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A Cognitive Knowledge based Framework for Enhancing Decision-Making Skills and Behavioral Development in Learning Environments

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ABSTRACT
The human brain plays a vital role in processing cognitive functions, including thinking, sensory perception, articulation, memory, intelligence, and emotion. Each individual possesses a unique structure of knowledge that facilitates the storage and retrieval of information. While knowledge organization occurs naturally in humans, analyzing its interrelations and functional representation remains a complex task. Existing cognitive models such as ACT-R and connectionist frameworks provide foundational insight into these principles. In this study, we aim to explore the correlations among various forms of defined knowledge through structured surveys. A data mining approach is applied to process the raw data for analysis and knowledge discovery. The results reveal that specific types of knowledge have a significant impact on decision-making abilities, which are essential for individual cognitive growth and performance.
Keywords: Cognitive Science, Knowledge Organization, Memory, Association Rule Mining, Concepts

INTRODUCTION

Knowledge organization (KO) refers to the systematic structuring, categorization, and retrieval of information to enhance understanding, learning, and decision-making. In educational and cognitive contexts, organizing knowledge effectively ensures that individuals can access relevant information when needed, apply it appropriately, and connect new information to existing mental frameworks. As learners encounter increasingly complex problems in academic and real- world scenarios, the ability to organize and utilize diverse types of knowledge becomes essential for effective problem-solving.

The importance of KO lies in its capacity to promote deeper learning, support transfer of knowledge across domains, and foster adaptive thinking. When knowledge is organized meaningfully rather than stored as isolated facts it enhances memory retention, supports inference- making, and improves strategic application in unfamiliar contexts. This process is closely linked to cognitive science, which studies how people acquire, process, and use knowledge. Cognitive science reveals that problem-solving is not a single skill, but a dynamic interaction of memory, reasoning, attention, and metacognition, all of which depend on how knowledge is structured internally. [1] Therefore, understanding the types of knowledge is crucial for analyzing and improving an individual's problem-solving capabilities. The present framework includes ten distinct knowledge types which are listed in section-II-Related works.

OBJECTIVE OF THE WORK

Each of these types plays a distinct yet interrelated role in enhancing an individual's ability to recognize problems, select appropriate strategies, and implement effective solutions. Organizing these knowledge domains provides a comprehensive foundation for assessing problem-solving skills in graduates and guiding their development through targeted feedback and recommendations.

SIGNIFICANCE OF COGNITIVE SCIENCE

Cognitive Science(CS) is the study of the mind which focuses on how the brain interprets the

environment, and how the mind transforms knowledge. It emphasises how the nervous system carries out the task of representing, processing, and transforming information. In general, it is associated with how people learn, perceive, remember, and think about information. Cognitive scientists aim to understand the mental computations fundamental to cognitive functioning and how neural tissue carries out these computations. [10] Cognitive researchers aim to enhance the understanding of human intelligence and behaviour by exploring the functions of nervous systems relating to critical mental faculties such as memory, perception, emotional experience, reasoning, learning, decision-making, problem- solving and language. The mind is often considered to be the machinery that processes inner representations and deploys them to perform actions.

CS is generally illustrated as an interdisciplinary field that focuses on understanding how the mind works including neuroscience, linguistics, psychology, philosophy, anthropology, and artificial intelligence. Each discipline contributes to distinct tools and perspectives. CS does not only refer to the sum of all these fields but to the intersection of the fields where they converge to work on specific problems. It helps in the understanding of how humans develop and organize thoughts which enhances the processes of idea formation, problem-solving, and information processing.

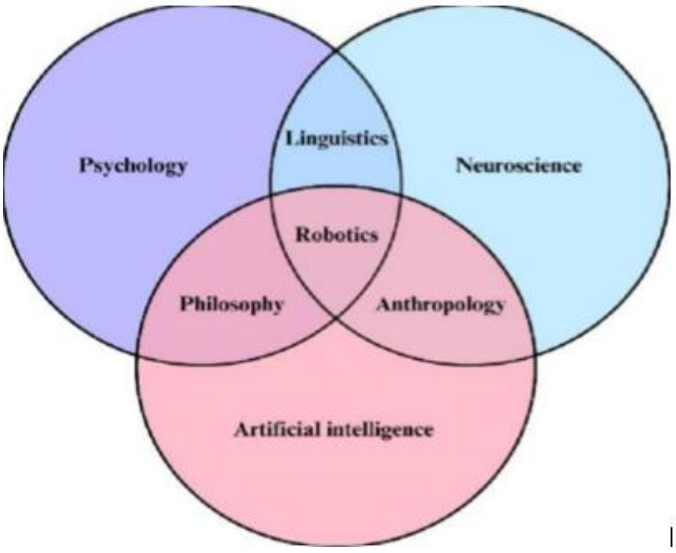

Fig 1 Venn diagram to highlight the interdisciplinary nature of Cognitive Science

As shown in Fig 1 CS is a complex mechanism of solving a problem based on the impact of behaviour, analysis of interpretation, studying mental representations functioning of the neurons at the level of brain, perceiving and sensing an object: a living: nature and nurture, a deeper understanding of psychological aspects, relating mind to the brain, handling emotional sense with Intelligent quotient, a meta-analysis study of automation, handling the issues dealing with biasedness due to lack of optimal Hypothesis, correlating to develop ontological representations and illustrating the language of thought on empirical evidence, observational phenomena and applying technologies of Deep learning, machine learning, statistics subset to Artificial Intelligence for optimality.[11]

RELATED WORKS

The research by Wang et al. aimed to understand the engineering students' process of transferring knowledge while solving problems by studying patterns of functional connectivity in their brains. The research establishes the neural dynamics arising during the process of knowledge transfer, using fNIRS (functional near-infrared spectroscopy) centered on the prefrontal cortex. Different problems with varying cognitive demands were solved by the students while their brain reactions were being recorded. Wavelet transform techniques are used for the neural signal extraction, including wavelet amplitude and wavelet phase coherence, correlating these with three major dependent variables: knowledge distance (conceptual

distance between what is being learned and what is being transferred); prior cognitive level(s); and actual performance. Their results suggested that the knowledge distance and cognitive level exert considerable influence on the neural synchrony, particularly amongst left and right prefrontal areas, but interestingly task performance, conversely, did not show a strong correlation with neural coherence. This suggests that a more profound level of brain activity may be a better measure of the readiness for knowledge than mere testing grade. Unique in its visualization of the brain working network during cognitive transitions, it validates that knowledge transfer has its bonafide roots in internal preparedness rather than overt outputs. Yet the study, while non-invasive, is plagued by all sorts of limitations associated with fNIRS on spatial resolution and movement artifacts and does not also control for all such individual variations related to motivation or emotion, which are sine qua-non in authentic problem-solving.

Therefore, while closely mirroring our goal of investigating the cognitive underpinnings of problem solving, our proposed work is distinctly designed to subsume signal data and declarative and procedural knowledge profiling, thus allowing for a much stronger behavioral and biological integration.[12] Different types of knowledge is illustrated.

Declarative Knowledge encompasses facts, information, and concepts that can be consciously recalled and verbally communicated. It provides the foundational framework for recognizing and understanding problems across various contexts. This type of knowledge includes semantic memory (general world knowledge) and episodic memory (personal experiences) [2]

Procedural Knowledge refers to the ability to perform tasks and procedures effectively. Unlike declarative knowledge, which is about "knowing that," procedural knowledge is about "knowing how." It is developed through practice and repetition until the task becomes automatic, such as solving equations, typing, or programming. This knowledge is central to skill acquisition and task execution, often performed without conscious awareness of each individual step. Procedural knowledge is stored in procedural memory systems, such as the basal ganglia.[2]

Implicit Knowledge is acquired unconsciously and demonstrated through performance without intentional recollection. It often manifests in habits or intuitive responses, such as catching a ball or recognizing a familiar face in a crowd. While difficult to verbalize, it supports fast, automatic responses that are critical in real-time problem-solving scenarios. Implicit learning typically occurs through exposure and interaction rather than formal instruction, complementing explicit learning by shaping behavioral patterns and intuition.[3]

Conditional Knowledge allows individuals to judge when and why certain facts or procedures should be used. It bridges the gap between knowing something and applying it correctly based on context. For instance, a student may know multiple math formulas but must decide which one to apply in a given problem. This knowledge is key for adaptive expertise, especially in non-routine or dynamic environments, and reflects maturity in learning as it is highly context-sensitive.[4]

Adaptive Knowledge enables flexible thinking and the ability to respond effectively to novel or complex situations. It involves combining prior experiences with new challenges to develop innovative solutions. This knowledge is especially important in uncertain or evolving environments, such as emergency response or entrepreneurship. Adaptive thinkers can reconfigure their mental models and strategies in real time, demonstrating cognitive flexibility, creativity, and resilience.[5]

Metacognitive Knowledge is the awareness and control of one's cognitive processes. It includes skills like planning, monitoring, and evaluating one's learning or problem-solving strategies. For example, a student using a checklist to evaluate their understanding after reading is employing metacognitive strategies. This self-regulatory capacity is vital for effective learning, particularly in independent or goal-oriented tasks, and enhances the ability to adjust strategies based on feedback or outcomes.[6]

IQ-Based Knowledge, often tied to fluid intelligence, supports abstract reasoning, problem-solving, and logical analysis. It underpins abilities such as pattern recognition, deduction, and complex computation. High IQ is often correlated with academic and cognitive performance, though it does not guarantee practical success. This knowledge is particularly useful in structured environments where logic and speed are valued. When combined with other types of knowledge, it contributes to a more holistic approach to

intelligence.[7]
Emotional Knowledge, or emotional intelligence, involves understanding, interpreting, and managing one's own emotions and those of others. It enhances interpersonal communication, empathy, and emotional regulation. In collaborative or high-stress environments, emotional intelligence influences decision-making, conflict resolution, and leadership. Individuals with strong emotional knowledge navigate social dynamics more effectively, which is crucial in both personal and professional contexts. It also supports mental well-being and self-awareness. [8]
Social Knowledge refers to the ability to function effectively within groups, understanding norms, roles, and expectations. It enables individuals to collaborate, negotiate, and share responsibilities within team settings. This knowledge is essential in organizational behavior, education, and group problem-solving tasks. It also encompasses cultural competence and ethical awareness. Socially knowledgeable individuals can build trust, resolve conflicts, and contribute positively to team dynamics.[9]
Creative Knowledge is the ability to generate original ideas, think diver gently, and approach problems from new perspectives. It thrives on imagination, synthesis, and breaking conventional patterns. This form of knowledge is crucial for innovation, design thinking, and artistic endeavors. It allows individuals to explore alternatives when traditional methods fail, leading to breakthrough solutions. Creative knowledge fosters curiosity, experimentation, and visionary thinking. [9]

METHODOLOGY

Existing work
The Existing system referred to for this proposed work is the ACT-R (Adaptive Control of Thought—Rational) model, which has been developed by John R. Anderson and his co-authors. ACT-R is a mature cognitive architecture that attempts to simulate the form and function of the human mind, especially addressing how people learn, organize, and use knowledge in problem- solving and learning situations. Based on cognitive psychology, ACT-R suggests that cognition is the result of modular parts of the brain interacting with each other to carry out a particular cognitive function, e.g., memory recall, visual perception, motor control, or goal management [13].
The two main forms of knowledge at the heart of ACT-R are declarative knowledge (facts and information recallable consciously) and procedural knowledge (the "how-to" rules operating on actions and decisions). The model describes how learning works, with the help of declarative knowledge initially, and repeated practice and exposure converting it into procedural knowledge and leading to more automatic, effective performance [13]. This conversion is made possible through a centralized system of production, which establishes which rules to apply cognitively depending on the goal at hand and environment. With increased experience, with the reinforcement of production rules, cognitive effort becomes reduced, displaying expertise development [14].
ACT-R's modular implementation is computationally realized and has been used to model a number of real-world activities, such as language processing, mathematical problem solving, and memory retrieval. Each module, such as the goal module, declarative memory module, or perceptual-motor modules, sends messages through a central buffer system [15]. This interaction enables sophisticated cognitive behavior to be broken down into measurable and explainable interactions, thus making ACT-R a versatile model for simulating human thought processes both
in theoretical and practical contexts. One of the advantages of ACT-R is that it can simulate time-dependent human performance and anticipate user behavior given different levels of cognitive load.

Contribution of existing system to the Proposed system
The system proposed here has great reference to the ACT-R model, particularly in its dealing with declarative and procedural knowledge as elementary cognitive building blocks. Just like in ACT- R, this current work recognizes the imperative of considering such kinds of knowledge in isolation and studying how they interact during real-time problem-solving [16]. The online platform designed in this proposed work applies this principle by displaying questions to assess declarative recall and procedural application

individually, and analyzing their interdependence using scoring logic and rule-based inferences.
In addition, the recommendation mechanism built into the proposed system functions similarly to ACT-R's production rules by linking gaps (e.g., poor procedural skills) to executable strategies [15]. Through the use of data mining algorithms like Association Rule Mining (ARM), the proposed system tries to simulate how habitual patterns of behavior and knowledge application arise, yet another idea borrowed extensively from the ACT-R paradigm. Essentially, this assists the system to mimic a reduced cognitive agent that can modify its response and interventions in function of the current knowledge state of the user.

Drawbacks of Existing system
Symbolic Limitations: ACT-R is primarily a symbolic system, which limits its ability to support unstructured or dynamic real-world data. This constrains its use in applications that involve emotionally driven decision-making or creative problem-solving [16].
Lack of Neurophysiological Integration: The model fails to demonstrate direct correspondence with neurophysiological data like brainwave patterns. While it is symbolic in the expression of cognitive activities like memory and attention, it lacks connecting these activities with actual neural processes, thus rendering its ability for real-time brain-based analysis less effective [17].
Oversimplified Modularity: ACT-R's modularity facilitates the management of the highly interconnected nature of human cognition. It Is devoid of important cognitive domains like emotional, social, or adaptive intelligence, making it inappropriate for simulating real-world, complex decision-making [15].
Scalability and Automation Issues: Act-R encoding of production rules and knowledge is extremely time-consuming. The model does not support any kind of dynamic, unsupervised learning strategy prevalent in modern AI, and thus it suffers in terms of scalability and the handling of large or dynamic datasets [14].

Proposed System
The proposed work workflow involves a comprehensive method that integrates cognitive assessment based on surveys, data mining concepts, web technology, and signal processing to test and improve the problem-solving skills of graduates.

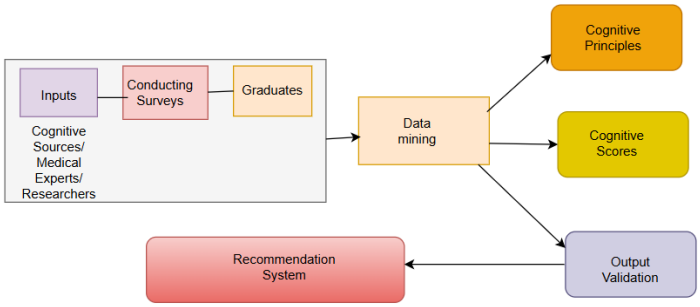

Fig 2: A Knowledge based framework for enhancing learning environments
As shown in Fig 2 The first step of the proposed work is phrasing questions for different types of knowledge like declarative, procedural, metacognitive, implicit, and explicit knowledge, etc. All the questions are phrased by referencing existing literature within psychology and cognitive science. These questions were presented using a Google Form and made available for a widespread and compelling collection of data from students. The responses received are processed using Association Rule Mining (ARM), the Apriori algorithm, to determine patterns between various knowledge deficits and problem-solving inefficiencies. Every response will be marked and the final score will be determined. Based on these scores, customized recommendations were developed, providing suggestions to enhance the

particular knowledge areas in students whose performance is below the acceptable range score. A Complete website is built for students to implement this solution interactively, where students can take the test, monitor their progress, and be given personalized feedback and suggestions in real-time. To investigate problem-solving skills, signals were collected from participants during cognitive tasks to track brainwave activity and link neural patterns to performance. By employing Convolutional Neural Networks (CNNs) for time-domain analysis and Fast Fourier Transform (FFT) for frequency-domain features, this approach uncovers cognitive processes like attention and memory, enhancing the understanding of problem-solving dynamics. Combined with survey data, it establishes a comprehensive framework that integrates neuroscience, cognitive theory, and data-driven insights, paving the way for innovative cognitive assessment and personalized educational strategies.

The Proposed system seeks to examine the impact of various types of knowledge on problem- solving and cognitive skills in graduates.

Text-based knowledge measurement

Question Framing: The foundation of this proposed work involves the careful crafting of questions that examine different types of knowledge-declarative, procedural, metacognitive, implicit, explicit, etc. These questions were created drawing extensively on the relevant research papers in psychology and cognitive science, thus lending them reliability and relevance. Each question was meticulously crafted to assess not only a particular knowledge category but also its backing by actual scenarios in order to factor in proper cognitive assessment in a real academic environment as shown in fig 4.

Survey through Google Form: After the questions were finalized, they were structured into a Google Form and distributed among graduate students. This kind of approach allowed the team to collect data on a large scale in an efficient manner. The form comprised both multiple-choice and scenario-based questions. The participants were anonymous, and informed consent from the respondents was obtained, ensuring adherence to ethical research standards. The responses to the survey served as the primary data set for the knowledge evaluation part of the system.

ARM on Responses: For meaningful deduction patterns and establishing relationships between types of knowledge and deficiencies in cognitive skills, ARM has been implemented on the data set. By using the Apriori algorithm, rules such as {Low Declarative, Low Procedural} → {Poor Problem Solving} were generated. This data mining process also exposed how weak combinations of knowledge types correlate with problem-solving deficiencies. The association rules generated by ARM would serve as the basis for the recommendation logic implemented in the system.

Knowledge Scoring and Adaptive Feedback Mechanism: The assessment process of a graduate in this proposed work is based on a formal and well-defined marking scheme where every survey question is matched to a particular cognitive or knowledge category. Every response option is then allocated a numerical score, generally ranging from 0.25 to 1, depending on its match with the ideal cognitive behavior or conceptual knowledge as determined by cited psychological and educational literature. For instance, declarative knowledge questions evaluate factual recall and conceptual understanding, and their scores improve with the quality of understanding. Likewise, procedures and metacognitive knowledge are also scored on applied reasoning, making decisions, and employing self-regulation strategies, with better cognitive maturity being rewarded in the form of full marks. After attempting all the questions, scores are computed both section-wise and cumulatively to produce a detailed profile of the student's knowledge organization. This scoring system is not only quantitative but forms the skeleton for the adaptive feedback system incorporated into the website. Based on scores obtained in different areas of knowledge, the system offers dynamic personalized suggestions. These suggestions are assembled from evidence-based cognitive development protocols and attempt to close the performance deficit in weaker domains. For instance, a low metacognitive awareness score may trigger suggestions that involve reflective journaling or peer discussion learning, while procedural knowledge deficits may demand experiential learning strategies. This closely coupled scoring and feedback system ensures that the students not only understand their performance, but also receive actionable feedback for mental improvement.

Built Website to Test Knowledge and Provide Recommendations: A responsive web application has been developed such that the whole system becomes interactive and accessible to students.The front end website allows the students to log in to the app, test their knowledge, check their scores, and get recommendations in real time. The application itself includes areas for various knowledge points and a generalized dashboard that allows a thorough assessment and the provision of suggestions for improvement. The backend logic takes care of self-scoring and generation of recommendations smoothly and user-friendly.

Questionnaire And Score Assignment

Sample questions under each section is given for clear understanding of the concept.

Section - 1: Story Writing

Prepare a story based on the below images, and keywords write the moral of the story in a few sentences and kindly title the scenario? Illustration of story board is shown in Fig 5.

[Keywords: Ambition, doctor, financial problems, humility, professor, old woman, Brother and 3 sisters, Agriculture.]

Keyword Matching: The script scans each response for words associated with Positive, Negative, Happy, Sad, Emotional, Romantic, and Value-based emotions.

Weight Assignment: Each keyword match increases the corresponding emotion score.

Normalization: Scores are converted to percentages so they sum to 100%.

Final Output: The script prints the emotion distribution for each response.

Section - 2: Gestalt's Section

When you see a traffic signal board, what do you feel like is happening?

the light is moving from one circle to another →[1]

disappearing at one and appearing at the other? → [0.5]

Section - 3: Meta-Cognitive Section

You have been reading the textbook multiple times to understand a concept, but you still find it difficult to grasp. What would you do next?

Switch to a different topic skipping the concept → [0.25]

Keep reading the textbook and trying to understand → [0.75]

Try a different method, such as watching explanatory videos or discussing with peers → [1]

Memorize the definitions without understanding the concept for the exam. → [0.5]

Guess the answer and move on without reviewing→ [0.5]

Leave the question unanswered and focus on easy ones→ [0.25]

Section - 4: Procedural Knowledge

You are assembling a piece of furniture using an instruction manual. How confident are you in completing the task?

I would struggle to understand the instructions and might not finish. → [0.25]

I would try but might assemble it incorrectly. → [0.5]

I would assemble it but might need help with some parts. → [0.75]

I would assemble it correctly with minimal issues. → [0.75]

I would assemble it quickly and efficiently without referring to the manual often.[correct answer] → [1]

Section - 5: Declarative Knowledge

How do you think social media can influence your mental health?

It can affect emotions. → [0.25]

It sometimes causes anxiety and self-esteem issues. → [0.5]

It affects mental health by influencing self-image, stress, and social behavior. → [0.75]

Excessive social media use impacts mental health by increasing anxiety, depression, and altering self-perception through unrealistic comparisons. → [1]

Section - 6: IQ - Based Questions

1. 1, 3, 7, 15, 31, 63, ? a)95 b)127 ->[1] c)125 d) 121

Section - 7: Implicit Knowledge

You are playing a new strategy game for the first time. After a few rounds, you start making better moves without consciously analyzing each step. What does this suggest?
You have developed an intuitive understanding of the game's patterns. → [1]
You are following a strict rulebook without deviation. → [0.5]
Your decisions are random and unrelated to past experiences. → [0.25]
You must explicitly study every rule before making any moves. → [0.25]
Section - 8: Emotional Questions
What kind of person do you want to be, someone who is kind and puts their loved ones before themselves, or a person who is authentic and sticks to his/her principles either good or bad?
"A authentic person who sticks to the principles either good or bad" → [1]
"Kind and puts their loved ones before yourself" → [0.5]
Section – 9: Creative Questions
You are cooking a recipe, but you realize you are missing a key ingredient. What would you do?
Find a substitute ingredient that serves the same function. → [1]
Throw away the dish and start over. → [0.5]
Refuse to continue cooking and order food instead. → [0.25]
Ignore the missing ingredient and risk ruining the dish. → [0.75]
Section -10: Social Knowledge
During a group proposed work, two members strongly disagree on how to complete a task. What is the best way to resolve this?
Encourage discussion to find a compromise that benefits the proposed work. → [1]
Ignore the conflict and continue working separately. → [0.5]
Let one person make the decision without input from others. → [0.5]
Avoid discussing the issue and hope it resolves itself. → [0.25]
Section – 11: Conditional & Adaptive Knowledge
You are working on a team proposed work when a sudden technical issue delays progress. What is the best approach?
Quickly identify an alternative method or tool to complete the task. → [1]
Wait for someone else to fix the issue instead of adjusting. → [0.25]
Continue using the same method, even if it's not working. → [0.5]
Abandon the proposed work and start a completely unrelated task. → [0.25]

Section	Benchmark Score (Acceptable Range)
Gestalt's Section	≥1.2
Meta-Cognitive	≥1.8
Procedural	≥1.2
Declarative	≥1.8
IQ-Based	≥3.0
Implicit Knowledge	≥1.2
Emotional Knowledge	≥2.4
Creative Knowledge	≥0.6
Social Knowledge	≥1.8
Conditional & Adaptive	≥1.2

Fig 3: Each section's score

The score that an individual should get under each section illustration as shown in Fig 3

Overall Score Range	Performance Level
7.85 - 14	Low Knowledge (Needs Significant Improvement) ❌
14 - 21	Medium Knowledge (Needs Moderate Improvement) 🔸
21 - 27	High Knowledge (Strong Proficiency) ✅

Fig 4: Overall score segregation as High, Medium and Low

The overall score classification is based on educational assessment frameworks used in cognitive learning theories [27] as shown in Fig 4.

Score 7.85 - 14 (Low Knowledge) – Struggles with Foundational Concepts

Explains that individuals who score below 50% often lack foundational cognitive processing efficiency and require structured practice to improve skills. [19]

States that learners in the lowest quartile require targeted interventions, scaffolding, and guided learning approaches to improve performance. [20]

Score 14- 21 (Medium Knowledge) – Partial Mastery but Inconsistencies

Introduces the concept of the Zone of Proximal Development (ZPD), where learners can perform moderately well but require guided learning to fully master concepts. [21]

States that learners in this range need targeted strategies like retrieval practice, self- explanation, and structured learning to reinforce weaker sections.[22]

Score 21 - 27 (High Knowledge) – Strong Proficiency and Application

Learners scoring above 80% demonstrate strong applied knowledge, problem- solving ability, and potential for expertise development. [23]

High scorers move beyond basic knowledge recall and demonstrate evaluation, synthesis, and application of concepts. [24]

Recommendations (through App/GUI)

Your perspective shapes the way you interpret and interact with the world. By finding balance, embracing growth-oriented thinking, and staying open to new experiences, you can cultivate a more positive, resilient, and enriching outlook on life. Keep reflecting, learning, and evolving—your mindset has the power to shape your reality as shown in fig 8[25]

App: Elevate – Brain Training for All Cognitive Skills https://www.elevateapp.com/

Challenge: 100 Days of Learning – Multi-Domain Skill Development
https://www.100daysoflearning.com/

Book: The Talent Code by Daniel Coyle https://www.amazon.com/Talent-Code-Greatness-Born-Grown/dp/055380684X

Overall Score-Based Recommendations

Your overall score provides insight into your strengths and areas for improvement. Based on your performance, here are tailored recommendations to help you grow:

If Score is HIGH

Fantastic work! You have a strong understanding across multiple areas, and your skills are well-developed.

Continue refining any weak areas and challenge yourself with advanced activities like case studies, research proposed works, or leadership roles.

Engage in peer mentoring-teaching others reinforces your own knowledge and deepens your expertise.

Explore real-world applications of your knowledge to keep pushing your learning to the next level.

If Score is MODERATE

You have a good foundational knowledge, but there's room to strengthen certain areas.

Identify your lowest-scoring sections and focus on targeted exercises to improve them.
Develop cross-functional knowledge by linking concepts—e.g., combining social knowledge with emotional intelligence to improve communication skills.
Use active practice—apply what you learn in discussions, hands-on proposed works, and real-life scenarios to solidify your understanding. Scores representation is shown in Fig 7.
If Score is LOW
It is time to reinforce your fundamentals and focus on core concepts. Don't worry— progress is always possible with the right approach!
Review key topics and strengthen your base knowledge through structured learning.
Engage in interactive learning activities like debates, group proposed works, and problem- solving tasks to make concepts more practical and memorable. No matter your score, consistent effort and the right strategies will lead to growth! Keep learning, adapting, and challenging yourself you've got this! [26]
3.3.2 Justifications for questions and recommendations Questions
You have been reading the textbook multiple times to understand a concept, but you still find it difficult to grasp. What would you do next?
Justification: The research conducted by Dunlosky et al. (2013) suggests that active learning techniques such as watching videos and discussing material with peers work better than passive rereading in promoting an understanding of concepts. Their thorough meta- analysis shows that rereading has low utility; against that, elaboration such as explanations improves problem-solving transfer. Recommender system will also provide valid citation. (Example like MLA format→Research paper)
MLA Citation: [Dunlosky, John, et al. "Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology." *Psychological Science in the Public Interest*, vol. 14, no. 1, 2013, pp. 4–54. DOI:10.1177/1529100612453266.]

RESULTS AND DISCUSSIONS

Association Rule Mining Rules: -Rules and graphs as shown in Fig 8 is represented
ConceptMapping → Low_IQ-Based
PublicSpeaking → Low_Implicit, Low_Declarative, HandsOnLearning, Low_Metacognitive
Low_Implicit → HandsOnLearning, Low_Declarative
Low_Declarative →Low_Metacognitive, HandsOnLearning
Low_Metacognitive →HandsOnLearning, Low_Implicit, Low_Declarative
HandsOnLearning →PublicSpeaking,
Low_Declarative→Low_Implicit, Low_Metacognitive

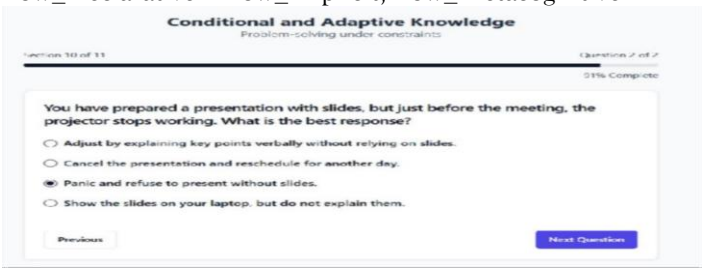

Fig 5: Illustration of Question responsive page

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Fig 6: Visualization of a story board question

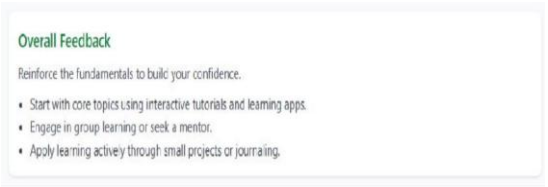

Fig 7: Visualization of Overall Feedback score

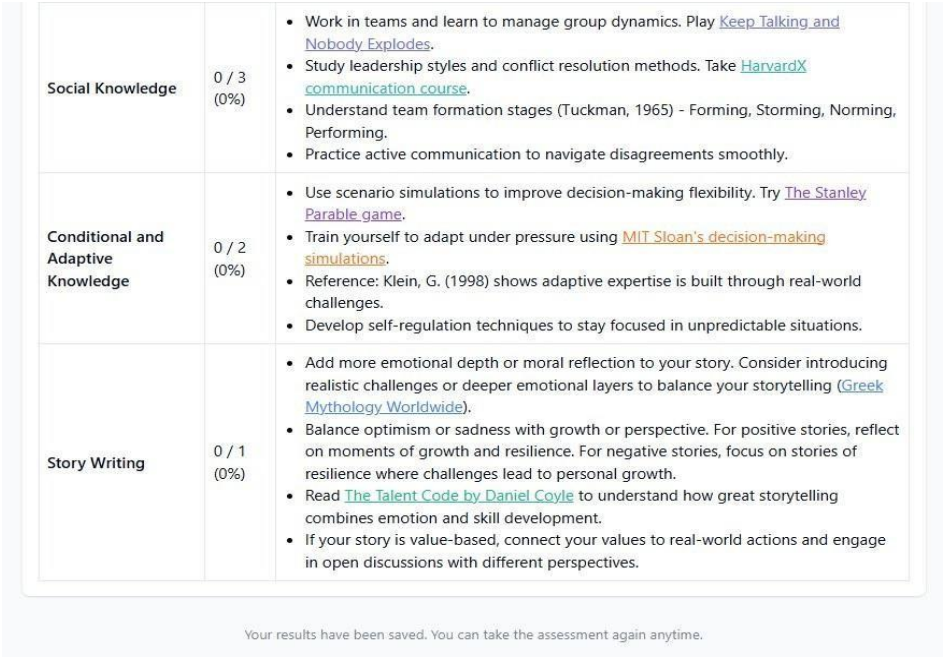

Fig 8: Section wise feedback (Social knowledge, conditional and adaptive knowledge, story writing)

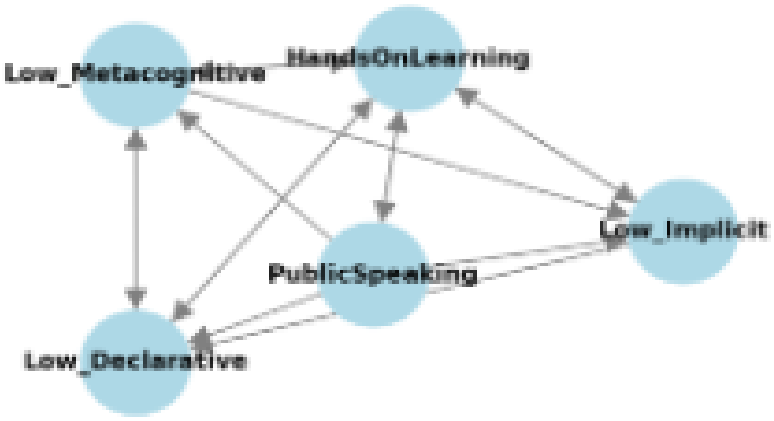

Fig 9: Patterns discovered form Association Rule Mining

Conclusion and Future Scope

The intelligent system developed in this proposed work successfully integrates cognitive science,and machine learning to assess and enhance graduates' problem-solving skills through personalized cognitive profiling and recommendations. Association Rule Mining further enriches the system by uncovering actionable patterns, such as linking low declarative knowledge to specific learning strategies (e.g., flashcards, concept mapping). This multidisciplinary approach not only bridges cognitive science and artificial intelligence but also offers practical applications in education, cognitive training, and clinical diagnostics, empowering graduates to improve their problem-solving efficacy through tailored interventions. Future enhancements to this proposed work could focus on expanding the system's capabilities by simultaneously collecting data while the person is answering the questionnaire, enabling real- time correlation between cognitive states and specific question responses for more granular insights into problem-solving dynamics. This could be achieved by integrating wearable devices with the web platform to capture neural activity during assessments, enhancing the accuracy of cognitive profiling. The system could also be adapted to support a broader range of cognitive and neurological conditions, such as attention deficits or memory impairments, by incorporating multi-modal data (e.g., eye-tracking, physiological sensors) for a more holistic assessment.

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