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A Parametrized Comparative Analysis of Performance Between Proposed Adaptive and Personalized Tutoring System “Seis Tutor” With Existing Online Tutoring System

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ABSTRACT Face-to-face tutoring offers a learning environment that best suits the learner’s preferences (learning styles) and grasping levels (learning levels). This cognitive intelligence has been blended in our proposed intelligent tutoring system christened as “Seis Tutor”. In this paper, we have detailed the architecture of Seis Tutor system and compared it with other existing traditional tutoring systems. Further, the performance of Seis Tutor has been evaluated in terms of personalization and adaptation through a comparison with some existing tutoring systems, i.e., My Moodle, Course-Builder, and Teachable.

INDEX TERMS SeisTutor, intelligent tutoring system, my moodle, teachable, course builder, personalization and adaptation.

I. INTRODUCTION

The intelligent tutoring system (ITS) is a computer-aided system that integrates artificial intelligence (AI) techniques to mimic the cognitive intelligence of human tutors. ITS is the amalgamation of three disciplines: Psychology, Computer Science, and education (as shown in Figure 1). The aforementioned disciplines are defined as follows: first, psychology refers to learner behavior during interaction with the tutoring system, second, computer science refers to the intelligent tutoring system’s technology to mimic human cognitive intelligence, and third, education refers to the subject domain used in ITS.

To make learning flexible, a variety of AI techniques amalgamated with educational methodologies to encourage researchers to develop an adaptive intelligent tutoring system. This intersection is referred to as Cognitive Intelligence and gained massive attention in the current era. This Intelligence mainly considers a solution model to other available tutoring

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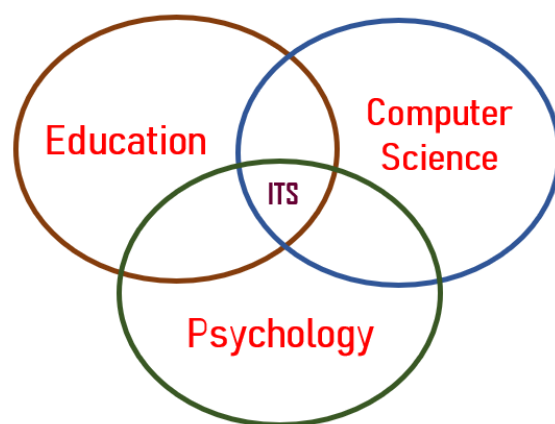


FIGURE 1. Interaction in intelligent tutoring system.

systems such as Learning Management System (LMS) and e-learning.

An ITS typically tracks the student’s activities through the tutoring session, tailoring feedback assistantship, and provides hints along the way.

It draws an inference mechanism to adjudge strengths and weaknesses based on learner performance during the test.

Bloom. *et al.* demonstrates that individual one-on-one tutoring is the most effective mode of teaching and learning, which is the essence of ITS [1]. An individualized instructional delivery mechanism shows effective up-gradation in learner performances and enhances their motivational levels.

Traditional ITS has a modular architecture, typically constituting modules, such as the domain, teaching, student, and learning modules [2]. Additionally, there are interfaces between these modules [3], [51].

Designing ITS is to emulate human Intelligence in a computer-aided system. Thus, the conclusion drawn from the literature is that adaptation and personalization act as key characteristics of an ITS that make it different from traditional e-learning systems. Therefore, to adjudge the effectiveness of a tutoring system over learning, this research explores a few tutoring systems. Based on some parameters (Personalization, Adaptivity, Custom-Tailored Curriculum, Dynamic Profiling, Navigation support, Learning Content and Learner Feedback), a comparative analysis has been performed. This article explores the adaptivity and personalization features used in existing and proposed tutors. Moreover, it reports a case study where all the tutoring systems have the same learning environment, i.e., subject domain. A brief overview report is presented, followed by a comparative analysis in section four. Finally, the article is concluded.

The proposed work is organized under subsequent sections. Related work has been deliberated in section two. Section three elaborates the existing and proposed methodology. Experimental results and implementation have been presented in section four. Section Five conclude the embodiment and achievement of the proposed article.

II. LITERATURE REVIEW

This section illustrates the comprehensive coverage of the development of intelligent tutoring systems from CAI (computer-aided-instruction) to many innovative tutoring systems. The first CAI was modernized in 1950 [5]. ITS system contains the pre-determined frames, organized sequentially to accomplish the desired goal. These frames contain objective questions with varying difficulty levels to test the learner, further to which the system provides feedback. During tutoring and testing, the system provides hints and necessary remediation. However, the system could not recognize learner delusion and adjust to the learner's learning style and knowledge level.

Woolf *et al.* developed Intelligent Computer-Aided Instruction (ICAI), which controls the learning content delivered to the learner and directs to communicate with the learner effectively. Here is some evidence of the problem-solving domain; the system adapts the sequence of natural action to the learner's answers. However, it did not appropriately handle the different aspects of the student module. The tutoring material became too huge to be amendable by straightforward programming.

Uhr used to generate questions on arithmetic and vocabulary but lacked modeling and adaptation. Several systems proposed by the authors in Suppes system [5], [8], [9], were considered adaptive because tests conducted were based on learner performance. These were the pioneer ITS. However, the learner module was not appropriately elaborated and contained only concise information. The basic information of the learner was not warehoused.

Other systems that came subsequently were "drill and test." They used students' performance and learning response as the criteria to present the next set of tests, rather than following preset rules to offer material and tests.

The inability of their ITS to provide a rich set of feedbacks led to the development of the new generation education system, ITS, with more intelligent features.

Architecturally, the ITS underwent significant modifications, incorporating additional features over the basic tutoring, student, and knowledge modules. Further advancement has been on the pedagogical module towards adapting course material to learners' abilities. The focus moved towards incorporating AI Techniques to refine pedagogical decisions and student feedback.

References [10] and [11], developed an intelligent tutoring system and considered Physics as a subject domain. They use the Bayesian network for decision-making. It is a domain dependent ITS with features, i.e., predict learner's actions, select the most appropriate strategy for the learner and performance assessment. In the Andes, a given physics problem is partitioned into subproblems and is used to construct a Bayesian Network. The Bayesian network facilitates finding the most feasible path throughout the learning process and continuously adapts to the given problem.

Reference [12] used a fuzzy inference system and graph data structure to align the learning material. Fuzzy sets have been utilized to use knowledge of subjects and learner's ability for determining the learning content for the learner.

References [13] and [14] developed an intelligent tutoring system christened as SQL Tutor by utilizing an artificial neural network (ANN). The agent records the learner's behavior through the tutoring sessions, observing the learner's responses to the questions in the form of constraints and further using this information to present successive questions.

Reference [15] developed an intelligent tutoring system christened as C++ Tutor. The questions were presented to the learners in the mode of feature vectors. The learner's task was to label the vectors with the help of a set of labels. They used an algorithm named NEITHER, which received these labeled vectors to bring changes in the rule base. This improved rule base inferred the learner's solutions instead of the correct answer. This process is named THEORY REVISION, which reveals the learner's perception of the content. When this theory revision process is over, the system illustrates the mistakes in the learner's concept by presenting some instance or model, which gives a complete picture or an idea where the learner is mistaken. The system automatically accomplished this whole procedure using a rule-based procedure.

References [16] and [17] developed a dialogue-based intelligent tutoring system christened as a CIRCSIM tutor and considered physiology a subject domain. The learner module is categorized into four sub-modules: performance, learner history (reply), record learner solution, and tutoring history.

As its name indicates performance module is generally used to store and analyze the learner's performance. This assessment is accomplished in four stages, 1) Global: to manage the complete performance of the learner, 2) Procedure-level: involved with the specific problem-specified responses of the learner, 3) Stage assessment: examines the learner's understanding concerning the different levels of physiology in the questions, and 4) Local assessment: concerning learner's understanding specific to the topic.

Reference [18] performs a rigorous review on ITS and describes the key research area. These are as follows:

1. Characterization and customization of the learner.
2. Development of customized knowledge base.
3. Customized learning material presentation
4. Customized curriculum delivery.

Zapata-Rivera and Greer developed an ITS christened as ViSMod [19]. The system is divided into three levels of the hierarchical network, facilitating the learner's delivery of different domain content. This makes it domain-independent and efficient.

An ITS, developed by Chen [37], is a personalized and remedial e-learning system (PDRLS) based on learner knowledge about the course it offers learning paths. For generating a learning path, they utilize the pathfinder algorithm.

Another ITS developed by Haoran [29] resolves the problem of determining a suitable learning path for a learner cluster. The profile-based framework was proposed and utilized to determine the appropriate learning path for the learner group by undertaking a few parameters.

The proposed online learning framework incorporates two techniques, one is learning path identification, and the other is learning path suggestion. Right off the bat, the framework creates some student courses utilizing a data mining strategy dependent on a priori calculation. For learning way development, they use formal concept analysis, which decides the course topics and creates the best desirable learning path [24].

Reference [25] proposed a genetic-based learning path sequencing strategy for creating an exclusive learning path for students. They utilized the difficulty level and concept relation degree as a fitness function.

Another methodology found was by utilizing Genetic techniques in e-learning systems that provide freely browsing learning mode and optimal learning paths to students.

The methodology depends on a pre-test to gather incorrect learning concepts of students; at that point, the Genetic Algorithm (GA) is utilized to build a relative optimal

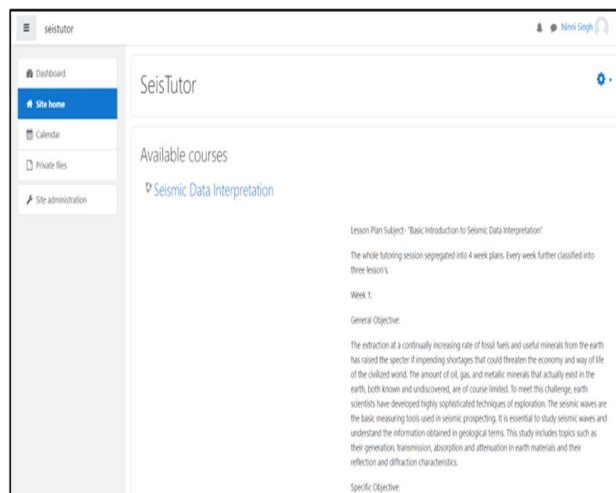


FIGURE 2. My-Moodle dashboard.

learning path based on incorrect responses during the pre-test [25], [26], [52].

III. EXISTING AND PROPOSED TUTORING SYSTEMS

A. MY-MOODLE

My-Moodle is an open-source tutoring system that helps researchers set up their environment and test their proposed intelligent tutoring system. *My-Moodle* comprises resources and activities, i.e., glossaries, assignments quizzes, databases, etc. The primary focus of *My-Moodle* is to provide activity-based modeling, in which activities club into sequences that guide the learner in the form of the learning path. One can confidently say that activities are aligned in such a manner that the outcome of one activity acts as an input to the next activity. Figure 2 depicts the dashboard of *My-Moodle*.

B. COURSE-BUILDER

Course builder helps create learning environments, i.e., subject domain and learning quizzes; using a rich feature set that does not require any programming. *Course-builder* built on the google app engine, so there is no limit on the number of students registered to learn the courses. It helps to keep the relationships with students and the teacher. Their vision is to provide broad access to education; that is why they collaborate with Openedx (open source software for higher learning developed by edx).

C. TEACHABLE

Teachable is an open-source tutoring system that provides a user-friendly learning environment. They provide a platform where subject experts can upload their learning content irrespective of their technology. *Teachable* LMS is easily manageable which helps to build the brand, and it is best for the entrepreneur. However, they did not focus on personalization but provided learning by adapting the learner's grasping levels and preferred media.

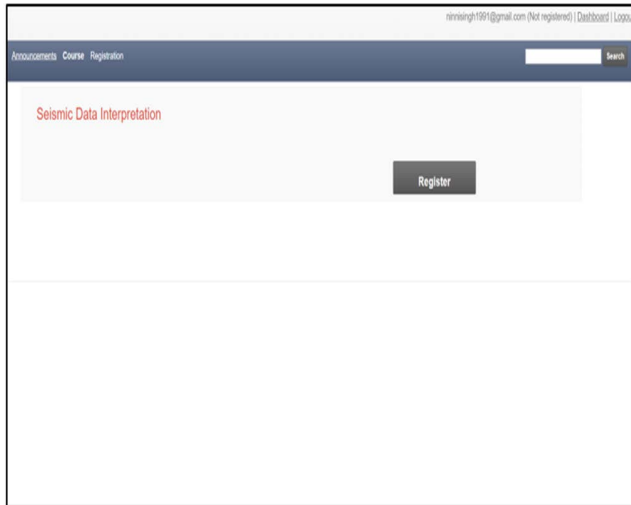


FIGURE 3. Course-Builder dashboard.

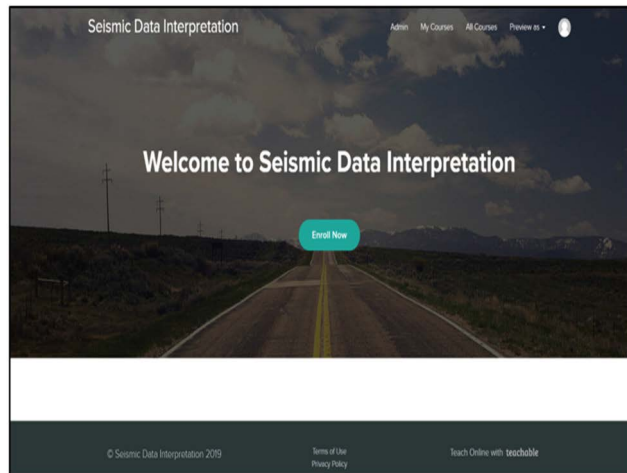


FIGURE 4. Teachable dashboard.

D. PROPOSED INTELLIGENT TUTORING SYSTEM “SEIS TUTOR”

The traditional architecture of ITS consists of four components: Learner interface Model, Learner model, Tutoring (pedagogy) Model, and Knowledge/Domain model. As shown previously in Figure 1 which depicted the basic architecture of the ITS. These components are elaborated in more details as follows:

1) LEARNER INTERFACE MODEL

This model enables the learner to interact with the tutoring system. It provides different modes of communication between learners and the system, such as dialog boxes, graphical user interfaces, and different navigational screen layouts.

2) LEARNER MODEL

This model captured and gauged the data about a learner’s learning style, learner grasping level, prior learner knowledge, learner cognitive and meta-cognitive abilities, learner

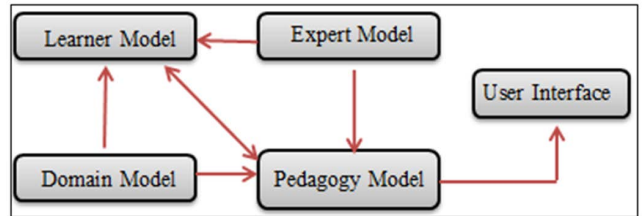


FIGURE 5. ITS Architecture.

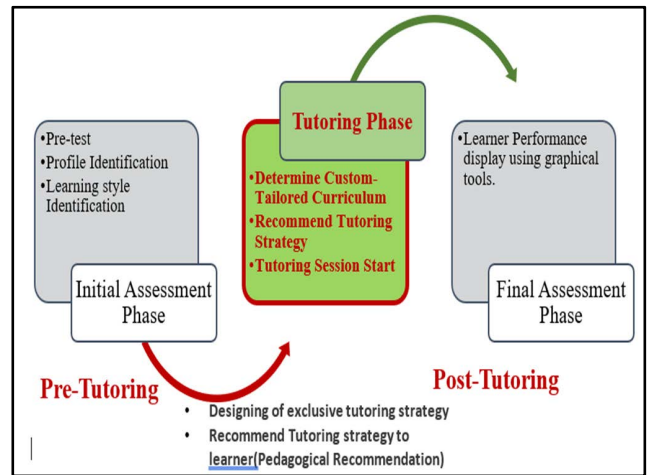


FIGURE 6. Schematic flow diagram of proposed ITS.

misconceptions, etc. [20], [32]. This model also gauged the learner activity throughout the learning session (i.e., time spent on learning topics, competency level, correct answer, hint taken, number of questions attempted, etc.) [21].

3) DOMAIN/KNOWLEDGE MODEL

This model contains the learning material to be taught to the learner via the learner interface [22]. This model contains the learning material designed by the knowledge experts, which further used by the ITS to offer the learning material to the learner [30], [31].

4) TUTORING/PEDAGOGY MODEL

This model is responsible for making the strategic decision based on the learner activity, instructional strategies, and learner information captured by the domain and learner model. This model is responsible for determining the pedagogy for the learner [23].

The developed system is christened as ‘SeisTutor.’ A detailed conceptual design of this system, eliciting its components, functionalities, workflow, and marking of various points where intelligent decision-making is integrated, has been designed. Fig. 6 presents the conceptual design of Seis-Tutor, under three phases. Presently, the SeisTutor is designed to work with three kinds of Learning Profiles (‘Beginner,’ ‘Intermediate,’ ‘Expert’) and four Learning Styles (‘Intuitive,’ ‘Imagistic,’ ‘Active,’ ‘Acoustic’). A combination of one learning style and one learner level is represented

as one pedagogy style. Thus, twelve pedagogy styles are in the current scope of the proposed work. Fig. 5 presents the architecture of traditional ITS. This section presents a detailed methodology for identifying learners' profiles and tutoring progress accordingly.

The execution is depicted in different phases. The pre-tutoring phase, also termed the Initial Assessment phase, is detailed below.

Firstly, the learner is put through a pretest, which provides a set of questions under two tests – domain knowledge test and learning style test. The learning style test comprises 18 questions, and this set is referred to as 'Learning Style Question Pool' in this text.

The outcome of the pretest acts as an input for the 'Learning Style' and 'Prior-Knowledge level' identification task of the Pre-Tutoring phase. The questions asked in the pre-tutoring phase are internally mapped to available Learning Styles and Pre-Knowledge Levels. Accordingly, by the end of the first phase, after the learner has taken the tests, SeisTutor determines the most appropriate Learning Style and learner Prior-Knowledge Level combination that is made available as a pedagogy style.

Presented below is an example describing the process of pretest results, determining tutoring strategy.

Assuming learner's learning style test score is: Imagistic = 9, Acoustic = 3, Intuitive = 5, Active = 8 and the learner level score is Beginner = 9, Intermediate = 4, and Expert = 7. Considering both the test scores in increasing order, a list of pedagogy styles is listed and maintained by SeisTutor as a priority queue. For example, in this pretest case, the following pedagogy styles have been listed Priority-wise: {(Imagistic-Beginner, 1), (Active-Beginner, 2), (Intuitive-Beginner, 3) and (Acoustic-Beginner, 4)}. Similarly, beyond the highest scores of 'Imagistic' and 'Beginner,' further combinations of the next highest scores of Learning Styles and Levels are listed and maintained. In this pretest case, the learner appears to be more of a 'Beginner' in terms of level and having a higher preference for 'Imagistic' learning style than any other styles, hence 'Beginner + Imagistic' tutoring strategy is identified, to be executed for him/ her.

The Second Phase is the Tutoring Phase. In this phase, based on previous knowledge adjudged in the pretest, SeisTutor determines the custom-tailored curriculum, which is exclusively designed for a learner. Each learner receives a different alignment of learning content based on his/her previous knowledge[26]–[29], [33]–[36], [54].

The combination of determining curriculum and the adjudged pedagogy style become a tutoring strategy. The learner gets started with the tutoring session, as per the initially identified tutoring strategy, and learner activities are captured. Activities include recording and analysis of psychological and non-psychological parameters. Learner Psychological parameters are the emotions during the ongoing tutoring sessions. In contrast, non-psychological parameters are the performance in the week-wise assessment, computed through 'number of question attempts, number of correct

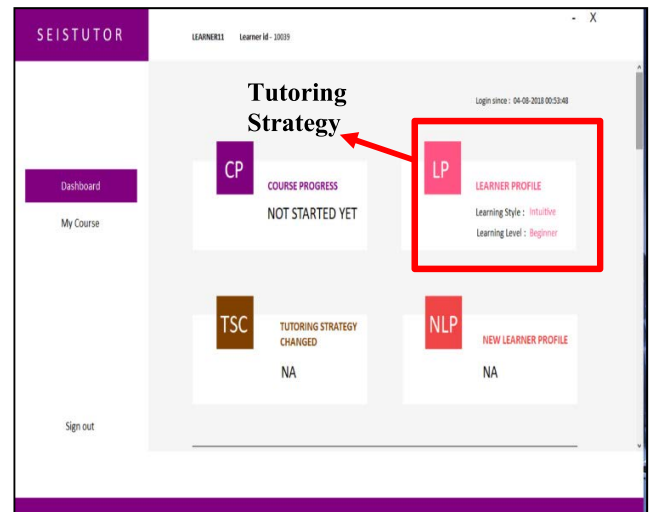


FIGURE 7. Learner dashboard after pretest.

answers, number of hints taken and time taken.' At the end of each week, one checkpoint is incorporated that offers to change tutoring strategy (in a user-driven or system-driven manner), bringing in adaptation features. The tutoring strategy gets changed only once during the entire tutoring session. Thus, the decision to change pedagogy through the change of tutoring strategy (choosing the next tutoring strategy in the priority queue) is based on learner comfort adjudged through performance parameters of the learner during the tutoring session.

Performance parameters play a vital role in understanding the learner's comfort level. Fig. 7 represents the learner dashboard.

The SeisTutor mimics the behavior of the human tutor. During ongoing tutoring based on numeric (quantitative) performance parameters, quantitative values such as the degree of engagement and learning gain are being determined and dynamically (in real-time) used to trigger the change of the tutoring strategy (if applicable).

5) INTELLIGENCE INCORPORATED IN SEISTUTOR

a: DEDUCING TUTORING STRATEGY

This mechanism is implemented using one of the soft computing techniques of Artificial Intelligence, the 'fuzzy logic.' This code snippet accepts an individual learner's Pre-Knowledge level and Learning Style and generates the best suitable tutoring strategy exclusive for that learner. Fig. 7 indicates the initially adjudged tutoring strategy.

b: TRIGGER TO CHANGE PEDAGOGY

The tutoring sessions are planned and executed in a week-wise pattern. After every week, the checkpoint has been incorporated into the system to change tutoring strategy once during the entire tutoring session. The checkpoint is a point at which the learner's comfort level is assessed by monitoring non-psychological parameters. A learner's comfort level going below a pre-defined threshold is a trigger for the

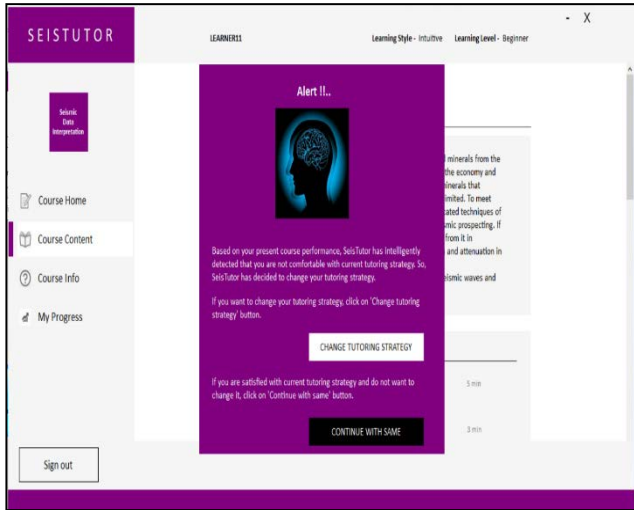


FIGURE 8. Alert to change the tutoring strategy.

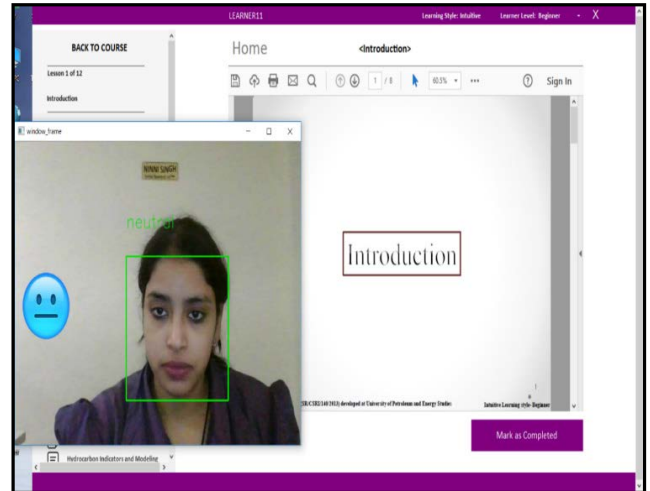


FIGURE 10. Emotion recognition during the tutoring session.

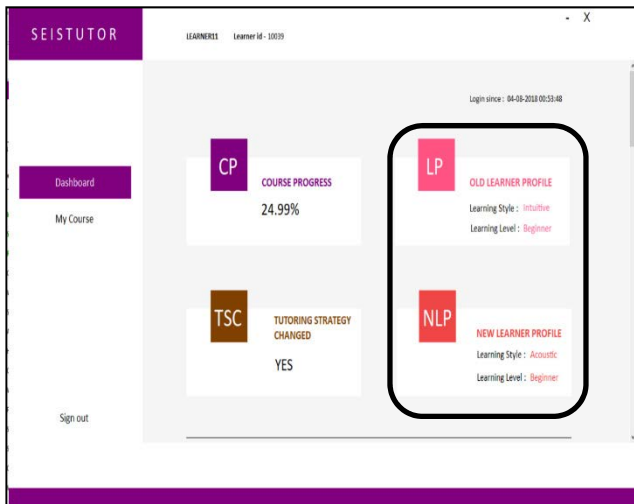


FIGURE 9. Tutoring Strategy change from 'Intuitive' to 'Acoustic'.

tutoring system to recommend changing tutoring strategy for the learner.

This part of the computation of non-psychological parameters and their comparison with the pre-defined threshold for implementing the change of pedagogy for the learner is implemented (fuzzy logic). The screen is shown in Fig. 8 and 9.

c: DETERMINING PSYCHOLOGICAL PARAMETERS THROUGH EMOTION RECOGNITION

This mechanism has been implemented using Machine Learning Techniques of Artificial Intelligence. This code snippet accepts input, an individual learner’s snap during the ongoing tutoring session, and recognizes the psychological states (“Happy,” “Sad,” “angry,” “surprise,” “fear,” “disgust”). Then, these states are displayed along with the learner’s progress. While currently, the recognized psychological states are just being used to keep track of learner

emotions during the ongoing tutoring, a progressive step that could be implemented further is to use them for recommending the pedagogy change for the learner. This is expected to lead to finetune the choice of tutoring strategy. This step is in the direction of building empathy in the ITS. Fig. 10 shows emotion recognition during an ongoing tutoring session.

d: CUSTOM TAILORED CURRICULUM SEQUENCING (CTCS)

Under the current scope of work, adaptive tutoring implementation is done using learners ’knowledge level’ ’learning style,’ and a curriculum is offered as per the adjudged tutoring strategy. Additionally, a feature of the custom-tailored curriculum has been implemented and made available to the learner based on the ’Bug Model’ mechanism. In this mechanism, the learner prior knowledge tested through the domain knowledge test yields a specific set of topics/subtopics that the learner may not have been comfortable with, evident through poor performance in answering the questions associated with them (termed as bugs). A customized curriculum specific to the learner is designed and offered using this information. This custom-tailored curriculum has been implemented through a customized delivery plan of a sequence of topics and sub-topics, available alternatively for the learner, and the standard curriculum presented as per the tutoring strategy. Each of the domain knowledge test questions is internally mapped with specific topics/sub-topics. Hence the custom-tailored curriculum is designed by including only those topics/ subtopics for which the questions answered by the learner have been incorrect and excludes all those topics/subtopics for which the responses of the questions have been correct. Thus, the learner gets an opportunity to undergo learning in a manner where he/she can concentrate specifically on topics that are not comfortable and need more preparation[55], [56].

Fig. 11 indicates the custom-tailored curriculum exclusively designed for the learner.

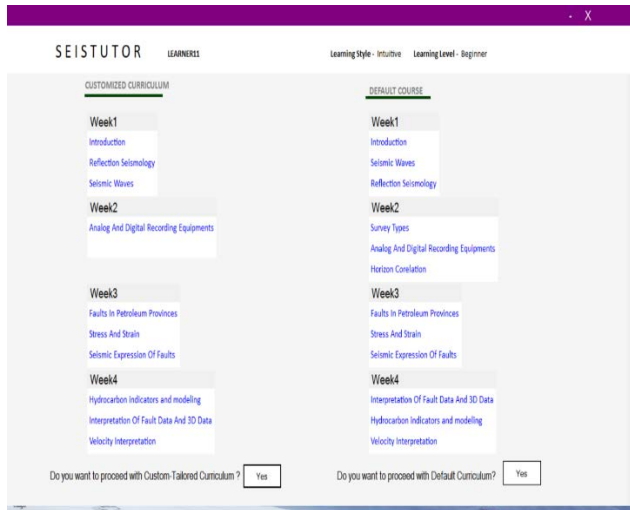


FIGURE 11. Custom-Tailored Curriculum offered to the learner.

TABLE 1. Parameter used to attain an adaptive tutoring system.

Adaptive Intelligent Tutoring System (curriculum system)	Learning Profile (Level)	Learning Style (Prefer mode of learning)	Other parameters (Interactive GUI, Feedback, navigation, modality, language, learning goal)
ABITS	✓	✓	✓
ADAM	✓	✗	✓
Aha	✗	✗	✓
APeLS	✓	✓	✓
CRS	✓	✗	✗
ELM-ART	✓	✗	✓
INSPIRE	✓	✓	✓
KBS Hyperbook	✓	✗	✓
Logic Tutor	✓	✗	✗
MASPLANG	✓	✓	✓
MATHEMA	✓	✓	✓
PWIS	✓	✗	✗
RLATES	✓	✗	✓
WLOG	✗	✗	✓

e: ARTIFICIAL INTELLIGENCE INCORPORATED INTELLIGENT TUTORING SYSTEM

Table 1 shows the pilot study over learner’s utilized course coverage sequencing frameworks attributes. 87 % of course coverage sequencing framework used learner profile (level), 73% used different modalities to offer adaptive learning, 40% used learning style (i.e., prefer mode of learning), and 26% used all amalgamation.

The scope of this research work is to implement adaptive learning by using learner’s ‘Learning Style’ ‘Learning Level,’ and a course coverage plan is recommended as per determined tutoring strategy.

IV. RESULTS AND DISCUSSIONS

This section illustrates the comparative analysis of the tutoring mentioned above with the proposed tutoring system,

TABLE 2. Parameters definition.

PARAMETERS	DESCRIPTION
INTERACTIVE GUI	Look and feel of learner interface. Learner interface is designed in such a manner that learner gets a complete picture of the system and also offer functionality without any ambiguity.
LEARNER LEARNING STYLE	Learner learning styles are learner’s mode of learning. From the literature, it has been observed that learner overall performance is improved if he/she learned as per his/her preferred mode of learning.
LEARNER LEARNING LEVEL	The learner learning level is the previous knowledge of a subject domain. For this scope of research Seismic data Interpretation is taken as a subject domain.
ADAPTIVITY TO DETERMINE PEDAGOGY STYLE	It is a style, based on which learning content is offered by the tutoring system. It is the style that best suits the learner’s learning preferences.
CUSTOM-TAILORED CURRICULUM	The system determines the learner’s previous knowledge and determines the curriculum which is exclusively designed for the learner. Each learner receives a different curriculum based on his/her previous learner.
LEARNER PRE-TEST	Test which has been conducted before the learning session begins.
LEARNER POST-TEST	Test which has been conducted when the learning session ends
LEARNER PSYCHOLOGICAL STATE DURING ONGOING SESSION	Determining the learner’s emotional state of mind during learning.
PASSIVE LEARNING CONTENTS	The predefined set of the frame has been offered to learner. Each learner receives the same set of learning content during the learning session.
HANDLE LEARNER PROBLEM DURING THE SESSION	Based on the learner, activity observes learner issues during the ongoing learning session and provide necessary guidance at runtime.
OTHER PARAMETERS (NAVIGATION, MODALITY, LANGUAGE, LEARNING GOAL)	Navigation around the developed system is important because it helps the learner to find and access necessary information easily and quickly.
LEARNER FEEDBACK	The tutoring system captures learner valuable feedbacks after completion of the learning session.

i.e., SeisTutor. Here the comparison is based on the functionality of the tutoring system listed in table 2 and table 3. A total of 28 learners are registered themselves for learning subject “Seismic Data Interpretation.” Teachable, Course-Builder, My-Moodle, and SeisTutor, were evaluated by the same set of 28 learners.

Feedback is ranked under three categories, i.e., strongly dissatisfied, neutral, and strongly satisfied. Neutral indicates that the learner is in an ambiguous situation and can strongly mark their experience with the system. Strongly dis-satisfied indicates that the learner is not satisfied with the feature experienced by the learner during the learning session. Strongly satisfied indicates that the learner is satisfied with the feature experienced by the learner during the learning session.

TABLE 3. Summary of exiting tutoring system.

	Parameters	My Moodle (LMS)	Course Builder	Teachable	SeisTutor
GUI Based	Interactive GUI	Yes	Yes	Yes	Yes
Learner Adaptivity and Personalization	Learner Learning Style	No	No	No	Yes
	Learner Learning Level	No	No	No	Yes
Dynamic Profiling	Adaptivity to determine Pedagogy Style	No	No	No	Yes
	Custom-Tailored Curriculum	No	Separate course tracks features are there but they are not customized. They are pre-decided by the administrator based on advance and basic courses opted by the learner.	No	Yes
Learning Content	Learner Pre-Test	No	No	No	Yes
	Learner Post-Test	No	No	No	Yes
	Learner Psychological State during Ongoing Session	No	No	No	Yes
Resolving Learner Query during Session	Handle Learner Problem during the session	Yes	Yes	Yes	No
Navigation Support	Other parameters (navigation, modality, language, learning goal)	Yes	Yes	Yes	Yes
Learner Feedback	Learner Feedback	Yes	Yes	Yes	Yes

TABLE 4. Analysis of responses of Learner feedback questionnaire: My-Moodle.

Parameters	Strongly-Dissatisfied (%)	Neutral (%)	Strongly-Satisfied (%)
GUI Based	21	32	47
Learner Adaptivity and Personalization	64.8	21	14.2
Dynamic Profiling	63.33	6	30.67
Learning Content	68	18	14
Resolving Query during the session	75	11	14
Navigation support	21	29	50
Learner feedback	4	11	85
Cumulative Percentage (%)	45.31	18.29	36.41

TABLE 5. Analysis of responses of learner feedback questionnaire: Course-Builder.

Parameters	Strongly-Dissatisfied (%)	Neutral (%)	Strongly-Satisfied (%)
GUI Based	21	29	50
Learner Adaptivity and Personalization	76.6	14.2	9.2
Dynamic Profiling	57.33	14	28.67
Learning Content	71	4	25
Resolving Query during the session	57	7	36
Navigation support	36	11	53
Learner feedback	39	11	50
Cumulative Percentage (%)	51.13	12.89	35.98

TABLE 6. Analysis of responses of learner feedback questionnaire: Teachable.

Parameters	Strongly-Dissatisfied (%)	Neutral (%)	Strongly-Satisfied (%)
GUI Based	4	39	57
Learner Adaptivity and Personalization	70.6	19.4	10
Dynamic Profiling	63.33	12	24.67
Learning Content	82	11	7
Resolving Query during the session	50	4	46
Navigation support	25	14	61
Learner feedback	25	11	64
Cumulative Percentage (%)	45.70	15.77	38.52

Each tutoring, as mentioned above system is tested upon 28 learners, and their valuable feedback is gauged. Learners can give their feedback ranges from 5 points Likert scale of 1-5. Table 2, Table 3, Table 4, and Table 5 indicate

TABLE 7. Analysis of responses of learner feedback questionnaire: SeisTutor.

Parameters	Strongly-Dissatisfied (%)	Neutral (%)	Strongly-Satisfied (%)
GUI Based	18	11	71
Learner Adaptivity and Personalization	4	14	82
Dynamic Profiling	6	10.8	83.2
Learning Content	10.33	12	77.67
Resolving Query during the session	18	14	68
Navigation support	21	11	68
Learner feedback	21	14	65
Cumulative Percentage (%)	14.05	12.4	73.55

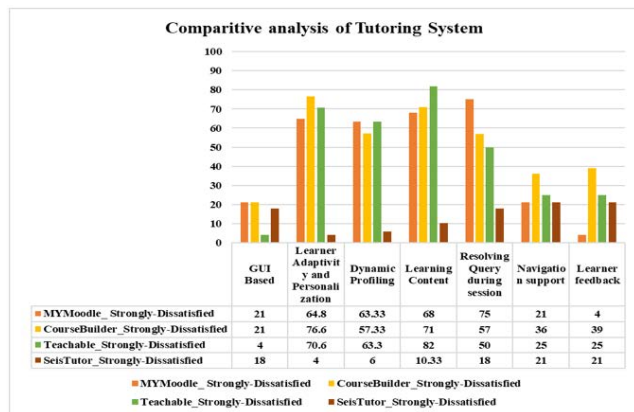


FIGURE 12. Comparative study of existing tutoring system with SeisTutor on Strongly Dis-satisfaction level.

the Analysis of Learner feedback questionnaire responses for My-Moodle, Course-Builder, Teachable, and SeisTutor, respectively.

Fig. 12, Fig. 13, and Fig. 14 demonstrate the comparative analysis of the tutoring as mentioned above system with SeisTutor based on strongly Dis-satisfaction, Neutral, and strongly Satisfaction levels. From fig. 12 and table 4, 5, 6, and 7, one can deduce that only 14.05 % of learners are strongly dissatisfied with Seis Tutor, while this percentage increases to 51.13 % with course builder. Fig. 13 and Table 4, 5, 6, and 7 conclude that with Seis Tutor, only 12.4 % of learners are neutral, while with My-Moodle, this percentage increased to 18.29 %. From Fig. 14 and table 4, 5, 6, and 7, one can strongly deduce that 73.55 % of the learner is more strongly satisfied with the Seis Tutor, while with Course Builder, only 35.98 % of learners are strongly satisfied.

The conclusion drawn from this analysis is that all the tutoring as mentioned above system lacks adaptivity, dynamic

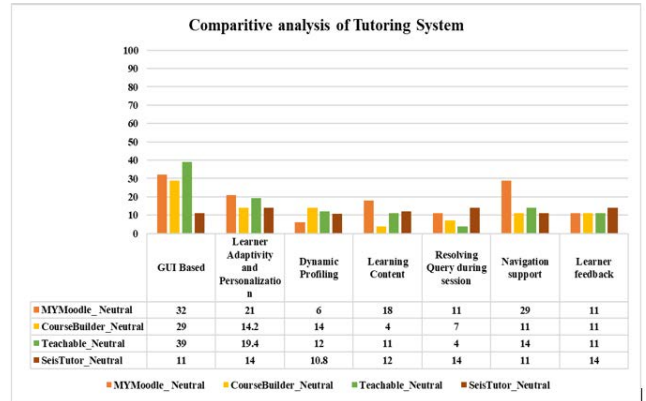


FIGURE 13. Comparative study of existing tutoring system with SeisTutor on strongly neutral level.

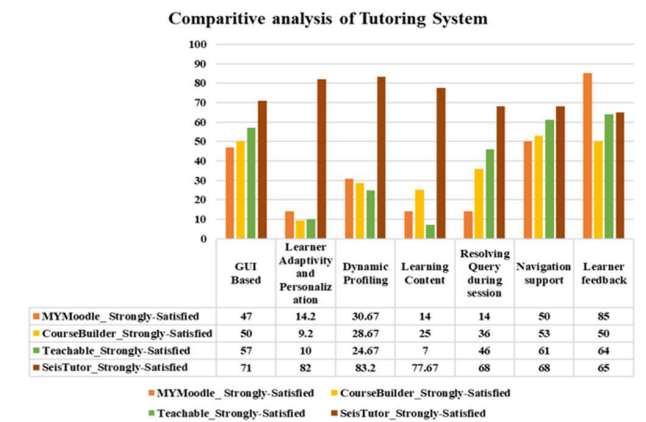


FIGURE 14. Comparative study of existing tutoring system with SeisTutor on strongly satisfaction level.

profiling, and personalization features. The key feature of Seis Tutor is personalization, adaptivity, and dynamic profiling. From this comparative analysis, 73.55 % are strongly satisfied with the artificial intelligence features such as determining custom-tailored pedagogy styles, curriculum based on prior knowledge, and dynamic profiling during the learning session.

V. CONCLUSION

The architecture of the proposed intelligent tutoring system, i.e., Seis Tutor, has been detailed. The objective of the e-learning and intelligent tutoring system is to emulate human cognitive intelligence; Human tutor in classroom teaching uses their cognitive intelligence to deliver suitable content. Thus, cognitive intelligence (adaptivity and personalization) has been incorporated into Seis Tutor. This exercise evaluates the proposed Seis Tutor with the existing tutoring system. From the analysis, it has been deduced that 73.55 % of learners are strongly satisfied with the artificial intelligence features such as determining custom-tailored pedagogy styles, curriculum based on prior knowledge, and dynamic profiling during the learning session in the Seis Tutor. However, there

is a lack of empathy in ITS. During class teaching, the human gives various examples and changes the pedagogy styles based on observing and understanding the learner's psychological and facial expression. Thus, incorporating this kind of human intelligence in ITS is one of the major bottlenecks and is considered a future research area in e-learning/ ITS.

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