CHAPTER 4

AI TECHNOLOGY IN RELATION TO ELT PEDAGOGY

This chapter envisages a controversy concerning the pivotal role played by a teacher in a conventional classroom. The theories, principles and methods of English language teaching have all along been evolving to cope with more suitable strategies of teaching, drawing inspiration from various disciplines such as psychology, sociology and technology, always focusing on the role of a teacher and his implementation of the pedagogical devices. Communicative Language Teaching which emerged as a popular trend in language teaching relegated the teacher to the background. The teacher was no more the centre of the class and the introduction of computer assistance has made his role even more subsidiary. Hence, integrating technology and pedagogy discarding the human teacher became a controversial issue because the study and theory of the principles and methods of teaching have always centered around the teacher. In this correlational study, pedagogy and technology are being related to meet on certain common grounds.

The objective of this chapter which is a study in relatedness is to find out ways and means of exploiting computer techniques and more particularly AI techniques for its application to the methods of teaching and learning English. Exploiting is the keyword here because once the activity of exploiting the techniques is done, the result of imparting learning takes place more effectively than expected of the conventional classroom learning.
The role of Artificial Intelligence in enhancing the learning and teaching abilities is of great significance to the world of education in general. "Artificial Intelligence research stimulates understanding of the brain just as understanding of the brain stimulates progress in artificial intelligence. As our understanding of the development of the brain increase so will our understanding of the processes which children undergo as they learn. Undoubtedly, the expanding use of computers as a learning aid will provide new insights into the learning process and will, by early in the next century, increase the efficiency of the learning process to undreamed of levels"\textsuperscript{1}.

The increase in efficiency envisaged depends on the essential difference between "ordinary" CALL and ICALL. "Whereas ordinary CAL is an automated version of a programmed learning text, albeit with the potential for a much better human interface, ICAL is intended to be adaptive"\textsuperscript{2}. A good ICALL system should possess the following characteristics in order to contribute to the net result of an ideal curriculum design.

1. It must be able to model the pattern of the students' responses in some way.
2. It must be able to reason about the knowledge regarding the subject it is trying to teach.
3. It must allow for flexibility in the interaction between the student and the system.

\textsuperscript{1} Tom Stonier and Cathy Conlin, \textit{The Three Cs: Children, Computers and Communication} (Chichester: John Wiley, 1985) p.48.
Because an ICALL program has the above mentioned abilities, it has the potentials of a very good teacher. It is desirable that computers understand the students' mistakes and not just react to them. "Computer should act as Super Books"3. When students are stranded not knowing how to seek explanation or an answer to a problem they confront while learning from CALL programs, it is believed that AI will come to the rescue and supply intelligent help system to deal with students' problems. Intelligence is defined here as "not simply that the system understood the subject area, but also that it 'knew' about the students (past scores, learning preferences etc., and also knew about how to teach, that is, how to explain points, organise special practice etc). But Cameron is quick to point out that "the contribution of the teacher to language learning is a complex, varied and subtle (and cheap) as to make take over by Intelligent Tutoring Systems unlikely for the foreseeable future"4. Thus though AI is expected to offer intelligent help to stranded learners, how far AI can go in its taking over from the teacher is hard to forecast.

It is not without reason that such views have been expressed. With the invention of LOGO by Seymour Papert at M.I.T., U.S.A. in 1967 influenced by the psychological theories of Piaget, expectations arose in academic circles that intelligence could be simulated using machines that could think. The development of LOGO is the earliest work of AI education based research which allows the learner to learn from the program and give instructions to the machine. This paved the way for a reversal in roles. It bridged the gap between the two opposing tendencies of "the computer


programming the child" and "the child programming the computer"\(^5\). Today most of the child centred work is governed by the methods of AI as it provides more learner freedom and autonomy.

4.1 **AI CONCEPTS RELATED TO ELT PEDAGOGY**

An important method common to ELT pedagogy and AI technology is programmed instruction. Programmed Instruction, a pedagogical practice during the fifties and sixties of this century in the US was based on Skinner's Behaviourist theory which affirmed that more effective control of behaviour can be achieved using contingencies of reinforcement. Reinforcement of 'correct behaviour' was an important factor as also feedback. This practice which was held in high esteem in ELT curriculum had its direct impact on the use of computers in education.

Programmed Instruction involved a sequence of teaching frames very much like Skinner's very complex sequences of schedules. The instructions were built in step by step. Programmed Instruction was based on six principles which adhered to Skinner's principles of learning. The following table gives the salient features of similarities between the principles of Skinner and the practices of Programmed Instruction.

Table 4.1
Comparison of Skinner's Principles and Programmed Instruction

<table>
<thead>
<tr>
<th>Skinner's Principles</th>
<th>Principles of Programmed Instruction</th>
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</thead>
<tbody>
<tr>
<td>1 'content' must be divided into small 'units' of information as it ensures a maximum number of reinforcement.</td>
<td>step by step presentation of learning units</td>
</tr>
<tr>
<td>2 the learner should work on each 'unit' with the help of exercises provided to learn the unit.</td>
<td>active learner participation</td>
</tr>
<tr>
<td>3 the exercises in each unit should be so designed as to lead the learner to success invariably, it is on his 'success' at every stage that he gets a reward, if there are chances of making errors the learner may not get a single reward for quite some time and his interest shall fade out.</td>
<td>success at every step so as to ensure reinforcements (rewards)</td>
</tr>
<tr>
<td>4 to ensure satisfaction and success the learner must know whether his action is correct, there must be immediate verification of learner activities.</td>
<td>immediate verification of learner activities</td>
</tr>
<tr>
<td>5 as learning progresses logically, the progress has to be graded by avoiding all superfluous elements even the most complex types of behaviour can be elicited by leading the learner from the simple to the complex logically.</td>
<td>logical and graded progress</td>
</tr>
<tr>
<td>6 the learner should be allowed to work at his own pace. This suggests the significance of individualised instruction.</td>
<td>'individual pace'</td>
</tr>
</tbody>
</table>
CALL thus had its roots in Programmed Instruction in which the student's response to each step received instant feedback. The branching facility allowed a slow learner who had difficulty with the lesson to go back and relearn or move to a different frame where the learning was made more explicit and easy. A quick learner on the other hand could progress to the next lesson. This kind of instruction was a great advantage given the heterogeneous nature of a class where a bright student often felt bogged down by a slow learner or a slow learner could not cope with the pace of a quick learner. Consequently, individualisation of learning in Programmed Instruction brought a revolutionary change in pedagogy yielding scope for CALL users to achieve learning progress and learner autonomy. It is thus no exaggeration to say that CAL has had its roots in programmed instruction. There exists an intense relationship between the pedagogic value of Skinner's Behaviouristic approach to program instruction and the CAL technique. But, Kenning and Kenning state that the computer is only an instructional medium and is not to be tied to any teaching approach in particular and that it should not be equated with Skinnerian programmed instruction. Hainline contradicts this view reaffirming that the evolution of CAL is the evolution of programmed instruction. Though CALL cannot be equated with Skinner's Behaviourist principles it cannot be denied that programmed instruction has its roots in Behaviourism.

Early programmed instruction suffered from "the strictly Skinnerian poverty" of replicating drill and practice programs. The lack of ingenuity in the preparation of Computer Assisted Instruction material begged for the


entry of AI as early CAI programs did not have anything by way of intelligence.

One of the most common applications of the computer as a Tutor is in drill and practice. Drill and practice involves any exercise, physical or mental, which is performed regularly and with constant repetition. It is often associated with rote-memory learning\(^8\). Though many educational computer programs are criticized for being mere drill and practice routines, the value of drill and practice as an effective method for learning cannot be ruled out. The automaticity of learning is promoted by drill and practice. To perform complex tasks like reading efficiently, performance of lower-level subskills must become automatic. In fact this practice which is condemned as routine and dull in a classroom situation is likely to become the most effective in the ICALL situation involving Intelligent Tutoring Systems.

Drill and practice programs which were very popular in the early stages of ELT evolution found a surer and surer stay in CAL when it first made its mark. Instructions given in the program formed the stimulus and the user provided the response by choosing the correct answer. The need for focus on the learner's difficulties, especially when the learner keyed in an incorrect response and lack of provision in the computer program to be more encouraging and sympathetic towards the learner caught the teacher's and programmer's attention.

The application of Intelligent Tutoring Systems have an important role to play to the teaching of language using drill and practice methods. The applicability of ITS to teaching and learning has been discussed in the previous chapter.

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The basic idea underlying programmed, step by step learning and the drilling practice lies in the steady development of cognitive learning. That the learner learns by doing, corrects himself, moves forward to the next stage of progress, are all determined by his reasoning abilities and his strategies for learning. Nobody can dispute that these methods of ELT have a strong logical foundation.

It is universally accepted that English as a language is illogical. But linguists have employed logic as a method to explain and describe the illogics of the language. The teaching of English based on rules is used for explaining those aspects of language as grammar, syntax and spelling. Teachers have resorted to rules to describe exceptions. To understand the discrepancies and exceptions of the language, logic is found to be essential. Great pathways in the teaching and learning of English can be achieved if all the rules of English can be described explicitly and exhaustively using logic. Though it must be admitted that this is not possible, the role of logic as a formalism will be the most important tool to describe and teach English.

The use of logic as a tool for the analysis of meaning is perhaps the least controversial application of logic to Artificial Intelligence\(^9\). It is expected that "logic programming literacy" will become widespread in the coming years. The major application of logic to Artificial Intelligence is to use logic as a knowledge representation formalism. Just as it is a truism to say that for a system to be intelligent, it must have knowledge, it is a truism to say that a problem solving system must have logic. Developing problem solving skills as part of language learning ought to be encouraged by the teaching fraternity because, "teachers are educators as well as

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subject specialists and therefore have a measure of responsibility for the development of the whole child, not just his or her language skills\textsuperscript{10}. And to develop the problem solving skills of learners it may be claimed that Artificial Intelligence systems are most suitable and logic is the obvious choice as formalism to promote thinking. To establish a systematic relationship between form and meaning, logic is essential. Logic can be used as a knowledge representation and reasoning system. To teach aspects like grammar in language studies too, logic as a representation of knowledge would be most useful and appropriate.

In the world of fifth generation computers, the term Knowledge Based System assumes great significance. Knowledge Based Systems are Cognitive Systems which can be seen in a new light as "computer based systems which support or perform automatically, cognitive tasks in a narrow problem domain, which is usually only carried out by human experts. Human experts perform these tasks by employing personal skills, expertise and judgement acquired and learnt over a period of time. By cognitive tasks, we mean tasks whose successful completion requires knowledge and/or expertise which are not accessible in any other organised external form\textsuperscript{11}. Though ICALL and KBS can be classified as two separate areas of Artificial Intelligence, for the purposes of this study, KBS has a vital role to play in developing ICALL programs for teaching and learning English.


Artificial Intelligence systems are built on knowledge because intelligence requires knowledge. Artificial Intelligence systems exploit knowledge that should be represented in such a way that\footnote{Elaine Rich and Kevin Knight, Artificial Intelligence 2nd ed (New Delhi: Tata McGraw Hill, 1983) p.109.}

1. the knowledge captures generalisations
2. the knowledge can be understood by those who must provide it
3. the knowledge is modifiable to correct errors and to make changes with changing time
4. the knowledge can be used in many other situations
5. the knowledge can be narrowed down for specific considerations.

How natural language is represented as knowledge is crucial to the processing of natural language. Knowledge in AI systems is represented as facts and as relationships between facts. There are five ways in which knowledge can be represented

1. through semantic networks
2. through object-attribute-value triplets
3. through rules
4. through frames
5. through logical expressions

All these representations are exploitable for language learning depending upon the nature of the text to be presented and the aspect of language learning to be taught.
An important development in the present day English Language Teaching methodology is its emphasis on teaching through interaction. While discouraging the lecture method it has encouraged interaction by allowing them to communicate freely among themselves and with the teacher. The teacher is expected to play the role of facilitator, communicator, monitor thus facilitating interactive learning within the classroom. It is here that the human factor scores over the machine and it is believed that a machine can never be expected to duplicate the role of a teacher entirely as far as enabling interaction is concerned. At its early stages, the criticism faced by CALL programs was that they were merely reactive and not interactive. But successive developments that occurred from CALL to ICALL made the interaction possible. For an ICALL program to be truly interactive as against the merely 'reactive' CALL programs\(^{13}\), Feigenbaum's formulations of a KBS can be abided by\(^{14}\). These formulations have been explained relating each of Feigenbaum's formulations to aspects of language learning for the sake of this study.

1. The knowledge must be domain specific i.e., only one aspect of language learning should be concentrated upon. For example, a KBS for teaching sentence structures should not be mixed with a KBS for teaching vocabulary. Knowledge by being domain specific facilitates easy organisation and search.

2. The knowledge base must be flexible providing ample opportunities for modification. A flexible knowledge base helps in updating the

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knowledge by adding, deleting or changing the content of the knowledge according to the requirements of the study.

3. All knowledge should have a clear line of reasoning. For example an ICALL program to teach the use of articles in a sentence is obviously rule based. Presenting this knowledge with a clear line of reasoning using explicit rules will aid the teacher and the learner.

4. The line of reasoning for representing knowledge should have the facility to be integrated from many sources.

5. Facility for explanation is the most important component of any ICALL program using a KBS, only by this facility can we come close to imitating the interaction provided by the teacher.

To provide explanations, a sound instructional strategy is essential. For example, rule-oriented instruction can be one of the many strategies for teaching aided with explanation facility. Given below is a suggested method\textsuperscript{15}.

1. Present a verbal statement or other representation of the rule.
2. Demonstrate the rule by applying it to several divergent example problems.
3. Provide several opportunities for students to practice using the rule to solve previously unencountered problems.

4. Provide corrective feedback. When an error occurs, show the student how the problems can be used using the rule.

By applying the proposed suggestions to say, rules of English grammar we can develop ITS promoting interactive learning. Thus, the interactive method about which doubts were expressed regarding its use in AI technology can also be made possible. The focus of AI based education research is on developing intelligent teaching systems that can interact with learners.

The functions of knowledge based systems in ICALL are multifarious. It can take on roles of intelligent help, assessor, advisor and tutor.

**KBS as intelligent help** - for example a program called Question and Answer (Q & A) available for sale in India has an intelligent help text which acts as an explanatory assistant to the user. Q & A can be used in a classroom situation to create a data base using natural language enquiry.

**KBS as assessor** - can be employed to assess the learner's performance at the end of an ICALL task. The KBS can be so designed as to comment on the learners' performance based on correctness, accuracy, common errors etc.

**KBS as advisor** - can offer advice to the learner about ways of improving his learning based on the information keyed in by him.

**KBS as tutor** - can actually teach the learner a particular aspect of a language skill according to the instructions in the program.
Expert systems are KBS that mimic the performance of many human experts put together and can be used effectively for language teaching.

4.2 CHARACTERISTICS OF AI LANGUAGES SUITABLE FOR CALL

The application of AI to CALL is at a crossroads. Much CALL material has been constructed using BASIC, Wordstar etc. Much has also been written about the futility of BASIC and its undesirable flirtation with drill and practice as a tutoring method. Lack of ingenuity in programming is not the fault of the programming language alone but BASIC had some disadvantages like lack of structure, slowness in reacting and limited memory of the machine in which it worked.

In the area of AI the choice of programming oscillates between LISP and PROLOG. They are both declarative languages. Both LISP and PROLOG are adept at handling strings. AI programming being predominantly logic programming uses the declarative approach to state the problem explicitly and descriptively. A declarative representation of a fact is an assertion that the fact is true.

Knowledge engineering is the process of acquiring specific-domain knowledge and building it into the knowledge base. There is appreciable difference in the knowledge engineering of AI and conventional programming. To work with programs in non AI languages, only those with a knowledge of programming can understand the workings of the program. It is not possible for a layman to stop the program midway and question why and how the program works the way it works. This rather deters the inquisitive learner. On the other hand, the more interactive knowledge based system provides the learner with ample opportunities to question the
line of reasoning at any stage. Using Knowledge Based Systems it is possible to give plausible suggestions rather than making a clear distinction between correct and incorrect judgements. Also, unlike in a conventional CALL program, it is possible to read and modify the knowledge base of an Expert System. Knowledge based systems are based on heuristics.

AI programs are more interactive in nature by being able to provide options (like in INVESTIGATOR, an ICALL program discussed in the next chapter). Providing options makes the task challenging and enjoyable and greatly motivates the learners.

There are several programs that can handle natural language queries in English. Continued research in the development of programs that can process and understand English is a definite boost to the speedy implementation of an ICALL curriculum. Natural Language Processing, another area of AI holds promise for building a natural language user interface. This can improve language learning manifold by psychologically eliminating the anxiety and fear of teachers and learners of their ignorance of programming for example, an AI program INTELLECT can enter into a natural language dialogue with the user16. LIFER is another program with a restricted semantic universe confined to the world of ships17. The advantage of natural language for beginners is that it gives them the confidence to use the computer moderately well.


Another significant aspect of Artificial Intelligence to be exploited for the benefit of ICALL is Artificial Intelligence's ability to **learn from examples and precedents**. This can be illustrated by citing the following example. A program by Winston meant for reading interpretation, deals with a precedent captured by the following description\(^\text{18}\).

This is a story about Macbeth, Lady Macbeth, Duncan, and Macduff. Macbeth is an evil noble. Lady Macbeth is a greedy, ambitious woman. Duncan is a king. Macduff is a noble. Lady Macbeth persuades Macbeth to want to be king because she is greedy. She is able to influence him because he is married to her and because he is weak. Macbeth murders Duncan with a knife. Macbeth murders Duncan because Macbeth wants to be king and because he is evil. Lady Macbeth kills herself. Macduff is angry. Macduff kills Macbeth because Macbeth murdered Duncan and because Macduff is loyal to Duncan.

Winston then gives an exercise in which there is a similar story about a weak noble and a greedy lady. The lady is married to the noble. The exercise needs to show that the noble may want to be king. Winston says that the program forms its own rule on the basis that a nobleman's weakness and his wife's greed can be the cause for his wanting to be king. This is an example of pattern matching where based on one set of rules many patterns of the same can be created. Concentrated effort in this field can allay the allegation against AI research that there is never any attempt to globalise the problem and apply it to similar situations.

It may be observed that the story is from literature. Understanding of the plot of the story can be enhanced by programs similar to Winston's. This also contributes to the encouragement of the development of reading and reasoning skills within a Language Arts syllabus.

Creativity in Artificial Intelligence is the most challenging aspect exploitable for the teaching of literature and Arts studies. By putting words under various heads in the knowledge base, like adjectives, nouns, pronouns, verbs, etc. and supplying relevant rules for the formation of sentences (eg. sentence structure = NOUN VERB ADJECTIVE) it is possible to help a child create new sentences or even come up with a story or a poem by specifying the rhyme pattern as a rule or heuristics. Playing with options in built in the inference engine can nurture the creative talent of children. Similar exercises have already been done by Andre Rubin (STORY MAKER without using AI)\(^{19}\) and Michael Sharpies using LOGO\(^{20}\). But the advantage of using AI lies in less effort on the part of the programmer, as once the facts and rules are provided, the inferences based on the rules are taken care of by the AI program.

4.3 AREAS OF INTEREST COMMON TO AI AND LANGUAGE LEARNING

There are certain features common to both AI and language learning. Problem solving is an important activity common to AI, psychology and language studies, Dewey's educational theory sums up the

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relevance of promoting problem solving skills as part of the language curriculum.

"Man is essentially an active, problem-solving creature. Ideally, he is a developing, 'growing', socially unconscious creature. To produce this ideal type the child must be set tasks which develop his intelligence, his capacity to live adequately, and this must be done in a way which makes him a cooperative social being. This calls for an education of the 'progressive', child-centred kind, making use of man's social resources to encourage individual growth".21

A problem solving approach requires time, effort and the combination of feasible and acceptable proposals. Stress is to be laid on maximising the use of knowledge and skills of the design groups, striking a balance between analytical and creative aspects of course design and an efficient use of time. An archetypal five stage model for a problem-solving approach in curriculum is as follows:22

1. problem formulation
2. brainstorming
3. creation of prototype designs
4. selection of prototypes
5. further work on design

Use of the computers as a tool for problem solving in education began in graduate schools in 1955\textsuperscript{23}. An experiment with an ICALL program for teaching problem solving is detailed in the next chapter. In the educational scene, TOSIPAR is a systematic approach adopted for problem solving in most schools in London\textsuperscript{24}.

\begin{itemize}
  \item \textbf{T} Tuning into the problem: appreciation of the situation; reconnaissance
  \item \textbf{O} Objectives: specifying what has to be achieved to solve the problem
  \item \textbf{S} Success criteria: how shall we know that the problem has been solved?
  \item \textbf{I} Information and ideas: what we need to know to solve the problem; generating alternative ideas for solving it and deciding which to adopt
  \item \textbf{P} Plan specifying what must be done by whom and by when in order to solve the problem
  \item \textbf{A} Action: Implementing the plan
  \item \textbf{R} Review: monitoring and evaluating to check plan is working; identifying both causes of success (to consolidate) and difficulties (to overcome).
\end{itemize}

Problem solving and search are the two inseparable sides of the same coin of AI. Problem solving is the area of AI concerned with finding the solution to a problem. It naturally involves viewing problems as spaces of potential solutions to be searched. Therefore, all of ICALL like creating


a story to understanding the plot of a story based on its rules involves problem solving and search.

Inference making is a very useful reading skill that can be honed by KBS' inherent ability to make inferences. KBES have inference engines. Inference making is an integral component common to the working of Expert Systems and the process of reading. Inference can be defined as the process of obtaining logical judgement from a given premise or from observed data\textsuperscript{25}. In the context of KBS, we use the system to add new information to the existing knowledge in the knowledge base. The new knowledge enters the inference system. The inference system makes inferences based on this new data. Thus learning can be said to have taken place. ICALL programs for reading can be developed centering around the inferencing technique of AI. To explain the process, the following example will help. A program called ARTHUR developed by Granger in 1983 stands for A Reader THat Understand Reflectively. ARTHUR can understand short, simple narratives. What is commendable about this program is that it can change its interpretation as it receives new information\textsuperscript{26}. This is a story that was told to ARTHUR

Geoffrey Higgins walked into Roger Sherman's movie theatre. He went up to the balcony, where Willy North was waiting with a gram of cocaine. Geoff paid Willey in large bills and left quickly.


To the question ‘why did Geoff go into the theatre?’ ARTHUR replied, "At first I thought it was because he wanted to watch a movie, but actually its because he wanted to buy cocaine". It is amazing to see the inference ARTHUR makes based on the first sentence and its ability to make new inferences with the addition of information. ARTHUR’s ability goes beyond just understanding these three sentences. ARTHUR already has sufficient information about movies, drugs and people. There is an ‘explanation triple’ behind the working of the program.

1. goal - buying cocaine
2. event - going to the theatre
3. inferential path connecting goal and event - going to theatre to buy cocaine.

ARTHUR attempts to teach the computer to infer by connecting the goal and event. In the above mentioned example, ARTHUR connects the goal of buying cocaine with the event of going to the theatre thereby making the logical inference that he was going to the theatre to buy cocaine. Programs can be designed on similar lines to teach learners to make inferences while reading based on new knowledge.

Among the characteristics common to AI and language teaching, Blackboard is another AI characteristic that works very analogous to a blackboard in a classroom situation. The blackboard works on the concept of distributed AI. Distributed AI is based on blackboard architecture which is analogous to a group of experts working around a table to achieve a common goal. This is very much like a classroom learning situation. In a classroom, the teacher states the problem, writes it on the blackboard and calls upon every student in the class to solve the results. Partial answers of individual students are written on the blackboard for the benefit of all the
children in the class. The teacher aware of the individual capabilities of the learners, calls upon them in an intelligent sequence is such a way that at the end, the entire problem gets solved. The results and the individual steps are still on the blackboard.

Similarly, the essence of distributed A.I. lies in using many software programs with common objectives, working together to solve large complex problems. This can be exploited to the hilt for language learning. For example, the knowledge of many experts in the field of linguistics can be put together to develop an intelligent parsing program. As CALL is an interdisciplinary area involving pedagogy, computing, cognitive psychology and computer programming, the blackboard concept is an ideal application area.

4.4 DIRECT APPLICABILITY OF ASPECTS OF AI TO LANGUAGE LEARNING

There are certain aspects of AI that can be applied to language teaching and learning. As the study centres on exploring what aspects of AI can be exploited for language learning, an attempt has been made to enumerate and discuss the possible applications of AI to language learning in general.
4.4.1 Knowledge representation by Natural Language

Knowledge Representation by natural language has the following advantages\textsuperscript{27}.

a. Natural language interfaces are typically more versatile than other types of interfaces, as they can respond to wider range of queries.

b. Access to knowledge with natural language queries can be more direct.

c. Natural language systems require less time for the user in many complex situations.

d. Natural language systems allow users to formulate questions in a manner that is consistent with the way they think about the problem.

An ICALL program using natural language for knowledge representation puts the learner that much more at ease. The learner feels more confident when he is allowed to word his queries in a language that he uses everyday and is comfortable with. Phrasing queries and getting feedback from the computer in natural language also gives a psychological edge over a CALL program as the learner experiences a more direct interaction.

4.4.2 Syntactic Parsing for Grammar Teaching

Syntax analysis facilitates the structural analysis of the sentence and also a study of grammatical features such as noun, verb, prepositional phrase and so on. Syntactic parsers written in Prolog can be modified suitably to teach grammar, mainly structure of sentences to learners. Grammar can be specified as a collection of rules, that is, a sentence may be decomposed into or built up out of some other structures arranged in a certain order. For example, a noun phrase may be followed by a verb phrase. Programs can be written describing a set of rules for English grammar "without having to worry about how these rules will be used"\(^{28}\). Using AI for syntactic parsing and adapting it to teach based on Chomsky's structure trees is a subject in itself and beyond the scope of this work.

4.4.3 Speech Recognition for studies in Phonetics

Speech recognition is an important problem of natural language understanding involving background knowledge, isolated words, connected speech, accent etc. Conversations comprise of ungrammatical sentences, repetitions and incompleteness. Studies in speech recognition using AI can be done by first restricting the vocabulary of words and then restricting the number of users. The application of AI in this area hasn't made any remarkable breakways yet. The difficulties involved are understandable. Making a machine work on the lines of human intuition is impossible. Presently, attempts are being made to achieve this using neural networks, a branch of AI.

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4.4.4 The application of logic in AI to Truth Conditional Semantics

Every knowledge is governed by truth conditional semantics. There is every correspondence between knowledge represented as a fact and the meaning to be attached to it based on its truth condition. Practitioners of AI rely (at least informally) on being able to provide truth - conditional semantics for their formalisms. Irrespective of the type of knowledge representation as soon as we say that a particular piece of structure represents the assertion (or belief, or knowledge) that "Ashok read a book" we have told of something that is true if Ashok did read a book and false if he didn't.

Facts are represented and conclusions are drawn using logical expressions which is fundamental to the technique of AI. Facts are represented in the form of propositions. These propositions are either true or false. The propositions are connected by logical operators AND, OR, NOT etc. The truthfulness of these sentences is governed by rules. This branch of logic is called PROPOSITIONAL LOGIC.

For Example,

if X is true
and
if Y is false
then X and Y is false
X or Y is true

These set of rules can be expanded to solve more complex problems involving compound statements. There is another school of logic which is an extension of propositional logic. It is called PREDICATE CALCULUS.
Predicates are statements about objects which are assertions of truth or falsity.

"Is - Tom (dog)" is an assertion that Tom is a dog. This predicate can be true or false. Logical operators are used to link predicates as in

"likes (Ashok, Abhisek) AND likes (Ashok, Akash)"

This predicate is true or false depending on the propositions. In O-A-V triplets and frames we could assign values to entries but in PREDIATE CALCULUS the facts can only be asserted and there are only two possible values - true and false. We cannot ask,

What is the name of the dog?

Instead, it is possible to ask

Is it true that the name of the dog is Tom?

for which predicate calculus will return the answer: TRUE.

It is impossible to assign and seek values in logic-based systems. But greater facility and explicitness in knowledge representation accounts for better understanding and inference making which is an invaluable contribution to the art of good reading.

Uncertainty in meaning can also be handled using logical expressions. When details about certain information is not known, then the rule pertaining to the information is allowed to fail. If the clauses in a
premise are linked together by the logical operator AND then all the clauses function as 'true' statements before a rule is carried out. Because of unavailable or unknown information, if the user types in "unknown" for any of the clauses in a premise, then the rule fails. On the other hand if the clauses are linked together by the logical operators "OR", then one unknown information need not exclude the rule form being carried out. In other words, even if the user answers 'unknown' to a clause in the rule, the rule will not fail.

Using truth conditions as formalism, exhaustive studies can be made in linguistics to develop AI based programs. It can also be related to computational linguistics.

4.4.5 AI and Computational Linguistics

AI can be used to analyse a given text critically based on the number of occurrences of every word, punctuation, space, etc. employing the statistical properties of the language. It is also possible to dissect words into better patterns. Using computational linguistics, it is possible to find out different patterns of sentences such as negative, affirmative and exclamatory. It also studies the length of the sentences, and characters to judge the readability of a text book to fix up its age and other societal backgrounds.

4.4.6 Lexical Analysis

Yannakudakis and Fawthrop have designed an "intelligent spelling error correction system" by studying literature with spelling errors. 1,377 spelling errors were identified and were classified into rules using a word processor. By merging a dictionary with it, the spelling errors of the words
were corrected\textsuperscript{29}. As the error classification is rule based, using a KBS to correct spelling and teach the right spelling would be more effective using AI. AI can be used for lexical analysis which aims at the study of lexemes, morphological and spelling pattern in a text book.

4.4.7 Use of Dictionary and Encyclopaedia

Information retrieval using AI's intelligent search should be the guiding principle to enable learners to refer to dictionary or encyclopaedia entries not withstanding the computer's superiority and sophistication in storing information. Referring to encyclopaedia should not focus only on retrieving information but discriminating between and rejecting irrelevant information too. For this an intelligent decision making KBS can assist the learner in scanning for specific information. For example, a reader searching for relevant material on 'evolution' can be asked to look under 'Darwin' by the intelligent help text but advised to skip reading under 'civilisation' if the reader chooses the 'civilisation' entry under 'evolution'.

Hypertext, another field of Artificial Intelligence used in library science has immense possibilities for information search in research areas.

4.4.8 Use of Semantic Parsers to understand meaning and in machine translation

Understanding language is a feature unique to AI. Semantic parsers attempt to understand language. This is a branch of AI which is a subject in itself. A program called BORIS developed by W.G. Lehnert at Yale

\textsuperscript{29}. E.J. Yannakoudakis and D. Fawthrop, 'An intelligent spelling error corrector' Information processing and Management 19(2), 1983. pp.101-108,
University in 1981 aims at an 'in-depth understanding of narratives'. BORIS is divided into four basic processing units.

1. a parser
2. event assimilator
3. question/answer module
4. English generator

When BORIS was fed with a story, the first para of which is given below it was able to answer questions by understanding it.

"Richard had not heard from his college roommate Paul for years. Richard had borrowed money from Paul which was never paid back, but now he had no idea where to find his old friend. When a letter finally arrived from San Francisco, Richard was anxious to find out how Paul was."

Q: What happened to Richard at home?
A: Richard got a letter from Paul.
Q: Who is Paul?
A: Richard's Friend?
Q: Did Richard want to see Paul?
A: Yes, Richard wanted to know how Paul was.

AI also has its application in understanding language by understanding the meaning associated with it. This is of utmost importance.

in machine translation where a sound understanding of language and its meaning is essential to translate from one language to another.

This study in relatedness equating concepts of AI with ELT pedagogy and discussing AI's applicability to language learning calls for viewing the ELT curriculum in a new light. This study in relatedness gains in credibility by including two experiments with ICALL programs. These experiments were conducted on secondary and tertiary level learners and the next chapter provides a detailed account of these experiments.