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Effects of Pedagogical Agent on Learner's Cognitive Load and Intrinsic Motivation: A Systematic Literature Review

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ARTICLE INFO	ABSTRACT
	This study aims to investigate the impact of pedagogical agents towards learners' cognitive load on various applications of pedagogical agents in teaching and learning. This systematic review has been conducted on 17 research of pedagogical agents that studied their cognitive load impact towards the learners. Guided by PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), using resources from Scopus databases. Three main themes and seven sub-themes have been identified on pedagogical agent impacts on learners' cognitive load and factors that influenced the impact. Findings show that pedagogical agent impact towards learners' cognitive load yields a mixed result. However, the review concludes that the pedagogical agent does influence the learner's cognitive load, but the impact may vary in accordance with the design factor of the pedagogical agent.

INTRODUCTION

A pedagogical agent, also known as an embodiment, teachable, and conversational agent, is not a newcomer to the teaching and learning scene. It was originally derived from two different research disciplines, namely animated interface agents and knowledge-based learning environments, that were commonly conducted as early as the 1970s (Johnson, Rickel, & Lester, 2000). Examples of pedagogical agents are digital personas that are incorporated into online multimedia learning experiences. Their presences are intended to guide learners and to positively influence their attitude towards learning. Pedagogical agents could help students be happier and more motivated to learn in multimedia learning environments (Wang et al., 2022). Metanalysis research concluded that 2-dimensional character that displays positive emotional states helps increase learners' interests and motivation for learning in most online subjects. Compared to the pedagogical agent that displays the neutral expression, body movement or comment, the positive pedagogical agent has a larger influence on the student's attitude and motivation (Lang, Xie, Gong, Wang, & Cao, 2022; Wang, Gong, Cao, & Fan, 2023).

Pedagogical agents offer new spectrum towards learning especially in instructional learning as it empowers by necessary technology that allows it to have additional role such as respond and facilitate the learning more like a tutor compared to an intelligent tutoring system (ITS) (Richards & Dignum, 2019). Despite its potential to evoke the response of the students, pedagogical agents can influence collaboration by making users aware of collaboration patterns (division of labour, explicit roles, etc.) and by creating focus shifts in the users' interaction (Jondahl & Mørch, 2023).

Several articles and research show that apart from its hype, pedagogical agent did improve learning upon its intervention. It was employed in a wide range of educational setting ranging from pre-school students, high school student, university student and in corporate and military training. It was due to the features and role that it can offer, such as role-playing, tutoring, become peer, giving feedback and motivation (Kim & Baylor, 2006).

There were several innovations that research can use it in the learning environment. If the agent maintains the eye contact with learner's learner will improve retention test scores and increased their eye fixations on relevant elements when the pedagogical agent also keeping the eye at the same position with the presented content. In the same research, when the pedagogical agent's pointing gestures as a stand-alone feature caused better retention test scores and more fixations on relevant elements of the graphic, but eye gaze direction did not (Li, Wang, & Mayer, 2023). By the emergence of artificial intelligence using large language model (LLM), students can generate more curious questions, using a natural language prompting approach that affords usability by teachers and other users not specialists of AI techniques and the results show that open-ended content may be more suitable for training curious question-asking skills (Abdelghani et al., 2023). There were trends that lead to the high demand of the AI-assisted pedagogical agent but still very few pedagogical agents that use real-time input technology by utilizing artificial intelligence to recognize learner's emotions to trigger an adaptive and personalized intervention (Septiana, Mutijarsa, Putro, & Rosmansyah, 2024).

One can say pedagogical agents may leave a significant impact towards teaching and learning, but does it improve learning in every intervention?

TOWARDS A SYSTEMATIC REVIEW ON THE EFFECTS OF PEDAGOGICAL AGENTS ON LEARNER'S COGNITIVE LOAD AND MOTIVATION.

Systematic literature review or often goes with abbreviation SLR, is a well -structured process of reviewing related prior research (literature) to find the answers to the formulated research question. The process of reviewing the literature involves screening, extracting and synthesizing literature in accordance with appropriate criteria and guidelines. Systematic review ensures the literature review process is rigorous, and the findings gathered from the process may find an appropriate gap in the research and open new opportunities for further research. Systematic reviews are different from traditional literature reviews because they aim to identify all studies (published and unpublished) that address a specific question, and their methodology has been developed to minimize the effect of selection, publication and data extraction bias (Nightingale, 2009).

Research on pedagogical agents and their efficacy towards learning has grown in numbers over the recent decade (Martha & Santoso, 2019). It is beyond reproach the ability of pedagogical agents to contribute to learning. It was proven by prior review and meta-analysis on pedagogical agent research showing the effectiveness of pedagogical agents in improving not only, student's performance but also several other learning spectrums, such as motivation and behaviour. Schroeder and Adesope (2014), together with Martha and Santoso (2019), show in their reviews that

pedagogical agent shows improvement in learning compared to the non-agent condition. This review is also coherent with the newer review conducted by Dai, Jung, Postma, and Louwerse (2022), which also indicates that pedagogical agents are effective in improving students' learning outcomes. However, despite the effectiveness of pedagogical agents in improving learning, it was not the case for every intervention that involved pedagogical agents. It shows that pedagogical agents may cause a drawback towards learning if it is not properly designed (Tolzin et al., 2023). Among the arguments of pedagogical agents is they might impose extraneous cognitive load towards learners and become deleterious towards the learning process (Clark & Choi, 2007; Tao et al., 2022). As a result of the claim made, several research on pedagogical agents and their impact towards student cognitive load has emerged (Ahuja et al., 2021; Ba et al., 2021; Müller-Wuttke & Müller, 2019). Most of the research has investigated the impact of pedagogical agents on cognitive load and what might be the cause.

Earlier, a review of pedagogical agents towards learner's cognitive load was conducted by (Schroeder & Adesope, 2014) whereas the outcome of the reviews on pedagogical agents' impact on learners' cognitive load shows mixed results. A more recent review by (Yusoff, Yusof, & Jamaludin, 2022) has studied elements of pedagogical agent design that might contribute to keeping learners' cognitive load in check during learning. However, some of the research also suggested that the cognitive load of the learner can also be influenced by their intrinsic motivation (Gupta, 2017). Some later research found that pedagogical agents do not have a significant impact on learners' motivation to learn despite found that students assisted by pedagogical agents reached a higher level of knowledge compared to those who were not assisted by the pedagogical agent (Zeitlhofer, Zumbach, & Aigner, 2023). The pedagogical agent is, without a doubt, proven to improve and enhance learning. Thus, investigating elements and factors that might create drawbacks for pedagogical agents will be beneficial in optimizing their capability towards learning. Therefore, this review aimed to investigate the relationship between intrinsic and cognitive load, as several research also indicate that pedagogical agents are able to improve learner's intrinsic motivation (Alfaro et al., 2020). Thus, this systematic review will be guided by research questions: 1) What is the influence of pedagogical agents on the learner's cognitive load? 2) Is a learner's cognitive load affected by their intrinsic motivation upon learning with a pedagogical agent?

PEDAGOGICAL AGENT, COGNITIVE LOAD AND INTRINSIC MOTIVATION

Integrating pedagogical agents in instructional learning is grounded in several key theoretical frameworks that explain their potential impact on learning and motivation. This section explores these theories, including cognitive load theory, multimedia learning theory, social learning theory, and motivational theories, to provide a comprehensive understanding of the mechanisms through which pedagogical agents influence learner outcomes.

When it comes to the cognitive load of the learner, the most common theory best to explain cognitive load in education settings is the Cognitive Load Theory. Cognitive Load Theory (CLT), proposed by Sweller (1988), is foundational in understanding how pedagogical agents affect learners' cognitive processes. CLT posits that learning is most effective when instructional design aligns with the human cognitive architecture, particularly working memory's limited capacity. Cognitive load can be categorised into intrinsic, extraneous, and germane. Intrinsic load is inherent to the material's complexity, extraneous load is imposed by the way information is presented, and germane load is related to the processing and construction of schemas (Sweller, 1988). Pedagogical agents can influence these cognitive loads in various ways. For instance, agents that provide clear, concise guidance can reduce extraneous load, allowing learners to focus more on intrinsic and germane loads (Mayer, 2008). Conversely, poorly designed agents with distracting animations or irrelevant information can increase extraneous load, hindering learning (Clark & Choi, 2007). The role of

pedagogical agents in managing cognitive load is thus critical to their effectiveness in educational settings.

Cognitive Theory of Multimedia Learning (CTML), articulated by Mayer and Moreno (2003), offers another crucial perspective. CTML suggests that people learn better from words and pictures than from words alone. This theory is supported by the dual-channel assumption, which posits that humans process verbal and visual information through separate channels (Mayer, 2002). Pedagogical agents leverage this dual-channel processing by synchronising verbal explanations with visual cues, enhancing comprehension and retention. Research has shown that multimedia presentations incorporating pedagogical agents can significantly improve learning outcomes. For example, agents that use gestures to highlight important information or facial expressions to convey enthusiasm can facilitate deeper cognitive processing and engagement (Moreno, Mayer, Spires, & Lester, 2001). However, it's essential that these multimedia elements are used judiciously to avoid overloading the cognitive system (Mayer, 2008).

Social Learning Theory by Bandura and Walters (1977) underscores the importance of observational learning, imitation, and modelling in acquiring new behaviours and knowledge. Pedagogical agents serve as models that learners can observe and emulate. This is particularly effective in online and multimedia learning environments with limited direct human interaction. Pedagogical agents can demonstrate problem-solving processes, model positive learning behaviours, and provide feedback, which learners can imitate. The social presence of an agent, characterised by its perceived intelligence, lifelikeness, and interaction capability, enhances learners' engagement and motivation (Kim & Baylor, 2006). By creating a sense of social interaction, pedagogical agents can make learning more interactive and personalised, fostering a more conducive learning environment (Johnson et al., 2000).

Motivational theories provide a framework for understanding how pedagogical agents can enhance learners' intrinsic motivation. Deci and Ryan's Self-Determination Theory (SDT) (2000) posits that intrinsic motivation is driven by the need for autonomy, competence, and relatedness. Pedagogical agents can support these needs in various ways. For instance, agents that provide personalised feedback and scaffold learning tasks can enhance learners' sense of competence (Ryan & Deci, 2000). Moreover, agents that offer choices and encourage exploration can foster a sense of autonomy. The social presence of an agent can also fulfil the need for relatedness, as learners perceive the agent as a supportive and interactive partner in the learning process (Baylor & Kim, 2005). Research has demonstrated that pedagogical agents that display empathetic and enthusiastic behaviours can significantly boost learners' intrinsic motivation and engagement (Kim & Baylor, 2006).

Integrating these theoretical perspectives provides a holistic understanding of pedagogical agents function within educational contexts. The cognitive load theory and the multimedia learning theory emphasise the importance of effective instructional design in managing cognitive load and facilitating dual-channel processing. Social Learning Theory highlights the role of agents as models and social partners, enhancing learning through imitation and interaction. Motivational theories, particularly Self-Determination Theory, explain how agents can fulfil psychological needs, thereby boosting intrinsic motivation. By synthesising these theories, it becomes evident that the design and implementation of pedagogical agents must be carefully considered to maximise their educational benefits. Effective pedagogical agents should be designed to minimise extraneous cognitive load, leverage multimedia principles to enhance comprehension, act as positive social models, and support learners' psychological needs to foster intrinsic motivation.

The theoretical frameworks discussed underscore the multifaceted impact of pedagogical agents on learning and motivation. Understanding and applying these theories can guide the design of more effective pedagogical agents, ultimately leading to improved educational outcomes. Future research should continue to explore these theoretical intersections to optimize the use of pedagogical agents in diverse learning environments.

METHODOLOGY

This section will further elaborate on the methodology and approach used throughout conducting a systematic review for this paper. As known by many others, conducting a systematic review requires a thorough process involving relevant articles and research journals to be included in the reviewing process. Thus, the process and method of obtaining and synthesizing relevant articles and journals for this review will be explained in this section.

Prisma

There are several commonly used methods in conducting systematic reviews, such as the Cochrane Collaboration Handbook, Campbell Collaboration Systematic Review Methodology, and Centre for Reviews and Dissemination (CRD) Systematic Review Guidance and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). This systematic review was conducted in align with the guidelines given by the PRISMA. PRISMA guidelines is considered a gold standard in conducting systematic reviews as it was cited by many systematic review articles in many fields, including instructional learning and pedagogical agent learning (Castro-Alonso, Wong, Adesope, & Paas, 2021; Coskun & Cagiltay, 2021). Among the reasons that PRISMA was chosen as an appropriate guideline for this review are 1) It provides a systematic guideline where the research was primed with a research question that led to the reviewing process, 2) it defines a clear guideline on the process of obtaining research and articles that need to be included in the review along with the inclusion and exclusion criteria, and 3) it defines appropriate times in examine large database of literature. Thus, PRISMA is able to facilitate rigorous and ensure high-quality evidence synthesis of the review on the effects of pedagogical agents on learner's cognitive load and intrinsic motivation.

Resources

Database used in this systematic review came from one of the well-known databases namely SCOPUS. This database was chosen as it contains a comprehensive number of databases from multiple research disciplines and that also includes research in pedagogical agents. It was created in 2004, and as of October 2019, it has accumulated 77.8 million core records (Singh, Singh, Karmakar, Leta, & Mayr, 2021). Thus, it justified the database selection used for this research.

Systematic Review Process

This section explains the process involved in the systematic review.

Identification

The first process in obtaining the articles and journals for the review is identification. Based on the formulated research questions, keywords similar to and related to the pedagogical agent, cognitive load, and intrinsic motivation were generated and used in the advanced search of the database to obtain appropriate articles and journals to be included in the systematic review. The query string built from the keywords is as depicted in Table 1.

Table 1. Keywords and Query String.

Database	Query string
Scopus	TITLE-ABS-KEY ("pedagogical agent*" OR "teachable agent*" OR "conversational agent*" OR "embodied pedagogical agent*" OR "embodied agent*") AND ("cognitive load" OR

	"cognitive load*") AND ("motivation" OR "intrinsic motivation")

Screening

Next is a screening process. In this process, all articles yield by the query string will undergo inclusion and exclusion criteria. The first criterion used for the screening is the type of literature. This review includes only research articles and excludes other types of journals, such as systematic reviews, book series, chapters in books and conference proceedings. Next is the language of the article. Articles that were written in other than English and Malay will be excluded as it is the only language that can be understood by the authors. Language that can be understand is required in the reviewing process. Next is the article timeline. This review only includes articles within the range of years from 2019 till 2024. The reason is to ensure that the article reviewed is up-to-date and not obsolete. Lastly, the research content. Since the article is focussing on impact of cognitive load upon learning with pedagogical agent, this review will only include research that study on pedagogical agent and its relation towards cognitive load. Summary of the criteria is as depicted in Table 2.

Table 2. Article Eligibility Criteria.

Criterion	Eligibility	Exclusion
Literature type	Journal (research articles)	Journals (systematic review), book series, book, chapter in book, conference proceeding
Language	English , Malay	Non-english
Time line	Between 2019-2024	<2019
Research content	Implementation of pedagogical agent and its relation on learner's cognitive load	Unrelated content on Pedagogical agents

Originally, total of 68 articles were identified upon using the query string. 19 articles were filtered out since it does not meet the literature-type criteria. Upon screening, another 31 articles were excluded from the review as the content of the research does not relate to the objective of the review. A total of 17 articles were eligible for the review, and the content was then analysed. The flow of the screening is depicted in Figure 1.
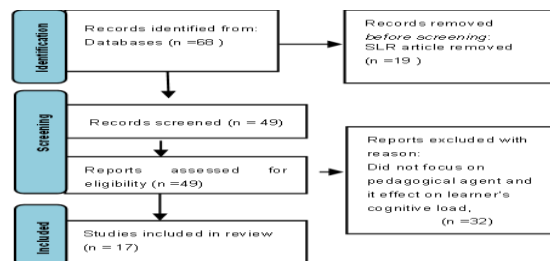

Figure 1. Screening Flow.

Data Abstraction and Analyses.

The remaining articles that met the requirements for inclusion were evaluated and examined. The paper that answers the previously posed research topics is the main focus of the review. The necessary information was retrieved by reading the abstract thoroughly in order to comprehend the

paper's entire content. Next, the entire document was read in order to synthesise the data needed for the review, which examined the pedagogical impact on learner's cognitive load. The data was analysed qualitatively using content analysis to find themes pertaining to pedagogical agent design. Following the identified topics, the authors arranged the data into related sub-themes. The summary of the data analyses is as depicted in Figure 2 below.

Authors	CL increase			CL improve					CL not affected		
	PA	SC	EM	PA	GS	EM	GN	FB	PA	V	EM
Davis, Vincent, and Park (2019)									/		
Ahuja et al. (2021)				/							
Darejeh, Marcus, and Sweller (2022)	/										
Moon and Ryu (2020)			/								
Petersen, Klingenberg, and Makransky (2022)	/										
Beege, Schneider, Nebel, and Rey (2020)			/								
Schneider, Krieglstein, Beege, and Rey (2022)				/							
Wang et al. (2022)					/						
Lin, Ginns, Wang, and Zhang (2020)			/								
Liew, Tan, and Kew (2022)			/								
Li, Wang, and Mayer (2023)					/						
Nguyen, Sidorova, and Torres (2022)	/										
Makransky, Wismer, and Mayer (2019)						/					
Ba et al. (2021)											/
Lang, Xie, Gong, Wang, and Cao (2022)								/			
Dever et al. (2023)								/			
Nebel, Beege, Schneider, and Rey (2020)									/		

Legends
PA= Pedagogical agent general
SC = Social Cues
EM= Emotion
GS= Gesture
GN= Gender
V= Voice
FB= Feedback

Figure 2. Data Analyses Diagram.

RESULT

Based on the review, the result has been divided into three main themes and 7 sub-themes. The finding categorized the finding based on the effect pedagogical agent toward learner's cognitive load. The main themes are Cognitive load increase, Cognitive load improve, and Cognitive load not affected. The sub theme is the factor studied in the articles that influenced the cognitive load of the learner. The sub-themes are Pedagogical agent (general), Social Cues, Emotion, Gesture, Gender, Voice and Feedback.

As for the years of publications, 2 out of 17 articles was published in 2019, 4 out of 17 articles was published in 2020, 2 out of 17 articles was published in 2021, 7 out of 17 articles was published in 2022 and the remaining 2 out of 17 articles was published in 2023. The summary is as depicted in Figure 3 below.
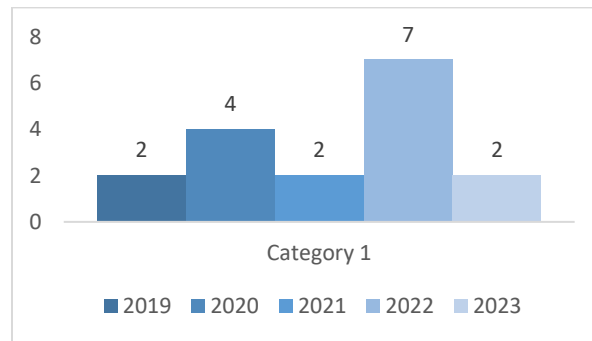

Figure 3. Numbers of articles in accordance with its years.

A total of 7 out of 17 articles show that pedagogical agent increases the learner's cognitive load upon intervention (Beege, Schneider, Nebel, & Rey, 2020; Darejeh, Marcus, & Sweller, 2022; Liew, Tan, &

Kew, 2022; Lin, Ginns, Wang, & Zhang, 2020; Moon & Ryu, 2020; Nguyen, Sidorova, & Torres, 2022; Petersen, Klingenberg, & Makransky, 2022). Another 7 out of 17 articles shows that pedagogical agent improved learner's cognitive load upon intervention (Ahuja et al., 2021; Dever et al., 2023; Lang et al., 2022; Li et al., 2023; Makransky, Wismer, & Mayer, 2019; Schneider, Krieglstein, Beege, & Rey, 2022; Wang et al., 2022), and the remaining 3 out of 17 articles reviewed shows that pedagogical agent has no influence towards learner's cognitive load upon intervention (Ba et al., 2021; Davis, Vincent, & Park, 2019; Nebel, Beege, Schneider, & Rey, 2020). The breakdown of the article reviewed in accordance with its theme is best visualised in Figure 4.
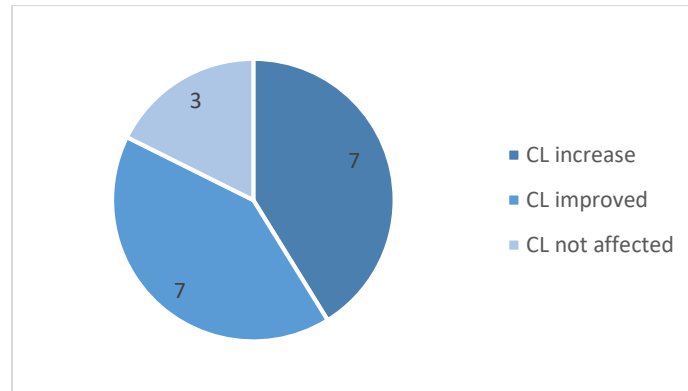

Figure 4. Numbers of article in accordance with its theme.

Cognitive Load Increase

Among the prominent concerns of pedagogical agents in learning is their tendency to impose cognitive overload towards learners (Clark & Choi, 2007). Thus, it was further proven in this review that there is a case where learning with pedagogical agent might increase cognitive load of the learner. 7 out of 17 articles reviewed indicate that the cognitive load of the learner increases while learning with a pedagogical agent. However, the factors that cause it may vary in every article. 3 out of 7 indicate using a Pedagogical agent vs a non-pedagogical agent in learning increases the cognitive load of the learner without stating what elements of the agent that might cause the phenomenon. In contrast, 3 out of 7 articles indicate that the emotion of the pedagogical agent will increase the cognitive load of the learner. Lastly, 1 out 7 articles indicate that the cognitive load increase that was experienced by the learners was increase by the social cues used in the experiment.

Cognitive Load Improved.

Next is the impact of pedagogical agent towards learner that improve the learner's cognitive load. Although some of the article shows that pedagogical increases learner's cognitive load, there are also several other articles that indicate otherwise. 7 out of 17 articles reviewed indicate that the learner's cognitive load improves upon learning with a pedagogical agent. Only 1 out of 7 articles does not rule out the element of the agent that caused the improvement. 2 out of 7 indicate that the cognitive improvement was caused by the gesture of the agent. 1 out of 7 articles indicates that the emotion of the agent caused the cognitive load improvement. 1 out of 7 indicates gender of the agent and 2 out of 7 indicates the feedback of the agent that caused the improvement of the learner's cognitive load.

Cognitive Load not Affected.

Lastly, 3 out of 17 articles show that the learner's cognitive load was not affected upon learning with a pedagogical agent. 1 out of 3 articles states that learning with a pedagogical agent vs non-agent does not affect the cognitive load of the learners. Other two articles respectively studied the effect of an agent's voice and emotion on a learners' cognitive load and indicated that it is not affected.

DISCUSSION AND CONCLUSION

Discussion

As mentioned previously, pedagogical agents have become a powerful instructional learning tool that can improve learning. Despite its effectiveness in improving learning, some argue its drawbacks that it might increase learners' cognitive load and hinder the learning process. Thus, several studies have been conducted to study the impact of pedagogical agents on learners' cognitive load.

What is the influence of pedagogical agents on the learner's cognitive load?

 The review was conducted on 17 articles that have gone through a rigorous screening process. The findings yield a mixed result on the impact of pedagogical agent towards learner's cognitive load. 7 articles indicate that pedagogical agents increase cognitive load, and on the contrary, another 7 articles indicate that cognitive agents do improve learner's cognitive load. The remaining articles indicate that pedagogical agents have no effect on learners' cognitive load. It is consensus that pedagogical agents impact learners' cognitive load either positively or negatively. The impact it may have towards the learner's cognitive load varies depending on the element used in designing the agent. This variability underscores the importance of considering the design elements of pedagogical agents and the specific educational contexts in which they are employed. Pedagogical agents that incorporate inappropriate or excessive emotional cues can impose extraneous cognitive load, distracting learners and hindering the learning process. For example, based on the review, emotion used by the agent during the learning process influences the cognitive load of the learners, whether positively or negatively. Enthusiastic agent increases the cognitive load of the learner compared to an agent with a more neutral expression. Enthusiastic agents might overwhelm learners if the emotional expressions are not aligned with the instructional content or learner preferences (Darejeh et al., 2022; Liew et al., 2022). In the case where it increases the learner's cognitive load, it might be because the emotion portrayed by the agent is not appropriate with the learner and has become extraneous material. Those extraneous materials have burdened learners' cognitive load. Conversely, agents designed with neutral or appropriately matched emotional expressions can facilitate cognitive processing by maintaining learner focus on relevant information (Beege & Schneider, 2023; Lang et al., 2022). This phenomenon is also coherent with the coherence principle as suggested by Mayer (2008) in the evidence-based principle of multimedia learning. Another example of pedagogical agent design is on gestures and social cues. Gestures and social cues pedagogical agents use also play a crucial role in managing cognitive load. Agents that employ gestures to direct attention to key elements of the instructional material can enhance learning by reducing extraneous load and supporting germane cognitive load (Li et al., 2023; Schneider et al., 2022). However, excessive or irrelevant gestures may increase cognitive load, emphasising the need for a balanced approach to design agent behaviours (Lin et al., 2020). Therefore, it is essential to understand the needs of learners prior to designing pedagogical agents that will be used in instructional learning.

Is a learner's cognitive load affected by their intrinsic motivation upon learning with a pedagogical agent?

Depending on whether intrinsic motivation makes learning more gratifying and meaningful or more difficult and challenging, it can either increase or decrease cognitive load (Skulmowski & Xu, 2022). Thus, this review aimed to find any relation between learner's cognitive load and intrinsic motivation as its secondary objective. However, based on the review there is not enough evidence that indicates any relations between cognitive load and intrinsic motivation. Out of 17 articles that was reviewed, only 4 articles include intrinsic motivation as dependent variable together with cognitive load. The finding from these 4 articles indicates mixed result on the relation between cognitive load and intrinsic motivation. Agents that provide personalised feedback and adapt to learners' needs can enhance their sense of competence and autonomy, fostering intrinsic motivation (Ryan & Deci, 2000;

Wang et al., 2022). For instance, empathetic and supportive agents have been shown to boost learner engagement and motivation by creating a more interactive and relatable learning environment (Zeitlhofer et al., 2023). However, the presence of pedagogical agents alone does not guarantee increased motivation; the effectiveness depends on how well the agents fulfil learners' psychological needs (Alfaro et al., 2020). Thus, this opens another spectrum for future work where a more focused systematic review can be conducted primed by this research question can be conducted. Several criteria can be changed to overcome the problem of not having enough evidence by expanding the publications years and database.

CONCLUSION

It can be concluded that pedagogical agent does have an influence towards the learners' cognitive load upon its intervention in learning. However, whether the impact is positive or negative relies on the elements that were used in designing the pedagogical agent. The review of this paper focuses on the impact of pedagogical agent design on learners' cognitive load. Several elements of pedagogical agent design have been ruled out as sub-themes in the thematic analyses as factors that might influence changes in the learner's cognitive load upon learning with a pedagogical agent. The practical implications of these findings are significant for educators and instructional designers. Effective pedagogical agents should be designed to minimize extraneous cognitive load by using appropriate emotional expressions, gestures, and social cues aligned with the instructional content and learner characteristics. This seems to be an opportunity for future research in investigating more thorough research on how the agent's design can positively impact the learner's cognitive load.

The relationship between a learner's cognitive load and intrinsic motivation remains a mystery. The review is lacking in a number of articles to investigate the relations. Future research should continue exploring pedagogical agents' nuanced effects on cognitive load and intrinsic motivation. Longitudinal studies and experiments with diverse learner populations can provide deeper insights into how different design elements influence learning outcomes over time. Perhaps, another systematic review should be conducted by expanding the years of articles that should be included in the review. It may result in better numbers of articles that can provide better empirical proof of the relationship between cognitive load and intrinsic motivation upon learning via pedagogical agents. Additionally, investigating the interplay between cognitive load and intrinsic motivation can offer valuable guidance for optimizing pedagogical agent design.

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