Towards a Gamified Recommender System to Facilitate Cognitive Function in Children with Dementia

MEROPI LOUKAIDOU, University of Twente, The Netherlands

Dementia in children is one of the most understudied diseases in today's research because it is extremely rare and often misdiagnosed. Characterized by a progressive loss of cognitive function, childhood dementia's symptoms mirror the ones present in adult dementia's patients. Due to the unavailability of research, no known interventions have emerged. Considering its similarity to adult dementia, adapting one of the interventions used in adult dementia patients to childhood dementia may be possible. Cognitive stimulation therapy is one of the most-widely used, non-pharmacological interventions in adult dementia. It subjects the patients to a set of sessions with themed activities that facilitate cognitive function. To enable at-home cognitive stimulation therapy sessions, a recommender system can be implemented that recommends activities based on the child patient's abilities. This study aims to propose a conceptual model for such a recommender system, incorporating gamification principles to promote intrinsic motivation and encourage its use. Thus, the child patients are able to receive personalized cognitive stimulation therapy at any place.

Additional Key Words and Phrases: Childhood dementia, cognitive stimulation therapy, recommender systems, gamification

1 INTRODUCTION

Childhood dementia (CD) is a rare neurological disease affecting approximately 700,000 children worldwide [15]. It is a combination of genetic disorders that cause progressive loss of brain function to the degree where previously acquired developmental skills are severely impaired. Symptoms of CD often appear during early childhood and mirror those present in adult-onset dementia (AD), the most common being a significant decline in cognitive activity, progressive memory loss, and a general decrease in quality of life (QoL). CD is terminal in all cases; most children die before the age of 18.

Existing literature on CD is limited due to a general lack of awareness in the medical community and the disease's rare nature [24]. The only available therapeutic approaches are symptom management and palliative care. Cognitive stimulation is a common, non-pharmacological approach used in AD patients to improve their cognition and QoL, among other psychosocial benefits [3, 14, 31, 36]. Given the similarity of CD's most prominent symptoms to those of AD [15], cognitive stimulation may also be proven effective in CD patients.

Cognitive stimulation therapy (CST) and reminiscence therapy (RT) are the two types of non-pharmacological, cognitive stimulation interventions in AD, with the strongest evidence regarding benefits in cognition and QoL, as shown by quantitative and qualitative studies [6, 20, 25]. Both interventions engage the patients in activities that facilitate their cognitive function, but RT stimulates cognitive function by encouraging patients to reminiscence past memories as the main activity. In this study, we focus on CST as it is the only non-pharmacological approach recommended by the National Institute for Health and Care Excellence [21, 27] for adults with mild-to-moderate dementia. Furthermore, several review studies and randomized controlled trials have shown that CST is the most effective intervention to improve cognition and QoL [2, 10, 21].

CST engages the patients in a number of activities to improve cognitive and social functioning [13]. It consists of 14 twice-weekly sessions, each session dedicated to a set amount of activities based on a specific topic [27]. The amount and duration of activities are predetermined by the trained professional, also referred to as the facilitator, but in general, a complete session's duration is approximately 45 minutes.

Because CST sessions are activity-based, the sessions could be provisioned using a tool known as a recommender system (RS). An RS is a tool that provides suggestions for items to users in various contexts [8]. In an RS for personalized CST, the activities of each session are translated into recommendation items which are suggested to the CD patients, enabling them to receive CST anywhere without the explicit need for the facilitator's intervention. The recommendation mechanism behind this is a knowledge-based filtering technique that recommends items to users based on a set of constraints that define the relationship between the item and the user. For the mechanism to work accurately, the knowledge base must be designed by domain experts. The domain experts are the facilitators responsible for providing the patient profile, the list of activities that have to be recommended, and the set of constraints. These three elements will be the core components of the knowledge base, the collection of information the RS uses to perform recommendation tasks.

Encouraging the CD patients to perform the activities suggested by the RS consistently ensures they receive the full benefit of CST. Loss of motivation may prevent the patients from completing the recommended session, which leads to a lower level of cognitive stimulation. The RS model suggests the implementation of a feature to overcome motivation difficulties and promote its intended use to CD patients. An example of such a feature is a user interface that incorporates game design elements, known as gamification, proven to increase users' intrinsic motivation and engagement in diverse contexts [17].

We aim to conceptualize a model for a personalized, knowledge-based RS with a gamified interface that provisions CST, facilitating cognitive function in CD patients and subsequently improving their cognition and QoL. To guide the investigation and design of this research, we will define the following research questions:

- **RQ1.** To what extent could cognitive stimulation therapy for adult dementia patients be adapted for childhood dementia patients, in order to facilitate their cognitive function?
- **RQ2.** Is it possible to provision cognitive stimulation therapy using a recommender system?

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- **RQ3.** Which game design elements could be applied in the recommender system's user interface to overcome motivation difficulties and promote engagement?

To the best of our knowledge, there is no research available on the implementation of RSs in the field of CD patient care, and our research may be considered a novel contribution. However, the model is not evaluated in this paper due to time constraints, thus, further research is needed to assess its feasibility in the implementation domain.

This paper is structured as follows. In section 2, we conducted a comprehensive literature review to answer the research questions, and in section 3 we explain the methodology used to conceptualize the model discussed in section 4. Finally, we explicitly answer the research questions, concluding the paper in section 5.

2 RELATED WORK

We conducted a comprehensive literature review with the aim to find enough information that will explicitly answer our research questions. First, we will validate that the literature provides strong evidence in favor of CST as an intervention to facilitate cognitive function in AD patients. Then, we will explore the possibility of adapting CST for adult patients to children patients. In the context of our research, we use the legal definition of a child; a human being below the age of 18 years. Finally, our research focus is directed towards answering RQ2, by identifying the different types of RSs to find the most appropriate. To find an answer for RQ3, we discuss the motivating power of gamification as highlighted in the existing literature.

2.1 Cognitive Stimulation Therapy for Dementia

During the literature review, we discovered only one paper by Nunn et al. (2002) [24] mentioning CD. This paper discussed CD's prevalence in the Australian population, intending to identify the disease's causes and investigate the psychosocial impact on the patients and their caregivers. The clinicians who were surveyed reported a negative impact on the relationship between relatives and patients in 63% of the participating families. In their conclusion, the authors stated that the lack of studies on CD's impact led to a delayed diagnosis.

Unfortunately, no non-pharmacological interventions for CD patients were found in the existing literature. However, considering the similarity of CD symptoms to AD symptoms, we hypothesized that adapting CST to CD patients may yield similar benefits as the ones in AD patients. AD shares the same definition with CD. It is an umbrella term for disorders that cause degeneration of cognitive function (in adults) [16]. The most common non-pharmacological interventions that facilitate cognitive function in AD are CST and RT [6, 9, 20, 25]. Clare and Woods (2004) defined CST as "the engagement in a number of themed activities (individual and group) with the goal of improving cognitive and social functioning" [13].

In the literature review, we focused on CST for three reasons. First, it is the only non-pharmacological intervention recommended by government guidelines to treat cognitive deterioration in AD [31]. Second, it is the intervention with the strongest supporting evidence on its effectiveness and benefits [3, 32]. Third, CST's focus is the improvement of cognition via cognitive stimulation activities while RT is concerned with the psychological aspect [19].

Spector et al. (2003)[33] designed a protocol for CST that involved 14 twice-weekly sessions with activities based on a specific topic (e.g. using money and word games). Each session lasted for approximately 45 minutes in a group setting. During these sessions, adults with dementia were involved in activities that stimulated their emotional, relational and social skills. This protocol was standardized, enabling CST to become the only program adapted to other cultures for adults with mild-to-moderate dementia [27].

The most commonly-identified benefits of CST in the reviewed papers were improvement in cognition as a primary benefit, and improvement in QoL as a secondary benefit. In 2010 and 2011, Spector et al. [30, 31] evaluated the effects of CST on cognition and QoL in AD patients, showing that CST improved both cognition and QoL. A later study by Aguirre et al. (2013) [1] had similar findings. International studies by Yamanaka et al. (2013) [38] in Japan and Capotosto et al. (2017) [10] in Italy also outlined the significance of CST's benefits on cognition and QoL. Several review studies [3, 36] highlight that the benefit on cognition was more statistically significant than the improvement in QoL, reporting mixed findings for QoL. In their review, Lobbia et al. (2019) [21] reported that 9 out of 12 studies showed that CST was effective for cognitive function, while 6 out of 9 showed that it was effective for QoL. Interestingly, Woods et al. (2006) [37] showed that improvements in cognitive function are correlated with improvements in QoL, as measured in the AD patients who participated in the CST sessions of their study.

CST is commonly delivered by a trained facilitator to groups or individuals. Most of the research on its effectiveness has been done on group CST but evidence suggests that individual CST could yield the same benefits, if more research is conducted. A randomized controlled trial set up by Gibbor et al. (2021) [14] found that individual CST improved cognition but at a lower level of significance than group CST. However, this trial was limited by the small sample size and concluded that further trials are needed to gain better understanding of individual CST benefits.

From our literature review on CST, we have seen evidence to support that it is an effective intervention to facilitate cognitive function in AD patients with benefits in cognition and QoL. RQ1 asks whether it is possible to adapt CST to CD patients. The adaptation techniques in literature focus on cultural differences. Specifically, a model of CST's adaptation to different cultures is discussed in the paper of Rai et al. (2018) [27]. The model consists of five phases, involving the facilitators throughout the process to ensure the needs of patients belonging to the target culture are met. Based on the existence of this model, the adaptation of CST to consider age differences may be possible, but further research is needed. Figure 1 shows the five-phase model.

2.2 Current State of Recommender Systems

Burke et al. (2011) [8] provided a general definition for RSs. An RS is "any system that produces individualized recommendations as output…". We use the same definition in this research, with the output being the personalized CST sessions.

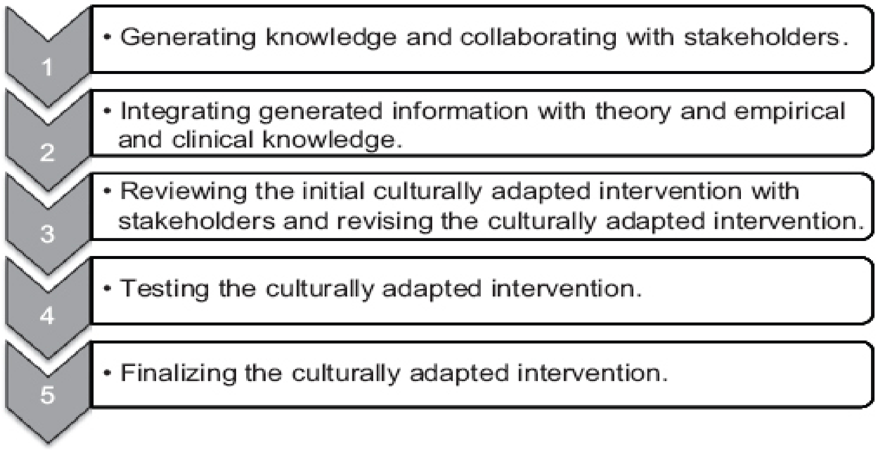

Fig. 1. The Five-Phase Model for Cultural Adaptation of CST

Literature on RSs implemented in the context of CST and dementia is limited. Nonetheless, we found several papers discussing the application of RSs in AD care. The main differences between the discovered papers and our research are that they do not involve CST and have a focus on adults instead of children.

The most relevant paper to our study was written by Bejan et al. (2018) [7]. It proposed a design for an assistive RS that helps caregivers conduct RT sessions tailored to life themes and past memories of AD patients. The study evaluated the system's feasibility regarding the automatic retrieval of reminiscence content for a specific adult with dementia, but a lack of test subjects indicated the need for further research. A similar study to Bejan et al. 's was done by Oliva-Felipe et al. (2018) [26], which proposed an RS that provides personalized interventions to caregivers of adults with dementia, focusing on the relationship between the caregiver and the patient.

Another paper described an RS system called Tamaringa, recommending custom music playlists to AD patients based on their musical preferences [5]. The authors concluded the use of music as a non-pharmacological intervention could promote well-being and improve the communication between AD patients and their caregivers.

An ongoing study by Steinert (2021) [34] investigated the implementation of an RS that automatically recognizes a patient's cognitive engagement by analyzing their verbal and non-verbal cues. Its purpose is to filter content for AD patients in a tablet-based activation system (I-CARE), promoting their engagement in various settings.

Several papers discussed RSs that have similar topics to our research and are worth mentioning. One paper, in specific, proposed a framework for a gamified RS to be implemented in elderly care [35], while other studies discussed RSs in the context of general health management of the elderly [4, 29].

To discover which recommendation mechanism was most appropriate for our model we conducted research on the typology of RSs. The main categories of RSs, as identified in current literature, were collaborative filtering, content-based filtering, and knowledge-based filtering [8]. Collaborative filtering recommends items based on the preferences of similar users in the system, content-based filtering recommends items based on past preferences of the user themselves, and knowledge-based filtering recommends items based on the relationship between the suggestion items and the user properties. The relationship in a knowledge-based filtering technique must be explicitly defined via a set of logical constraints or rules.

As we have stated in RQ2, our RS's conceptual model has the purpose of provisioning personalized CST sessions for CD patients. In this context, the knowledge-based recommendation mechanism is the most appropriate. Collaborative filtering is not possible, since there are no multiple users to collect ratings from, and content-based filtering would defeat the purpose of personalized and diverse CST sessions. A CST session should contain different activities each time to facilitate cognitive function in areas not stimulated in the previous session. Content-based filtering would generate CST sessions that are similar to each other. An RS with knowledge-based filtering ensures the system has the domain information necessary to recommend CST sessions, solving the cold-start issue faced by other techniques [28] and ignoring past preferences.

Knowledge-based RSs have two specific implementations, case-based and constraint-based. Our proposed model focuses on the latter, as it allows for explicit definition and customization of the relationship between the user properties and the recommendation items.

2.3 Gamification as a Motivational Tool

Gamification has been defined as the process of applying game design principles and elements to non-game, real-world contexts [17]. It has been proven to help with motivation difficulties and promote user engagement [18].

An interesting study by Lier and Breuer (2019) [18] highlighted the motivating power of gamification when applied to worksite health promotion programmes. The findings of this study showed an increase in participants' physical activity levels attributed to the

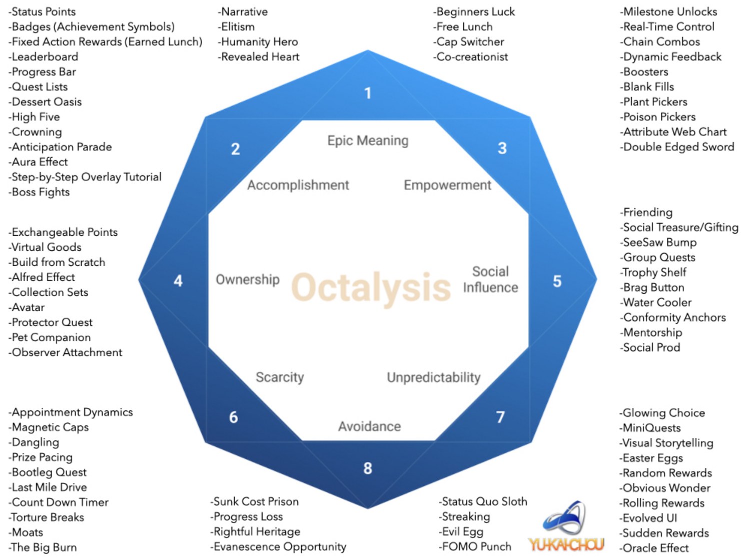

Fig. 2. The Octalysis Framework

motivating effect of a game design element called the step challenge, which prompted participants to move more.

Multiple gamification frameworks exist that provide guidelines for its implementation. In their review study, Mora et al. (2017) [23] assessed gamification frameworks for a number of domains, such as learning, business, and health. Of particular interest was the Octalysis framework proposed by Chou (2013) [11]. It is a complete gamification framework with a human-centered approach. Octalysis has an octagon shape and each side emphasizes eight game design elements, as seen in Figure 2. Two concepts are introduced by this framework; White Hat Gamification and Black Hat Gamification. Black Hat Gamification refers to instilling a sense of obsession, anxiety, and addiction in the user while White Hat Gamification makes the user feel powerful, fulfilled, and satisfied. Based on RQ3, we want our framework to empower, motivate, and encourage the user, therefore, applying White Hat Gamification. We note that we have chosen this framework as it provides clear guidelines with explicit design elements and a focus on human needs. Other frameworks outlined in the review study do not provide such a straightforward guide of implementation and have a more generic approach to gamification that we find inappropriate for our model.

By conducting a comprehensive literature review, we have identified a gap in the existing research. Our proposed model aims to be a novel contribution that will address this research gap.

Fig. 3. Biphasic Methodology Approach

3 METHODOLOGY

In this section, we explain the methodology for conceptualizing the proposed model of our research. We used a biphasic approach as follows (Figure 3).

3.1 Phase 1: Collection of Data

The first phase was to collect all the necessary information that would help us answer the research questions. For this, we conducted a comprehensive literature review, a qualitative approach that enabled us to evaluate the availability of research. During this phase, we divided our search into two types: (a) scientific search, and (b) non-scientific search. In the scientific search, we collected scientific literature on the topics of dementia, CST, RSs in healthcare, and gamification. Some example keywords used were:

- *Cognitive stimulation therapy for dementia*
- *Adaptation guidelines for cognitive stimulation therapy*
- *Recommender systems for dementia*
- *Gamification in healthcare recommender systems*

The aim of the scientific search was to help us identify the gap in the existing literature, and provide a theoretical background for answering the research questions.

In the non-scientific search, we looked for available information on the world wide web from sources such as blog posts and medical forums. Several Youtube videos were found that showed real-life experiences of children with dementia. This helped us empathize with them, as we were able to see the impact of CD on their daily functioning and how it affected their caregivers. In addition, we searched for books on the technical implementation of RSs that would help us conceptualize our model. We found that Ricci et al.'s (2011) [28] book contained the most information on implementing a knowledge-based RS. The collected information from the non-scientific search was not included in the literature review section of this paper.

3.2 Phase 2: Evaluation of Data

Once phase one was completed, the second phase was to evaluate the collected data based on inclusion and exclusion criteria (Figure 5) and combine it to answer the research questions. RQ1 focused on the adaptation of CST as used in AD patients to CD patients, based on the hypothesis that it would yield the same benefits irregardless of age group. The collected data provided a five-phase model for adapting CST to different cultures [2], which we believe could be used as a baseline to consider age differences, if a facilitator is involved in the phases. RQ2 guided us to compare the types of RSs in the collected data in order to determine which type of system could recommend CST sessions in the most efficient and accurate way. Lastly, data collected for RQ3 helped us determine which framework should be used to add game design elements to the system's interface, increasing the patient's motivation and engagement.

This methodology bears resemblance to Grounded Theory [12], an approach for conducting research in order to derive new theoretical knowledge grounded in existing theories. However, instead of a new theory, we aim to propose a new model grounded in the available knowledge on our main topics. Ideally, we would have been able to evaluate the proposed model, but due to time constraints, it was not possible. The model is described in the next section.

4 PROPOSED MODEL

4.1 Implementation Domain

The proposed model is intended for implementation by medical institutions and researchers where facilitators are able to provide domain expertise. Issues to consider are the choice of programming language and how the knowledge base should be designed to fit possible existing infrastructure of the institution. We have made an attempt to propose an open concept, flexible to be implemented by most modern technologies.

4.2 Domain Knowledge

The domain knowledge is provided by facilitators and it represents all the information the RS needs to make inferences about the relationship between the users and items, also known as the knowledge base [28]. In the context of our research, the domain knowledge consists of the adapted CST activities for CD, the CD patient's properties, and the constraints that define the relationship between the CST activities and the patient's properties.

4.3 Knowledge Base

Designing a robust knowledge base requires an explicit specification of its format to decrease inaccuracy of recommendations. Insufficient domain knowledge may lead to integrity issues, especially if the constraints are not properly defined. To translate the domain knowledge into a format the knowledge base can understand, we introduce the concept of a Class. A Class is a virtual representation of a real-life object and it is the core of modern object-oriented programming languages [22]. Representing the knowledge base with a Class structure enables inheritance and adds flexibility for its implementation. Elaboration of the Class structure is outside the scope of our research.

As mentioned in the methodology section, we used the Recommender Systems Handbook by Ricci et al. (2011) [28] to define the entities and other elements of our RS's knowledge base. The book mentions five generic elements that are part of the knowledge-based filtering technique: customer properties, product properties, constraints, filter conditions, and products. We have adapted these elements to fit our class-based structure as follows (Table 1). First, we convert the customer properties, the product properties, and products to Entity classes. Then, we define the relationships between them by converting the constraints and filter conditions into Relationship classes. The Relationship classes do not contain any properties, but provide logic to check the relationship between the properties defined in the Entity classes, using if-else reasoning. Figure 4 illustrates an example specification of such a class-based knowledge base.

Table 1. Classes Mapped to Ricci et al.'s Definition

Class Type	**Class Name**	**Definition**
Entity	Patient	Customer Properties
Entity	Cognitive Activity	Product Properties
Entity	Session	Products
Relationship	Constraint	Constraints
Relationship	Filter	Filter Conditions

4.3.1 Entity Classes. The Entity classes contain the properties of the patient, cognitive activities, and the CST session itself. The specific property definition depends on the implementing institution, as we lack the domain knowledge.

- **Patient** During the CD patient's assessment, the facilitator creates a patient profile with properties related to the provision of CST sessions. The properties are translated into an instance of the Patient class. Such properties may be the patient's age, and level of cognitive impairment.
- **Cognitive Activity** The Cognitive Activity class represents a cognitive activity that may become a recommendation, if it meets the constraint criteria. An instance of this class contains properties relevant to the cognitive activity, such as name, short description, and the area of cognitive function they facilitate.
- **Session** The Session class contains a list of Cognitive Activity classes that meet the recommendation criteria. It is effectively a representation of a CST session and must not contain any duplicate instances of the Cognitive Activity class. The number of Cognitive Activity class instances depends on the implementing institution.

4.3.2 Relationship Classes. The Relationship classes define the relationship between the properties of the Entity classes. They ensure that the recommended CST session reflects the domain knowledge, and must be defined accordingly.

- **Constraint** To prevent the instantiation of incompatible properties in the Entity classes, the system looks at the Constraint class. For example, a Patient class with property age = 4 cannot have property age of diagnosis = 7 because this indicates that the patient was diagnosed at age 7 while they are currently 4 years old.
- **Filter** The Filter class defines the explicit relationship between the properties in the Patient class and the properties in the Cognitive Activity class, which the RS uses to generate the Session class. An example instance of the Filter class is as follows. A Patient class associated with a Session class that contains a Cognitive Activity class with the property cognitive function = language, should next time be associated with a Session class that does not contain a Cognitive Activity class with this property.

4.4 Gamification Elements

Adding game design elements to the system's interface is another feature suggested by our proposed model. We have chosen to implement the Octalysis Framework with White Hat Gamification principles [11], thus we will use core drives in the upper half of the octagon (Epic Meaning, Accomplishment, Empowerment, and Ownership).

4.4.1 Core Drive 1: Epic Meaning. The Epic Meaning core drive motivates the user to participate in the system, creating a sense of higher self. When a patient starts using the RS, it is important to stress how they are helping other future CD patients because the RS provides valuable insight of the disease to the facilitators. Therefore, by using the RS, the patient understands they are part of the change in CD research. To incorporate the Narrative element in the user interface, a text dialog that stresses the importance of the patient's participation can be added before the first CST session is initialized.

4.4.2 Core Drive 2: Accomplishment. Patients have to experience real-time progress in order to feel a sense of accomplishment. To ensure the interface promotes this feeling, we propose the implementation of the Quest Lists and Progress Bar. The Quest Lists contain the CST sessions that have yet to be completed, while the Progress Bar shows the progress based on how many CST sessions the patient has already received.

4.4.3 Core Drive 3: Empowerment. During a CST session, the patient can quickly lose motivation if they dislike the recommended activities. Here, the role of the Dynamic Feedback element is integral since it can encourage the patient to continue performing the activities. An example implementation of this element is a graphic or text element that appears after a number of activities is performed, to ensure the patient is doing a good job and promote their sense of empowerment.

4.4.4 Core Drive 4: Ownership. To boost ownership of the system, the interface will implement the Avatar element in the patient profile. This element is fully customizable by the patient. Professional designers can create a stage during the onboarding of the patient to allow the creation of a character that matches the appearance of the patient.

Discussion Our study contributes to the research on CD and existing implementations of healthcare RSs in two ways. First, we evaluate the feasibility of adapting CST to CD patients by conducting a comprehensive literature review. Second, we propose a conceptual model that combines the existing literature to provision CST via a personalized and gamified RS tool to facilitate CD patients' cognitive function. Our proposed model is based on hypotheses both about the theoretical background and the practical implementation. Limitations in scientific literature, expertise, and time led us to these hypotheses. We have made two main hypotheses. One, the adaptation of CST is feasible if the five-phase model is modified to consider age differences, and two, the knowledge base of the RS will be developed by domain experts at a medical institution. We could not reject or accept these hypotheses due to the limitations we mentioned and further research is needed to evaluate the model's feasibility. Another limitation to consider when implementing the model is the progression stage of dementia in the child patients. The reviewed literature states that the benefits of CST were not evident in AD patients with severe dementia, therefore we suggest that the model is implemented for CD patients with mild-to-moderate dementia. In

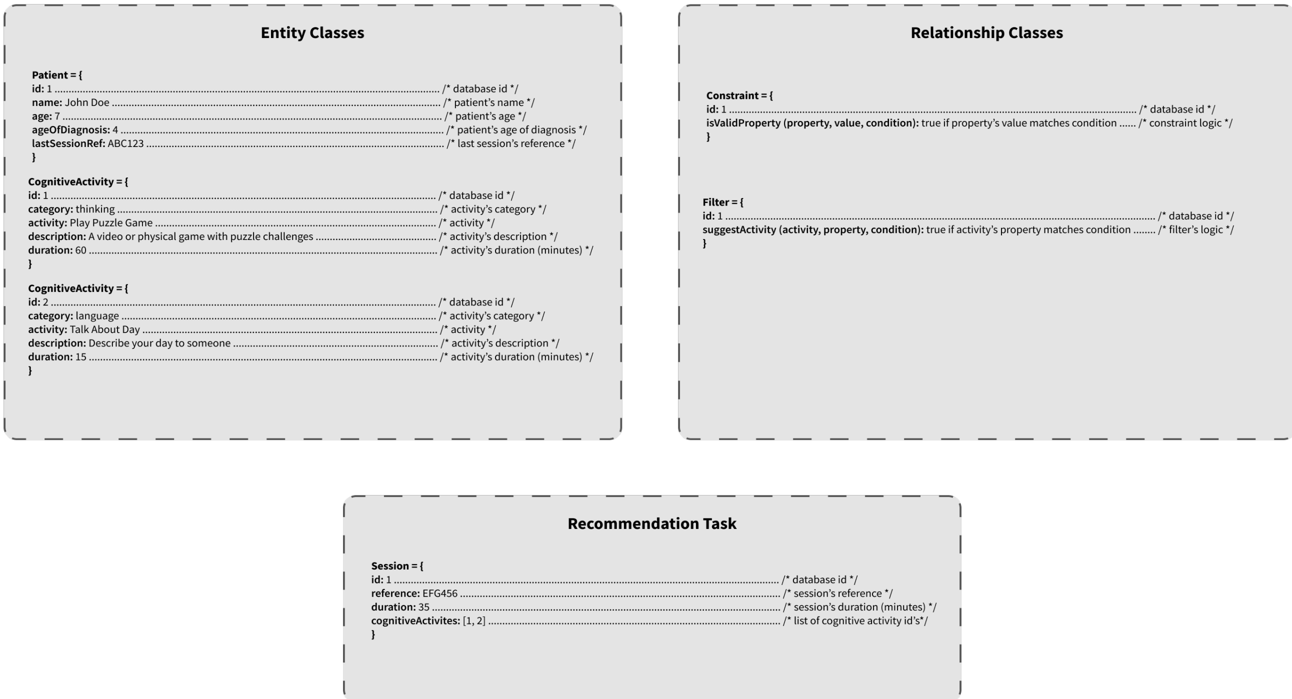

Fig. 4. An Example Specification of the Knowledge Base

the future, it may be possible to contact a CD expert to gather more information about how CST could be adapted to CD patients and implement the model in a real-world system to evaluate it with the help of experts. Furthermore, machine learning could be an added feature in the system to improve accuracy of recommendations and decrease the need of domain experts. Overall, we believe there are many possibilities for future research on this topic to counter the unavailability of existing literature.

5 CONCLUSION

In this section, we explicitly provide answers to the three research questions defined.

5.1 RQ1

Starting with the first research question, we theorized that the techniques used in CST for AD patients may be adapted to CD patients based on symptom similarity. The aim of the adaptation is to facilitate cognitive function, yielding the benefits of improved cognition and QoL in the CD patient. The benefits in AD are supported by evidence in the existing literature, but adaptation guidelines are aimed at cultural differences. Therefore, we cannot answer for certain if it is possible to adapt CST to CD patients, but we hypothesize that using the five-phase model with the help of a facilitator, it may be possible to achieve this. Further research is needed to answer RQ1.

5.2 RQ2

With the condition that RQ1 is researched more to conclude whether the adaptation of CST to CD patients is in fact possible, we hypothesized that the CST sessions can be provisioned via the implementation of a knowledge-based RS. Our proposed model attempts to answer RQ2 by providing a concept for a knowledge-based RS that recommends personalized CST sessions to CD patients. However, further research is needed to evaluate the model and give a definitive answer to RQ2.

5.3 RQ3

RQ3 was the most straightforward to answer as the literature on gamification is plenty. We discovered the Octalysis framework, an all-purpose and human-centered framework to incorporate game design elements into a system's interface. Thus, we answer RQ3 by stating that the elements suggested in the proposed model section are sufficient to promote the CD patient's motivation and increase their engagement when using the system.

Due to the lack of time and resources, it is a necessary future step to conduct further research in order to validate the hypotheses made in our model. The model acts as a baseline for future researchers that possess the necessary resources to implement the proposed RS and evaluate its feasibility in CD patient care.

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A INCLUSION & EXCLUSION CRITERIA OF LITERATURE REVIEW

Topic	**Inclusion Criteria**	**Exclusion Criteria**
Cognitive Stimulation Therapy	Dementia Patients	Other Health Conditions
	Clinical Trials	No Evidence for Benefits on Cognition and Quality of Life
	Benefits on Cognition and Quality of Life	Insufficient Amount of Participants
	Expert Evaluations	Sole Focus on Caregivers
	Review Studies	Sole Focus on Psychosocial Aspect
Recommender Systems	Healthcare Applications	Group-based Systems
	Dementia	Non-Healthcare Applications
	Elderly Population	
	Aspect of Game Design Elements	
Gamification	Explicitly Defined Game Design Elements	Generic Guidelines
	Human-Focused	
	Focus on the Motivating Power	

Fig. 5. Inclusion/Exclusion Criteria of Research Papers