Psychological factors of flow state in online learning

Daša Jalen*

Abstract: **Purpose of the article** – The objective of this paper is to review and summarize the existing literature regarding the flow experience, its psychological drivers, and consequences in the context of e-learning, as well as to provide concrete suggestions for creating an optimal online learning experience.
Research methodology – A systematic review was conducted, and the literature was analysed through thematic analysis. The search was carried out in three electronic databases (PsycINFO, PubMed, and Scopus), and 17 articles were selected after applying inclusion criteria. Common tags in at least two articles were identified as themes. The main findings are synthesized in the discussion.
Findings – The findings indicate that flow is associated with a range of positive cognitive, emotional and motivational factors. Platforms that help students achieve flow are interactive, provide feedback, contain entertaining yet professional content, and consider the difficulty level. Teachers should promote interaction with and between students and tailor the level of support to individual students.
Practical implications – This study aims to provide concrete suggestions for improving online learning platforms and teaching, contributing to e-students' satisfaction, performance, and continuance intentions.
Keywords: e-learning, flow state, psychological factors, facilitation methods
JEL classification: I20

*Faculty of Arts, University of Ljubljana, Ljubljana, Slovenija, dasa.jalen2@gmail.com

Psihološki faktorji zanosa v e-učenju

Povzetek: Namen – Cilj raziskave je pregledati literaturo in povzeti dosedanje ugotovitve raziskav glede psiholoških prehodnikov in posledic zanosa v kontekstu e-učenja ter podati konkretne predloge za doseganje optimalne izkušnje virtualnega izobraževanja.
Metodologija – Sistematični pregled literature je bil izveden s pomočjo tematske analize. V treh elektronskih bazah (PsycINFO, PubMed in Scopus) je bilo najdenih 17 člankov, ki so ustrezali vključitvenim kriterijem. Identificirane teme so skupne vsaj dvema člankoma. V diskusiji so sintetizirane glavne ugotovitve.
Rezultati – Zanos je povezan z vrsto pozitivnih kognitivnih, čustvenih in motivacijskih faktorjev. Platforme, ki spodbujajo zanos, so interaktivne, učencem dajejo povratne informacije, ponujajo zabavno vendar strokovno vsebino ter upoštevajo nivo težavnosti. Vloga učiteljev je spodbujanje interakcije z in med študenti ter prilagajanje ravni podpore posameznim študentom.
Praktične implikacije – Podani so uporabni predlogi za izboljšavo e-izobraževalnih platform in poučevanja, z namenom povečanja zadovoljstva, izboljšanja učne uspešnosti ter vztrajanja v e-učenju.
Ključne besede: e-učenje, zanos, psihološki faktorji, spodbujevalne metode

INTRODUCTION

With the rise of digitalisation, all aspects of human life, including education, must adapt and evolve to take advantage of the tools and strengths of new technologies (OECD, 2019). Although often perceived as a relatively new concept, remote learning has existed for over a century, with roots in European correspondence courses (Sherry, 1995). Some benefits of e-learning include promoting independence and individual satisfaction, allowing learning at anytime, anywhere, and for students from any background, significantly saving time and costs, and reducing environmental and audio pollution (Somayeh et al., 2016). One fascinating aspect of the learning experience that is challenging to achieve yet incredibly rewarding is the state of total immersion, where time feels non-existent and the only thing that seems to matter is the task at hand. Flow is a state of concentration so focused that it amounts to absolute absorption in an activity (Csikszentmihalyi, 2013). It involves intense and focused concentration on the task at hand, a merging of action and awareness, a loss of reflective self-consciousness, a sense of control over one's actions, a distorted perception of time, and an experience of the activity as intrinsically rewarding (Nakamura and Csikszentmihalyi, 2002, as cited in Abuhamdeh, 2020). In the context of e-learning, flow states facilitate positive emotions, enhance academic performance, and contribute to students' effective continuation in online learning (Rodríguez-Ardura and Meseguer-Artola, 2016).

Although flow has been extensively studied as a concept, there remains a need for a comprehensive synthesis of current findings on flow in virtual education. This systematic review, therefore, aims to summarize and synthesize existing literature on psychological variables associated with the flow state in online educational settings and to explore ways to enhance the flow experience in the context of online learning. With technological advances over the last few decades, online learning has gained an important place in education (Kaufmann and Vallade, 2022) due to its potential to provide more flexible access to content and instruction at any time, from any location (Castro and Tumibay, 2019). Since the flow state is related to many positive academic outcomes (e.g., Buil et al., 2019; Klein et al., 2010; Zhang and Qi, 2023), it raises questions about how it manifests in an online learning environment, what facilitates it, and its relationship with various psychological factors (e.g., self-efficacy, intrinsic motivation, attention, etc.). The following research questions were asked:

RQ1: Which psychological factors are associated with the flow experience in online learning?
RQ2: What are the ways/methods that the flow state can be facilitated in online learning?

1 Materials and methods

This systematic review was conducted using thematic analysis, a commonly used qualitative method in scientific research (Castleberry and Nolen, 2018; Naeem et al., 2023; Rosairo, 2023). One advantage of qualitative analysis lies in its flexibility and adaptability. When specific recommendations and steps are considered and the researcher is transparent about the process and their own biases, the resulting findings are valid, reliable, and contribute valuably to the scientific literature (Castleberry and Nolen, 2018). Naeem et al. (2023) outline the following steps for conducting a well-structured analysis that ensures thoroughness and minimizes potential bias:

1. Transcription, familiarization with the data, and selection of quotations relevant to the research objectives.
2. Selection of keywords - recurring patterns, terms, or visual elements.
3. Coding – assigning short phrases or words to segments of data that capture the data's core message, significance, or theme.
4. Theme development - organizing codes into meaningful groups to identify patterns and relationships.
5. Conceptualization through interpretation of keywords, codes, and themes.
6. Development of a conceptual model which serves to answer the research questions.

While traditionally applied to qualitative data (Naeem et al., 2023), thematic analysis can also be used with quantitative research, as demonstrated by Mehta and Vyas (2022). This approach is not limited to primary studies; it can also be applied in systematic reviews, where Thomas and Harden (2008) adopted the term thematic synthesis. According to Thomas and Harden (2008), conceptual innovation is not necessary when the selected studies directly address the research questions. Consequently, this method was chosen for the present systematic review, and the steps were simplified to enable an effective synthesis of the topic. The process is detailed in the following sections.

The researcher carried out the online literature search in three electronic databases: PsycINFO, PubMed, and Scopus. To find articles, relevant to the review, the following Boolean search term combinations were used: (flow state OR flow experience OR flow theory) AND (online learning OR e-learning OR distance education OR virtual classroom OR remote learning). The same search filters were set in all three electronic databases: publication year (2004-2024), language (English), and full text available. Clear and concise inclusion criteria, adapted from a similar systematic review, were applied (Mehta and Vyas, 2022; see Table 1).

Table 1. Inclusion criteria for the review

Criterion type	Description
Topic	The study must relate to both the flow state and online learning and must answer at least one of the two research questions.
Date of publication	Published between 2004 and 2024.
Type of publication	The study must be a peer-reviewed journal article.
Research type	Results must be quantitative in nature.
Participants	The study participants are adolescents or young adults.

The search in the three electronic databases was conducted on October 20, 2024 and yielded 72 results, which were first screened by titles. In the next step the abstracts of the relevant studies were read and those that met the inclusion criteria were retained. The remaining 21 articles were thoroughly read to determine their eligibility for this review. At the end the final set of 17 articles were selected, which were reread and analysed to allow for a comprehensive synthesis and conclusion of the topic.

2 Results

The final 17 studies included undergraduate and/or postgraduate students, except for a study by Giasiranis and Sofos (2017), which included junior high school students. Different research methods were used; however, each study included questionnaires or scales to measure flow and/or related constructs.

To conduct a thematic analysis, the researcher followed a method used by a similar systematic review (Mehta and Vyas, 2022). In the first step, the sections that answered

one or both research questions were extracted and assigned key words or tags (see Table 2). In the next step, tags that appeared in at least two studies or more, either verbatim or in terms of content, were determined as themes. The final 17 themes are presented in Tables 3a and 3b.

The two findings that appear to be the most common among the chosen articles are the positive associations between flow and its cognitive benefits—such as increased absorption, enhanced memory, and reflective thinking—and between flow and continuance intention or behaviour, both in the context of e-learning.

Table 2. Final research studies and their tags

Citation	Aim of the study	Psychological factors (RQ1)	Facilitation methods (RQ2)
Baydas et al. (2016)	Explore how instructor's guidance and users' experience affect retention scores and flow.		Guidance
Bian and Zhou (2022)	Explore how animated pedagogical agents feedback strategy and personality type affect learning performance and flow (Study 1).		Feedback
Giasiranis and Sofos (2017)	Investigate how AR technology affects performance and flow.	Performance	AR technology
Goh and Yang (2021)	Explore the associations between flow and different factors in an e-learning environment	Continuance intention, perceived ease of use, perceived usefulness	Engagement
Gu et al. (2022)	Study the factors that affect the continuation willingness of online learning.	Continuation willingness	Teacher support, learning interaction
Guerra-Tamez (2023)	Explore the impact of immersion VR mediated by flow.	Motivation, curiosity, cognitive benefits, reflective thinking, value perception	Immersion VR
Ha and Im (2020)	Investigate the effects of interactivity and skill-challenge balance on online learning and flow.		Interactivity, skill-challenge balance
Hewei and Youngsook (2022)	Explore the influencing factors of online course learning intention.	Learning intention, usability	Professionalism, interactivity, entertainment
Hu et al. (2023)	Investigate experiences with collaborative MALL and factors influencing intentions for further adoption.	Continuance intention, perceived cost	Collaboration
Jebur et al. (2022)	Investigate the potential of integrating flow into MTL to reduce anxiety and increase self-regulation.	Telepresence, sense of control, anxiety, self-regulation	Skill-challenge balance
Li et al. (2022)	Investigate the impact of system characteristics on flow in online learning.	Continuance intention, learning effect	System availability, feedback timeliness, interactive sociality, system functionality, interesting content
Rodríguez-Ardura and Meseguer-Artola (2016)	Explain the intrapersonal factors of flow state and what effect it has in a virtual education environment.	Control, challenge, presence, attention, positive affect, continuance behaviour, performance	
Rodríguez-Ardura and Meseguer-Artola (2019)	Explore the factors that capture the formation of flow in personalised e-learning environments.	Attention, playfulness, mental imagery, positive mood, performance	Professor's competency, professor's support, didactic resources quality, skill-demand balance
Shao et al. (2022)	Explore factors that influence the learning effect in an online learning environment.	Self-directed learning, learning ineffectiveness	

Wang et al. (2023)	Investigate the influence of using MARLS on students' preceived learning effectiveness.	Continuance intention, perceived learning effectiveness	Feedback
Wu and Fan (2024)	Explain the impact of flow antecedents on flow experience and explore the students' continuance intention in e-learning.	Motivation, satisfaction, continuous intention, perceived usefulness	Information quality, service support quality
Zhao and Khan (2022)	Investigate how flow drives the intention to engage in online learning.	Continuous intention, perceived enjoyment, satisfaction, challenge, perceived usefulness, situational envolvement	

Table 3a. Thematic analysis of the final set of studies

Citation	Continuance	Interactivity	Learning interaction	Skill-challenge balance	Control	Attention	Challenge	Perceived usefulness	Usability
Baydas et al. (2016)									
Bian and Zhou (2022)									
Giasiranis and Sofos (2017)		x							
Goh and Yang (2021)	x							x	x
Gu et al. (2022)	x		x						
Guerra-Tamez (2023)		x							
Ha and Im (2020)		x		x					
Hewei and Youngsook (2022)	x	x							x
Hu et al. (2023)	x		x						
Jebur et al. (2022)				x	x				
Li et al. (2022)	x		x						
Rodríguez-Ardura and Meseguer-Artola (2016)	x				x	x	x		
Rodríguez-Ardura and Meseguer-Artola (2019)				x		x			
Shao et al. (2022)									
Wang et al. (2023)	x								
Wu and Fan (2024)	x							x	
Zhao and Khan (2022)	x						x	x	

Table 3b. Thematic analysis of the final set of studies

Citation	Cognitive benefits	Positive affect	Motivation	Satisfaction	Feedback	Professor factors	Content	Presence
Baydas et al. (2016)								
Bian and Zhou (2022)					x			
Giasiranis and Sofos (2017)	x							
Goh and Yang (2021)								
Gu et al. (2022)						x		
Guerra-Tamez (2023)	x		x					
Ha and Im (2020)								
Hewei and Youngsook (2022)							x	
Hu et al. (2023)								
Jebur et al. (2022)								x
Li et al. (2022)	x				x		x	
Rodríguez-Ardura and Meseguer-Artola (2016)	x	x						x
Rodríguez-Ardura and Meseguer-Artola (2019)	x	x				x	x	
Shao et al. (2022)	x							
Wang et al. (2023)	x				x			
Wu and Fan (2024)			x	x			x	
Zhao and Khan (2022)				x				

3 Discussion

The objective of this systematic review was to synthesize existing knowledge regarding the flow experience in an e-learning environment. The focus was on identifying the psychological factors that precede the flow state and those that follow it. In addition, methods and ways of facilitating flow were investigated, from setting up systems with flow-enhancing characteristics to behaviours that teachers can adopt to provide the students with an optimal online learning environment. Common factors and methods found across multiple studies are discussed, along with additional insights from individual articles.

3.1 Psychological factors and the flow experience

One of the arguably most important outcomes of flow is the intention to stick to the activity that induced it (e.g., Goh and Yang, 2021; Gu et al., 2022). In the case of e-learning, students who achieve flow are engaged in an enjoyable activity (e.g., feeling satisfied) and thus perceive online learning as useful or beneficial (Wu and Fan, 2024), which leads to the decision to continue using the platforms and systems to deepen their theoretical knowledge and practical skills. Other psychological factors commonly found to be positively affected by flow, include cognitive benefits, motivation (Guerra-Tamez, 2023), and positive affect (Rodríguez-Ardura and Meseguer-Artola, 2016). Cognitive benefits, such as increased absorption, enhanced memory (Wang et al., 2023), and reflective thinking (Guerra-Tamez, 2023), seem to underpin the perceived learning effectiveness (Wang et al., 2023) as well as actual improved performance (Rodríguez-Ardura and Meseguer-Artola, 2019). In contrast, motivation and positive affect function not only as consequences (Guerra-Tamez, 2023; Rodríguez-Ardura and Meseguer-Artola, 2016) but also antecedents of flow (Rodríguez-Ardura and Meseguer-Artola, 2019; Wu and Fan, 2024). Students in a positive mood and those who are highly motivated to learn are more likely to achieve the state, which in turn leads to enhanced mood and motivation.

Control (Jebur et al., 2022), attention, challenge (Rodríguez-Ardura and Meseguer-Artola, 2016), perceived ease of use (Goh and Yang, 2021) and presence (Jebur et al., 2022) were also found to be positively associated with flow. In other words, students who have a sense of mastery over their environment, focus on the task at hand—to the point of feeling as if they are in a "real" environment—and engage in activities that are just challenging enough possess an optimal internal state to facilitate flow.

3.2 Methods - ways of flow facilitation

The previous chapter focused on internal states, while this chapter is intended to give practical tips for flow facilitation. The characteristics of an optimal e-learning environment for enhancing flow, be it an online classroom, a VR system or a phone application, are the following:
- Interactivity: Interactive visual tools (Ha and Im, 2020) or whole systems that are based on active exploration of the environment, such as AR (Giasiranis and Sofos, 2017) or VR technology (Guerra-Tamez, 2023).
- Learning interaction (e.g., Gu et al., 2022): Collaboration between students, such as problem-solving, mutual assessment of assignments or participating in a discussion, as well as collaboration between teachers and students.
- Skill-challenge balance (e.g., Jebur et al., 2022): The difficulty level that is tailored to the students, so that the activities are challenging but managable.
- Feedback (e.g., Bian and Zhou, 2022): Optimal feedback is positive (rewarding), timely and constructive.
- Content (e.g., Li et al., 2022): Interesting, entertaining (e.g., humorous) yet professional content, that focuses on expected, important and useful information.

In terms of factors pertaining to professors or teachers, competency was found to be important for flow (Rodríguez-Ardura and Meseguer-Artola, 2019). Instructors who are enthusiastic, supportive, motivating, effectively use teaching methods, have a good understanding of the content being taught and the systems being used, are more likely to promote the flow state in their students. Interestingly, professor competency had a greater effect on flow in male students. Regarding academic performance, teacher support was

shown to be more important for low-performing e-learners, while high-performing e-learners thrive on self-directed approaches. Interestingly, a study by Wu and Fan (2024) didn't find an association between instructor quality (defined as learners' perception of instructor's personality and training) and flow. The reason for this might lie in the difference between the terms teacher competency, teacher quality and teacher support, which overlap but are not exactly the same. The term teacher support appears to be the narrowest, as it is often included within broader concepts like teacher competency and teacher quality which encompass both teaching skills and relational support provided to students.

3.3 Additional insights

Individual studies also included unique findings, such as the positive effect of flow state on reducing anxiety, improving self-regulation (Jebur et al., 2022), fostering curiosity, increasing value perception of the experience (Guerra-Tamez, 2023), and situational involvement (Zhao and Khan, 2022). In terms of factors influencing flow, playfulness, mental imagery (Rodríguez-Ardura and Meseguer-Artola, 2019), perceived cost (Hu et al., 2023), perceived enjoyment (Zhao and Khan, 2022), e-learning engagement (usage intensity and learning activity; Goh and Yang, 2021) as well as self-directed learning attitude and approach (Shao et al., 2022), were identified.

Service support quality (Wu and Fan, 2024) and system characteristics, including availability and functionality (Li et al., 2022) were also found to be important predictors of flow state. However, the type of guidance in a 3D virtual world (e.g., avatar guidance, reflective guidance, nonguided navigation) did not matter in terms of improving or reducing flow (Baydas et al., 2016).

3.4 Limitations and future directions

Conducting this study alone may lead to bias, which can affect the objectivity of the results. Therefore, the findings should be interpreted and applied with caution. Future research should focus on older generations who might require different approaches and methods to experience effective and satisfying online learning. This is particularly important in the context of lifelong learning.

4 Conclusions

This paper is intended for e-learning platform developers, professionals working in the educational sector, and others looking to integrate online learning into their practice. The main findings indicate that the flow state is associated with several psychological factors and is crucial for learning outcomes and persistence in online learning. Additionally, the reviewed studies highlight various platform and system characteristics, as well as learning approaches, that can help students achieve flow for an optimal e-learning experience.

References

Abuhamdeh, S. (2020). Investigating the "flow" experience: Key conceptual and operational issues. *Frontiers in Psychology, 11.* doi:10.3389/fpsyg.2020.00158

Baydas, O., Karakus, T., Topu, F. B., Yilmaz, R., Ozturk, M. E., & Goktas, Y. (2015). Retention and flow under guided and unguided learning experience in 3D virtual worlds. *Computers in Human Behavior, 44*, 96–102. https://doi.org/10.1016/j.chb.2014.11.041

Bian, Y., & Zhou, C. (2022). Motivation effect of animated pedagogical agent's personality and feedback strategy types on learning in virtual training environment. *Virtual Reality & Intelligent Hardware*, *4*(2), 153–172. https://doi.org/10.1016/j.vrih.2021.11.001

Buil, I., Catalán, S., & Martínez, E. (2019). The influence of flow on learning outcomes: An empirical study on the use of clickers. *British Journal of Educational Technology, 50*(1), 428–439. https://doi.org/10.1111/bjet.12561.

Castleberry, A., & Nolen, A. (2018). Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning, 10*(6), 807–815. doi:10.1016/j.cptl.2018.03.019

Castro, M. D. B., & Tumibay, G. M. (2021). A literature review: Efficacy of online learning courses for higher education institution using meta-analysis. *Education and Information Technologies*, *26*(2), 1367–1385. https://doi.org/10.1007/s10639-019-10027-z

Csikszentmihalyi, M. (2013). *Flow: The psychology of happiness*. Ebury Publishing.

Giasiranis, S., & Sofos, L. (2017). Flow experience and educational effectiveness of teaching informatics using AR. *Journal of Educational Technology & Society*, *20*(4), 78–88. http://www.jstor.org/stable/26229207

Goh, T. T., & Yang, B. (2021). The role of e-engagement and flow on the continuance with a learning management system in a blended learning environment. *International Journal of Educational Technology in Higher Education*, *18*(1). https://doi.org/10.1186/s41239-021-00285-8

Gu, Y., Song, C., Zhong, Y., & Comite, U. (2022). The impact of teacher support and learning interaction on online learning continuation willingness: A flow experience perspective. *International Journal of Emerging Technologies in Learning (Online), 17*(17), 78–89. https://doi.org/10.3991/ijet.v17i17.34029

Guerra-Tamez, C. R. (2023). The impact of immersion through virtual reality in the learning experiences of art and design students: The mediating effect of the flow experience. *Education Sciences*, *13*(2). https://doi.org/10.3390/educsci13020185

Ha, Y., & Im, H. (2020). The role of an interactive visual learning tool and its personalizability in online learning: Flow experience. *Online Learning, 24*(1), 205–226. https://doi.org/10.24059/olj.v24i1.1620

Hewei, T., & Youngsook, L. (2022). Influencing factors of online course learning intention of undergraduates majoring in art and design: Mediating effect of flow experience. *Sage Open, 12*(4). https://doi.org/10.1177/21582440221134004

Hu, L., Hei, D., Wang, H., & Dai, X. (2023). Chinese college students collaborative mobile-assisted language learning experience and flow as a key factor for further adoption. *Frontiers in Psychology, 14*. https://doi.org/10.3389/fpsyg.2023.1165332

Jebur, G., Al-Samarraie, H., & Alzahrani, A. I. (2022). An adaptive Metalearner-based flow: A tool for reducing anxiety and increasing self-regulation. *User Modeling and User-Adapted Interaction*, *32*(3), 469–501. https://doi.org/10.1007/s11257-022-09330-1

Kaufmann, R., & Vallade, J. I. (2022). Maximizing the student experience: Moving forward with online learning. *Communication Education*, *71*(2), 152–154. https://doi.org/10.1080/03634523.2021.2022730

Klein, B. D., Rossin, D., Guo, Y. M., & Ro, Y. K. (2010). An examination of the effects of flow on learning in a graduate-level introductory operations management course. *Journal of Education for Business, 85*(5)*, 292-298.* doi:10.1080/08832320903449600

Li, M., Wang, T., Lu, W., & Wang, M. (2022). Optimizing the systematic characteristics of online learning systems to enhance the continuance intention of Chinese college students. *Sustainability*, *14*(18). https://doi.org/10.3390/su141811774

Mehta, P., & Vyas, M. (2022). A systematic literature review on the experience of flow and its relation to intrinsic motivation in students. *Indian Journal of Positive Psychology*, *13*(3), 299–304.

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods, 22*. https://doi.org/10.1177/16094069231205789

OECD, 2019. *Trends shaping education 2019*. OECD Publishing, Paris. doi:10.1787/trends_edu-2019-en

Rodríguez-Ardura, I., & Meseguer-Artola, A. (2016). Flow in e-learning: What drives it and why it

matters. *British Journal of Educational Technology, 48*(4), 899–915. doi:10.1111/bjet.12480

Rodríguez-Ardura, I., & Meseguer-Artola, A. (2019). Flow experiences in personalised e-learning environments and the role of gender and academic performance. *Interactive Learning Environments*, *29*(1), 59–82. https://doi.org/10.1080/10494820.2019.1572628

Rosairo, H. S. R. (2023). *Thematic analysis in qualitative research* [Editorial foreword]. *The Journal of Agricultural Sciences, 18*(3). doi:10.4038/jas.v18i3.10526

Shao, M., Hong, J. C., & Zhao, L. (2022). Impact of the self-directed learning approach and attitude on online learning ineffectiveness: The mediating roles of internet cognitive fatigue and flow state. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.927454

Sherry, L. (1995). Issues in distance learning. *International Journal of Educational Telecommunications, 1*(4), 337–365.

Somayeh, M., Dehghani, M., Mozaffari, F., Ghasemnegad, S., Hakimi, H., & Samaneh, B. (2016). The effectiveness of E-learning in learning: A review of the literature. *International Journal of Medical Research and Health Sciences, 5*(2), 86–91.

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology, 8*(1). doi:10.1186/1471-2288-8-45

Wang, W. T., Lin, Y. L., & Lu, H. E. (2023). Exploring the effect of improved learning performance: A mobile augmented reality learning system. *Education and Information Technologies*, *28*(6), 7509–7541. https://doi.org/10.1007/s10639-022-11487-6

Wu, C. H., & Fan, W. S. (2024). Students' flow experience of using AI-powered online english learning platforms. *HighTech and Innovation Journal*, *5*(2), 382–399. doi:10.28991/HIJ-2024-05-02-011

Zhang, J., & Qi, F. (2023). Relationship between learning flow and academic performance among students: A systematic evaluation and meta-analysis. *Frontiers in Psychology, 14*. https://doi.org/10.3389/fpsyg.2023.1270642.

Zhao, H., & Khan, A. (2022). The students' flow experience with the continuous intention of using online English platforms. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.807084