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Crystallized Intelligence Wisdom Repository Management System with a Conversational Agent

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Abstract

This research was undertaken by synthesizing theories, documents, textbooks, research articles, and related academic articles relating to the wisdom repository management process. The objective is to present a system architecture and develop a knowledge management system which culminates in a repository of crystallized intelligence with a conversational agent that can promote learning for medical students by introducing a system architecture to develop intelligent agent technology. Through mobile technology, accessible anytime, anywhere, lifelong learning for medical students will be supported via an intelligent crystallized intelligence inventory management system. This keynote includes a comprehensive implementation and has API. The application has been tested with a trial run of all commands, with satisfactory results in the communication of the system that the user accesses through chatbots.

Keywords: wisdom repository management system, wisdom management process, conversational agent

1. Introduction

Knowledge management and technology are becoming increasingly relevant as they are important in today's era, so it is important to focus on managing the vast amount of knowledge. In this study, that is achieved via the use of conversational agent technology. In Thailand, raising the educational standard of the population is crucial for keeping up with change, especially in the field of medical knowledge. Learning and combining educational knowledge with digital technology is a key strategy in this regard. Driving Thailand towards UNESCO's Sustainable Development Goals and towards Global Citizenship. As the globe evolves, digital technology is a crucial instrument for a nation's progress. In the study of medicine, one part of the student's intelligence concerns knowledge of the basics of textbooks and the other on the art of treatment. In many cases, there is often no time to open books or textbooks (Srikong, Wannapiroon, & Nilsook, 2021). Consequently, it is essential to have information on patient care that is available in a split second. Consolidation of the huge quantity of medical information is attainable using digital technologies to integrate learning, as well as with the dependence on and adaptation of digital technology in medical activities. The wide variety of medical studies provides medical students with a limited learning experience for a limited time. The role of technology is to manage the clinical practice system that includes registration for identity verification, handbook information, class schedules, timetables, doctor schedules, patient information, additional knowledge, and e-learning. Furthermore, by recording patient care experiences along with the curriculum, to check whether information has been retained in its entirety or is missing, it is possible to identify if medical students have not consult-ed with patients in critical disease groups for referrals. The technology can also be used for adding or exchanging knowledge and experiences among medical students.

Thus, the development of digital technology today has become important in the field of medicine. Studying the trends of communication technologies, and the evolution of mobile applications, innovative learning processes can be developed with artificial intelligence technology. Chatbot presentation is a technology that gives learners quick access to knowledge information via online social media messaging, using an automated process of human-like natural language conversations. Taking pictures, sharing documents, networking, and interacting socially through the inter-net can be performed anytime, anywhere, and can all be adapted to enhance learning for medical students.

A literature review is the first step in this inquiry, which then presents the system architecture and application description, evaluation of the results, and conclusions.

2. Related Works

An application of a knowledge management method is a knowledge management system in which knowledge content is managed by using information technology systems to help manage and provide services to exchange, collect, classify, and share knowledge so that it can be easily used and accessed. Using an intelligent management system, knowledge can be stored, and it may be easier to organize, disseminate, and retain information with knowledge management processes. There-fore, the transfer of knowledge from experts is of paramount importance in sharing best practices for creation and storage.

2.1 Wisdom Management Process

In this study, the process of managing the wisdom repository was obtained from a synthesis of theories, documents, textbooks, research articles and related academic articles. The results of the synthesis of the wisdom repository management process are shown in Table 1.

Table 1. Results of the synthesis of the wisdom management process

Wisdom Management Process	(Bhatt, 2001)	(Becerra-Fernandez & Sabherwal, 2015)	(Kankanhalli, Lee, & Lim, 2011)	(Botha, Kourie, & Snyman, 2008)	(Rehman et al., 2021)	(Andersson, Dasi, Mudambi, & Pedersen, 2016)	(McInerney & Koenig, 2011)	(Bin HADEEBA & Wan YUSOFF, 2022)	(Agresti, 1996)	(Zouari & Dakhli, 2018)	Result
Knowledge Creation	✓	✓		✓	✓	✓	✓			✓	✓
Knowledge Sharing		✓		✓	✓	✓		✓		✓	✓
Knowledge Capture		✓					✓		✓		✓
Knowledge Application	✓	✓	✓			✓		✓	✓	✓	✓
Knowledge Utilization	✓		✓	✓	✓						✓
Knowledge Acquisition				✓	✓	✓	✓		✓		✓
Knowledge Validation	✓			✓							
Knowledge Presentation	✓										
Knowledge Collection			✓							✓	
Knowledge Diffuse			✓				✓				
Knowledge Identify							✓				
Knowledge Transform									✓		
Knowledge Access									✓		

Per Table 1, there are 6 processes for wisdom management in the wisdom repository, as follows: Knowledge Creation, Knowledge Sharing, Knowledge Capture, Knowledge Application, Knowledge Utilization, and Knowledge Acquisition.

Figure 1. Process for wisdom management

Knowledge Sharing - the process of sharing knowledge with other people, groups, agencies, or organizations, as well as knowledge receivers, so that they may comprehend and put it to use. Within this process, experiential skills are distributed to individuals, departments, groups, or organizations, and will promote learning and response to environmental changes. Socialization encourages implicit knowledge sharing, tools for team cooperation, internet access, exemplary databases and repositories, lesson learned systems, and expert locating systems. It is an example of technology that makes it easier to share and communicate clear knowledge. Social assisting technologies, such as video conferencing and electronic discussions, implicitly facilitate the transfer of data (Becerra-Fernandez & Sabherwal, 2015).

Knowledge Capture - capturing information about knowledge in a way that the organization can store and access, or tracking newly acquired resources in a clear format (Agresti, 1996).

Knowledge Application - The process of utilizing knowledge inside a company to make choices, carry out activities, address new issues, and boost productivity. The transmission of knowledge or information between actual persons is not included in the definition of knowledge application; rather, it solely involves the provision of advice that is pertinent to a certain situation. Organizations that value knowledge require knowledge to respond to problems effectively and efficiently and to give them an edge over their competition (Becerra-Fernandez & Sabherwal, 2015).

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Knowledge Utilization - the process of applying knowledge in a real environment to organizational activities. Using knowledge to accomplish general organizational tasks. Through integration it becomes a component of the organization's problem-solving process.

Knowledge Acquisition - learning from the experience of collecting data to formulate ideas and insights into deep solutions; variously known as knowledge acquisition, persuasion, collection, analysis, modeling, and validation. Such learning begins at birth and continues as individuals grow in experiences and social interactions (Rehman et al., 2021).

2.2 Crystallized Intelligence Wisdom Repository Management System

Modern technology manages knowledge within a hierarchy of knowledge based on the DIKW pyramid by collecting various scattered medical knowledge that is Tacit Knowledge. Tacit Knowledge becomes Explicit Knowledge in a continuous spiral of knowledge (emeritus I. Nonaka, 2007), developed as a management system for crystallized intel-ligence repository (Platz & Biljon, 2016). Artificial intelligence has been used to create the intelligence wisdom repository system in the form of information and communication technology. (Gartner, 2020) technology trends (Brandtzaeg & Følstad, 2017) with conversational agents integrated to support operations through intelligent automation. The synthesis of components of the crystallized intelligence wisdom repository management system process are shown in Table 2 below.

Table 2. The synthesis of components of the crystallized intelligence wisdom repository management system

Crystallized Intelligence Wisdom Repository management system	(Muttaqi, 2020)	(Nadarzynski, Miles, Cowie, & Ridge, 2019)	(Schmitt, 2018)	(Patil & Kulkarni, 2019)	(Gizaw & Tessema, 2020)	(Zhao, Li, & Lin, 2019)	(Abu Shawar & Atwell, 2007)	(Le, Sahoo, Liu, Chen, & Hoi, 2020)	(Sarosa, Kusumawardani, Suyono, & Wijaya, 2020)	(Ong, Raof, Sudin, & Choong, 2021)	(Mustapha & Sayed, 2018)	(Mezghani, Exposito, & Drira, 2016)	(Masmoudi A and Mezghani E, 2017)	(Alavi, 2001)	(Marques Júnior, Gobbo, Fukunaga, Cerchione, & Centobelli, 2020)	Result
Information System					✓				✓	✓			✓	✓	✓	✓
Knowledge Management System	✓		✓		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
Intelligent Conversational System		✓		✓		✓	✓	✓	✓	✓		✓		✓		✓
Knowledge sharing	✓									✓					✓	
Knowledge transfer	✓									✓					✓	
Retrieval system	✓					✓	✓	✓			✓			✓		✓
Artificial intelligence (AI)		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
KMS repository	✓		✓								✓				✓	✓
Decision support systems	✓				✓											
Dialogue systems						✓	✓	✓								

Per Table 2, the result of the synthesis of components of the crystallized intelligence wisdom repository management system consists of: Artificial Intelligence (AI), Intelligent Conversational System, Information System, Knowledge Management System, Retrieval System, and Knowledge Repository. The details of each component are as follows:

Artificial Intelligence (AI) is a system designed to work like a human brain. It is a computing system that has deep analytics like human intelligence and can produce actionable results that can directly interact with the user.

Intelligent Conversational System is a conversational agent. This is an intelligent machine that can understand language and conduct text or speech conversations with users. Its use is intended to improve the user experience experience (Chattopadhyay, Ma, Sharifi, & Martyn-Nemeth, 2020).

Information System consists of computer systems, hardware, software, network systems, databases, system developers, users and related staff, and professionals that work together to create, collect, store, and analyze data to

produce and provide further data or outcomes to users to support their efforts to reach their objectives. (Gede Abdi Sudiatmika, Wirahadi Putra, Santhi Dewi, & Budimas Aryawan, 2019)

Knowledge Management System itself consists of 4 processes. (1) Socialization: Tacit to Tacit Process 1 describes the social transmission relationship between tacit knowledge and face-to-face sharing of experiences, such as meetings, brain-storming sessions based on learning, and individual experiences in a specific area, which are then shared and exchanged in the same environment rather than just acquired by reading books, manuals, or textbooks (Nonaka & Takeuchi, 1995). (2) Externalization: Tacit to Explicit Process 2 describes the externalization relationship between Tacit knowledge - Explicit Knowledge. The knowledge that is buried deep in knowledge to be communicated to the outside can be concepts, diagrams, charts, and documents that support easy-to-understand communication between learners. Deep knowledge is developed, crystallized, and refined, and then shared, transforming into a new knowledge base that is used to create new products in new processes. (3) Combination: Explicit to Explicit Process 3 describes the relationship of the combination of Explicit knowledge through the organization and integration of different forms of knowledge. For example, using knowledge to create new models to create new work, gain new knowledge by explicit knowledge obtained from gathering knowledge within or outside the organization and then bringing it together to improve or create new knowledge and then disseminating it to members of the organization.(4) Internalization: Explicit to Tacit Process 4 describes the internalization of the relation-ship through which explicit knowledge is transferred to Tacit knowledge and then applied at the individual level. It covers processes of learning and operationalizing in which explicit knowledge is transformed into deep personal knowledge and be-comes the property of the organization. Retrieval system comprises two retrieval methods for knowledge management systems. (1) Retrieval, where users search for data based on a specific query, is called a matching framework. This depends on how the data is retrieved, with the difference that each response from the user is combined to create more precise and robust search criteria (Xing, 2011). (2) Push (proactive), which can provide users with information based on pre-defined criteria (Zhu et al., n.d.).

Knowledge repository consists of knowledge management system content. For example, a database system web file system that provides specific details about providing access to knowledge to users.

The result of the components of the crystallized intelligence wisdom repository management system are shown in Figure 2.

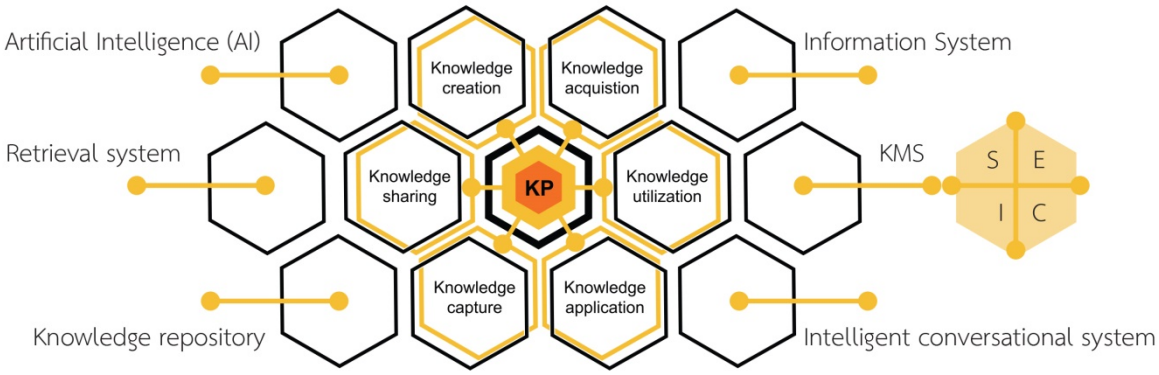

Figure 2. Process for components of the crystallized intelligence wisdom repository management system

3. System Architecture, User Interface Design and Implementation

3.1 Architecture Overview

The three phases of the system architecture in which it operates are as follows. In the first step, users join the application through Line OA. The network connection through cloud computing is effective in delivering knowledge to users, and effective in sending knowledge to end users in JSON format. This format enables users to process conversations from automated chat channels or send events, known as Messaging API (Application Programming Interface). Conversation occurs in natural language that makes users want to interact with real people.

In the next step, the user accesses a repository of knowledge content, images, and videos related to the study of ophthalmology medicine into an intelligent repository of crystallized intelligence that connects users to instant

messaging at the same time. The knowledge management system provides a rule-based and AI-based approach in which access to the knowledge warehouse is processed according to the NLP (Natural Language Processing) pre-processing and processing steps and the NLU (Natural Language Understanding) and NLG response generation steps.

In step 3 the system is linked via the conversional agent to the intelligent crystallized intelligence repository that gathers Tacit Knowledge into the explicit referral process. Knowledge is transformed into crystallized knowledge, enabling users of lifelong learning to become part of a knowledge spiral using cloud services. We have presented a general overview of the system design, shown in Figure 3.

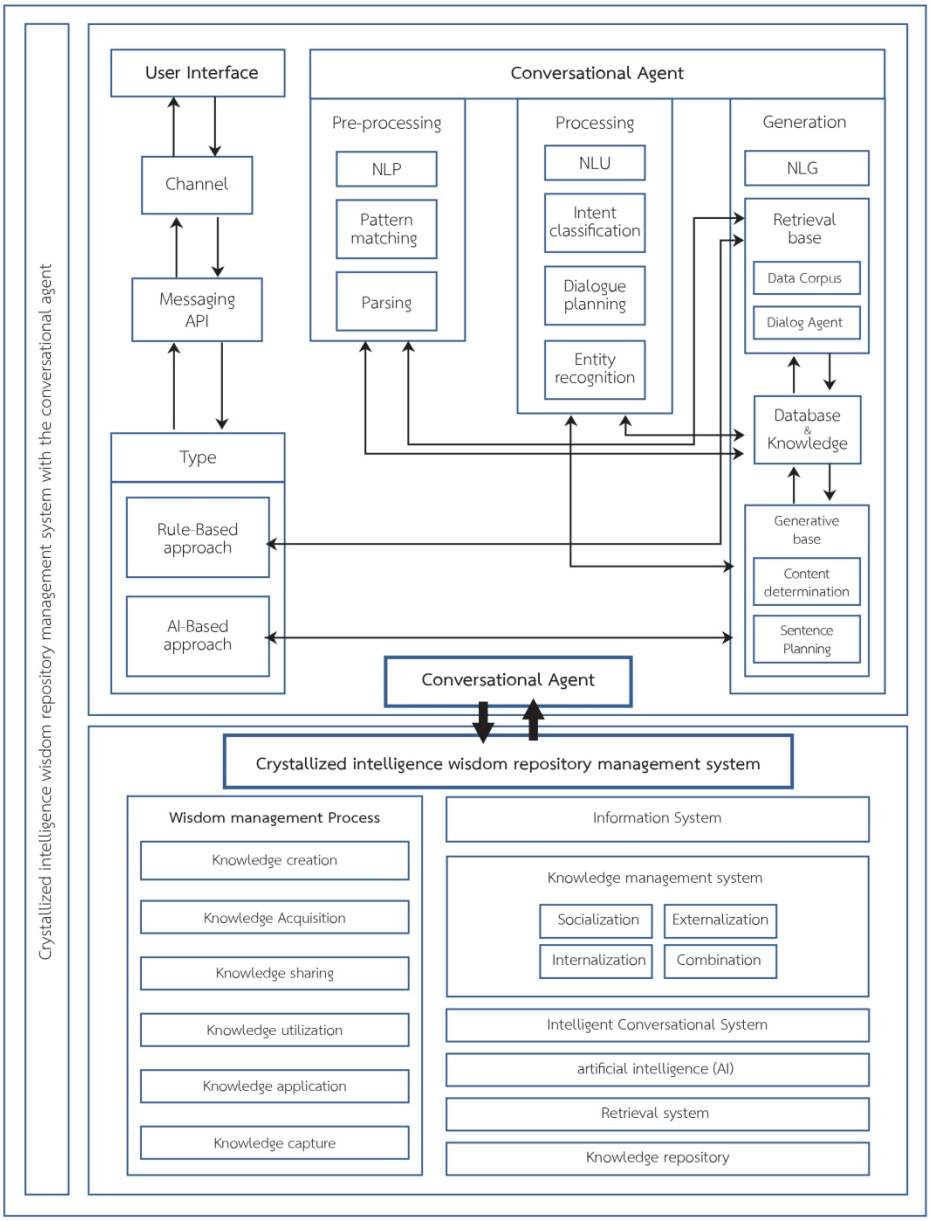

Figure 3. General system design

3.2 The Information Flow

The IT services are established using innovative computing influences known as cloud computing and improved storage capacity. Cloud computing is a technique for offering on-demand network access to a shared pool of reconfigurable computational resources. Four major categories may be used to categorize cloud computing: (1)

Hybrid Cloud (2) Community Cloud (3) Public Cloud (4) Private Cloud (Songsangyos, Ayutthaya, & Nilsook, 2015) and service structure, as follows:

- SaaS (Software as a Service) refers to the Cloud Computing Layer, through which a normal user accesses software created by third parties via a web browser, maintained and offered by others as a web service.
- PaaS (Platform as a Service) means the service platform is used by the operating system and supports sharing through web applications.
- IaaS (Infrastructure as a Service) means that the data infrastructure can use resources to automatically deploy and use virtual machines to run applications (Eumbunnapong, n.d.).
- Standard interface Cloud computing enables the delivery of cloud services based on APIs. API standards provide users with internal commands for communication between two applications or data sources using the internet. Standard interface users can more easily connect cloud services together.

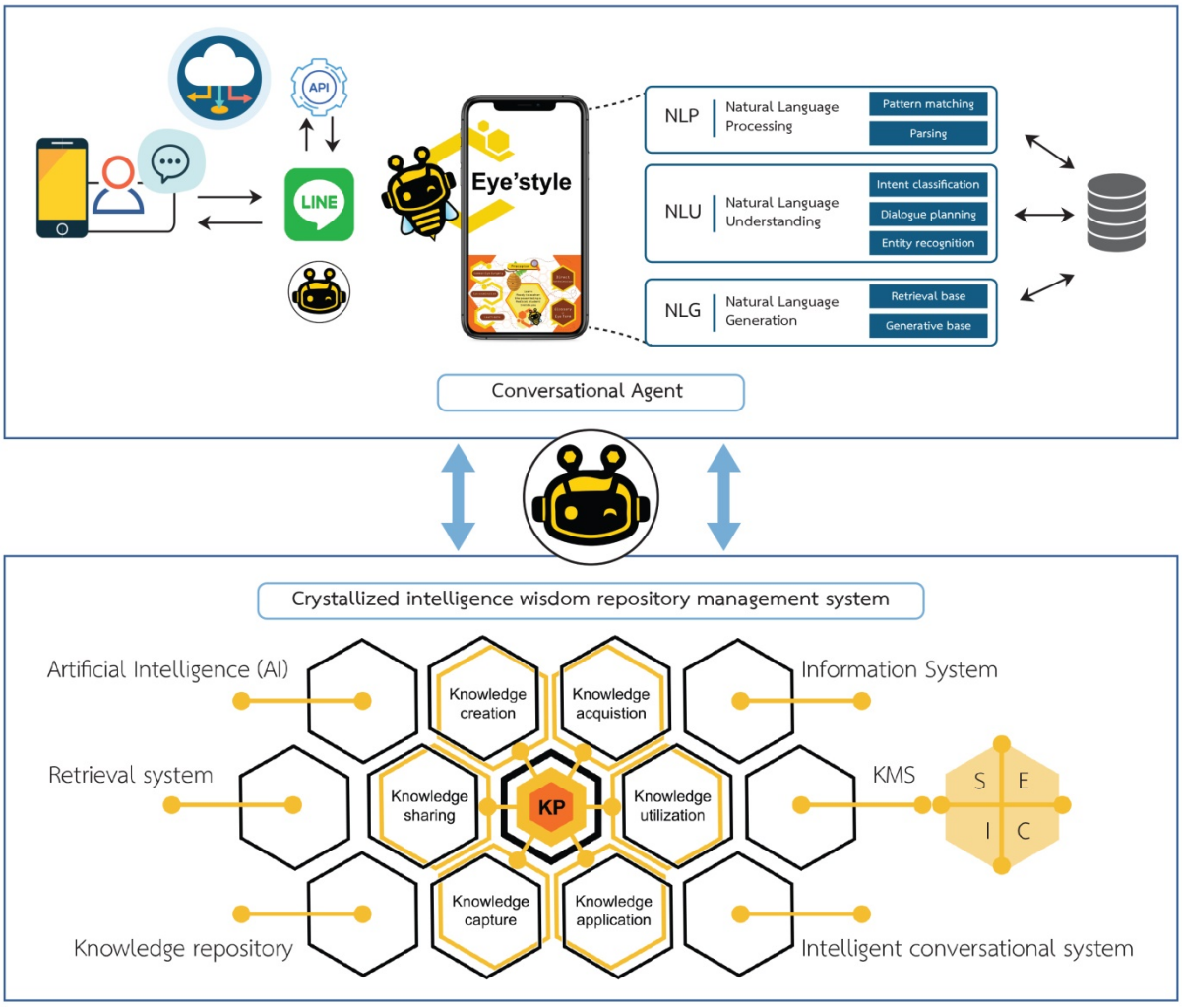

Figure 4. System architecture of the crystallized intelligence wisdom repository management system with the conversational agent

The architecture of the intelligent crystallized intelligence repository system with a conversational agent is a knowledge collection management system that provides medical students with access to the repository of intelligence and in order to develop themselves by gaining a wide range of medical experiences on existing chatbots in the platform of Line official account. The system is designed to answer learners' questions about basic medical knowledge, and to provide video examination exercises, preparation for diagnosis, and tools to direct an Ophthalmoscope to enhance learning.

The intelligence process for our chatbots is named ‘Eye Style’, corresponding to the course name and pronounced similarly to ‘Einstein’, and its purpose is to consolidate knowledge into a treasury of intelligence. Bot characters appear in the shape of smart bees who are diligently hoarding honey in their hive, whereas through user engagement the crystallized knowledge they possess can be expanded. Medical students in ophthalmology courses can learn more with their mobile phones through conversations with chatbots and internal structures, import instructional videos, learn samples of basic eye exam skills, and conduct mock examinations with special tools. These affordances are included in the developed intelligent crystallized intelligence inventory management system.

The process involves searching user logins and providing recommendations based on machine learning techniques applied to collaborative filtering algorithms, ma-chine learning clustering, and processing with data from the wisdom repository. The results of multiple assumptions are replicated with confidence scores and the results closest to the search are those with the greatest scores. The results set and data from the second corpus are returned as results, stored in the repository, and fed back into the implementation cycle to optimize search performance. The API to manage the exchange of data between applications and systems by machine learning algorithms includes:

1) Collecting data from the input
2) Processing data using machine learning and knowledge-based learning algorithms that are stored in the wisdom repository.
3) Handling of the data by a fictitious workflow.
4) The knowledge base receiving the outcomes of assumptions and projections for relevant search criteria.
5) Processing the results of the assumptions to the results for further analysis and presentation to users.

Figure 4 shows the architecture of the crystallized intelligence wisdom repository management system with the conversational agent. Each component can be explained as follows:

3.2.1 Chatbot Integration and User Interface

Building a system from scratch is the first, and most crucial, stage. It enables people to connect and communicate with chatbots. Users can connect and communicate with chatbots through a variety of channels thanks to the user interface. For instance, an application with a chat machine or chatbot such as Botnoi (Winn, 2017) has a function of bots that set up a Channel access token (Channel ID), Channel secret, and Channel MID, which APIs must use over HTTPS by connecting Line applications developed to be accessed with the API. The LINE Platform transmits code to LINE users that enable software applications to connect with one another. Requests to send data must be in JSON format. This format allows users to process conversations from automated chat channels or send events. Known as messaging API, messaging is an intelligent process for chatbots or natural language conversation management that makes users feels like they are interacting with real people.

3.2.2 Conversational Agent

Providing a natural interface, the most important core tasks of Artificial Intelligence are those of artificial intelligence developed on the basis of linguistics, psychology, and computer science. These include systems capable of understanding human language (natural language), virtual reality systems, hybrid AI systems, and expert systems that help in solving problems or making decisions in the same way as human experts. The components of an expert are as follows: 1. Knowledge Base, which is the part of all experts’ knowledge that is stored in the system database; 2. Expert System Software (Software Resources) can in turn be divided into 2 sections A) the part used to process knowledge from the knowledge base and B) the part used to communicate with the user. (Raschka, 2015)

Currently, Conversion Agent’s built-in software is powered by AI, which demands users interact with humans as much as possible. The newly created AI also must learn and apply learning just like a human being: it receives information, which is then processed and stored to be applied in the future. The process of analyzing an incoming message and translating it into another language is called translation, for instance.

Machine learning (ML) is a component of the computer processing system that powers AI. The following general categories of machine learning include its many different forms:

- Supervised Learning - the creation of functions that link inputs to desired out-comes
- Unsupervised Learning - the creation of data models in the same way as classification data
- Reinforced learning - determines an action by observing the response of the environment to the action.

Conversational Agent (CA) is system software that can be associated with learners for instant messaging while the

knowledge management system provides an efficient way to deliver knowledge to the end user. There are two types of Conversational Agents.

- Rule-Based - this model has predefined rules for broad but limited situations. It is a development of a chatbot that will interact with users through certain conditions or rules that need to be covered.
- AI-Based - this is a method for developing a conversational agent or chatbot that focuses on intent and context, which requires the use of technology such as Natural Language Processing.

3.2.3 System Processing

The processing of the system can be divided into 3 steps.
Stage 1: Pre-processing: NLP - Natural Language Processing is a technique for retrieve outside data in text for a data repository or to gather fresh data from user discussions and the system, and to prepare and convert the data into appropriate text. Other chatbot processes' feedback can be incorporated and data from this process will be used in two components: 1) as a foundational understanding of the system or system database; 2) as data the system receives and collects from conversations with users. It is used as information to help chatbots understand their users in the process of processing.

Coordinated in order that the system may produce the proper response and understanding from the pre-processing and processing stages.

- Pattern matching. This procedure involves comparing user input to the database and then analyzing the answer from the input match.
- Parsing. This is an artificial intelligence system that parses each communication into components according to pre-defined algorithmic principles once the text has been entered.

The advantage of NLP (Natural Language Processing) in chatbot technology is that the ability to chat with the technology, rather than just asking and receiving information, allows for richer contextual information extraction (Ikemoto, Asawavetvutt, Kuwabara, & Huang, 2019)**.**

Stage 2: Processing: Using natural language understanding (NLU), conversations can be gathered and modified based on user input, to function and perform as intended the simulation must comprehend the communication between the model and the user: 1) Intent classification is an important element used to classify the intent of user input for use with a knowledge base; 2) Dialogue planning, which draws upon the system's capacity to handle conversations involving several users or comprehend the context of conversations with specific users; 3) Natural language comprehension, which includes entity recognition, and is used for recognizing and labelling names, locations, and people for unstructured text input, and is used to build the knowledge base of a system.

Stage 3: Response Generation: NLG - Natural Language Generation is the process of generating or generating responses. It refers to how a system or agent reacts to a user base based on information from a conversation. When a response is intended to inform the user or to extract information from the user, the user's knowledge base and the system must be coordinated in order that the system may produce the proper response and understanding from the pre-processing and processing stages.

- Retrieval base, wherein the system retrieves user-exported quotes in a big database and provides answers that most closely match the question.
- In linguistics, a data corpus is a collection of texts, and a dictionary is a natural language interface that is used to interact with relational databases.
- Intents are a compilation of natural language dialogues that is used to imitate discussions spanning numerous areas on a number of subjects involving people and systems.
- Generating bases are based mostly on recurrent neural networks (RNNs), providing a conversational, natural language, relational database interface that may generate fresh responses.
- Determination content relating to decision-making on the content of a text piece of information is made up of knowledge.
- Sentence planning, performed through either text planning or sentence recognition, simplifies the focused review of subtasks, and helps explain the building process.

Figure 5. The mobile screen shows the user interface in the crystallized intelligence wisdom repository management system

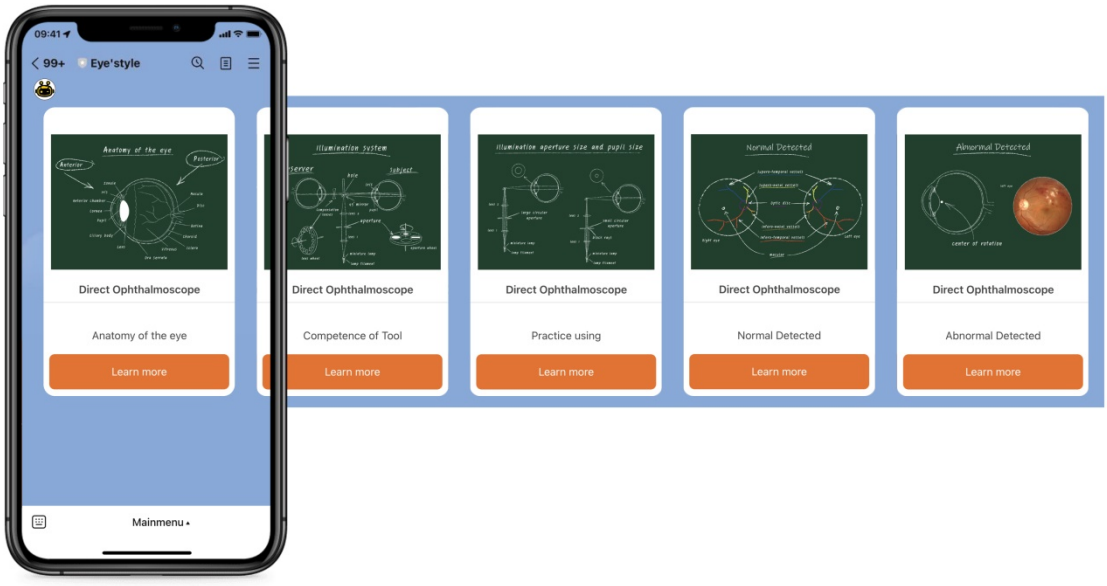

Figure 6. An example of content on a mobile screen in the crystallized intelligence wisdom repository management system

4. Performance Evaluation

The assessment of the synthesis of the crystallized intelligence wisdom repository management system with the conversational agent can be summarized as follows. There are 12 components, consisting of 2 parts: A) 6 processes

of the wisdom repository management process – Knowledge Creation, Knowledge Sharing, Knowledge Capture, Knowledge Application, Knowledge Utilization, and Knowledge Acquisition, and B) 6 components of the crystallized intelligence wisdom repository management system – Artificial Intelligence (AI), Intelligent Conversational System, Information System, Knowledge Management System, Retrieval System, and Knowledge Repository. The researcher has brought together all these elements to develop the crystallized intelligence wisdom repository management system with the conversational agent. In the second part, following the development of the system, let us evaluate the design presented above using a heuristic assessment proposed by Jacob Nielsen (Nielsen, 1994) to inspect the interface independently.

In this case, the heuristic assessment involved 5 assessors monitoring and evaluating the interface. The assessors examined 10 heuristics, where (0) was defined as 'I do not see any problems in use'; (1) 'very few problems that do not need to be fixed'; (2) 'minor problems that need to be fixed'; (3) 'big problems that need to be fixed before use', as shown in Table 3.

Table 3. The results of Heuristic Evaluation

Heuristic Evaluation (Nielsen, 1994)	E1	E2	E3	E4	E5
System status visibility	0	0	0	0	0
Relationship between the system and the actual world	0	0	0	0	0
User freedom & control	0	0	0	0	0
Standards and consistency	0	0	0	0	0
Preventing errors	0	0	0	0	0
Recognition	0	0	0	0	0
Flexibility and ease of usage	0	0	0	0	0
Design aesthetics and minimalism	0	0	0	0	0
Assist users in identifying, analyzing, and recovering from mistakes	1	0	0	0	1
Support and information	1	0	0	1	0

Overall, the results of the heuristic assessment drew incredibly positive attitudes and experiences from the evaluators, most of the evaluators did not see any usability problems at all, and there were only a few topics which received scores as high as 1 (i.e., 'very few problems that do not need to be solved'). Feedback on the chatbots recognized the benefits of helping to get information from quick response questions promptly and described them as very responsive and helpful. The chatbots also demonstrated that a friendly (cute) avatar is an interesting communication technology to use in education. Chatbots were expected to serve as a medium for discussions with medical teachers, and conversations with chatbots were expected, with assessors saying that the chatbots did not answer unprogrammed additional questions. Conversational agents or chatbots have useful features, and learners can use chatbots to ask questions, making it a 2-way communication as well (Villegas-Ch, Arias-Navarrete, & Palacios-Pacheco, 2020). It is said to enable learners to learn from chatbots as much as chatbots can from learners.

5. Conclusions

The crystallized intelligence wisdom repository management system with the conversational agent described in this work has been developed by designing the system architecture, from the wisdom management process to the crystallized intelligence wisdom repository management system, bringing Tacit Knowledge and Explicit Knowledge as crystallization knowledge into a knowledge spiral to provide development guidelines and be able to implement the system with the appropriate design. The 'Eye Style' conversational agent response to this research is a phenomenon that shows a positive impact on the field of study and indicates that the promising prospects of the research are accepted. It also makes it easier for users to acquire new abilities at the right moment, and in a learning setting also acts as an online tutor using artificial intelligence which allows chatbots to answer. The questions identified by the initial research query have enabled this study to show that the chat-bot's preferences are just as important as the baseline data collected.

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