borgatti S, Gravlee CC, et al. Open-ended interview questions and saturation. PLoS One. 2018;13(6):e0198606. https://doi.org/10.1371/journal.pone.0198606

29. Zimmerman BJ. Becoming a self-regulated learner: An overview. Theory Pract. 2002;41(2):64–70. https://doi.org/10.1207/s15430421tip4102_2

30. Zimmerman BJ, Greenberg D, Weinstein CE. Self-regulating academic study time: A strategy approach. In: Self-regulation of learning and performance. Routledge; 2023. p. 181–99. https://doi.org/10.4324/9780203763353-8

31. Avsec S, Jagiełło-Kowalczyk M. Investigating possibilities of developing self-directed learning in architecture students using design thinking. Sustainability. 2021;13(8):4369. https://doi.org/10.3390/su13084369

32. Lendway W, Bonde M, Jansma M, Marquart L, Perteet-Jackson A. Preparing the Future Nutrition Professional: Culinary-Focused Summer Internship for Nutrition Undergraduates. Curr Dev Nutr. 2022;6:429. https://doi.org/10.1093/cdn/nzac056.009

33. Kirschner PA. Cognitive load theory: Implications of cognitive load theory on the design of learning. Vol. 12, Learning and instruction. Elsevier; 2002. p. 1–10. https://doi.org/10.1016/S0959-4752(01)00014-7

34. Surgenor D, Hollywood L, Furey S, Lavelle F, McGowan L, Spence M, et al. The impact of video technology on learning: A cooking skills experiment. Appetite. 2017;114:306–12. https://doi.org/10.1016/j.appet.2017.03.037

35. Huang AYQ, Lu OHT, Yang SJH. Effects of artificial Intelligence–Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. Comput Educ. 2023;194:104684. https://doi.org/10.1016/j.compedu.2022.104684

36. Motlagh MA, Zavaraki EZ, Vahedi M, Noroozi D, Bakhtiarvand M, Azizi Y. The Impact of Blended Collaborative Learning on the English Reading Comprehension. Randwick Int Educ Linguist Sci J. 2023;4(1):1–12. https://doi.org/10.47175/rielsj.v4i1.608

37. Bruner JS. The act of discovery. Concepts Art Educ Anthol Curr Issues. 1970;

38. Manurung AS, Pappachan P. The role of discovery learning in efforts to develop students' critical thinking abilities. J Educ Learn. 2025;19(1):46–53. https://doi.org/10.11591/edulearn.v19i1.21788

39. Sterpu I, Herling L, Nordquist J, Rotgans J, Acharya G. Team-based learning (TBL)

in clinical disciplines for undergraduate medical students—a scoping review. BMC Med Educ. 2024;24(1):18. https://doi.org/10.1186/s12909-023-04975-x

40. Martaida T, Bukit N, Ginting EM. The effect of discovery learning model on student's critical thinking and cognitive ability in junior high school. IOSR J Res Method Educ. 2017;7(6):1–8. DOI: 10.9790/7388-0706010108

41. Sutopo Y, Kusumawardani R. Development and Implementation of Jobsheets for Enhancing Basic Culinary Competence. J Vocat Career Educ. 2024;9(1). https://doi.org/10.15294/jvce.v9i1.17883

42. Tlili A, Huang R, Shehata B, Liu D, Zhao J, Metwally AHS, et al. Is Metaverse in education a blessinor a curse: a combined content and bibliometric analysis. Smart Learn Environ. 2022;9(1):1–31. https://doi.org/10.1186/s40561-022-00205-x

43. Tan J, Atamanchuk L, Rao T, Sato K, Crowley J, Ball L. Exploring culinary medicine as a promising method of nutritional education in medical school: a scoping review. BMC Med Educ. 2022;22(1):441. https://doi.org/10.1186/s12909-022-03449-w

Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA)

Putri, Y. E., Efi, A., Refdinal, Anugerah, A. I., & Reflianto. THE EFFECTS OF DISCOVERY LEARNING AND SELF-REGULATED LEARNING ON INNOVATIVE FUSION CUISINE SKILLS IN CULINARY ARTS EDUCATION. Veredas Do Direito, e234504. https://doi.org/10.18623/rvd.v23.n4.4504