

An Instructive Framework of Intelligent Tutoring System for Learning Disability

Akanksha Bisht, Anuraj Malav, Neelu Jyothi Ahuja

Abstract: Learners with learning disabilities face some basic processing problem while reading, writing or solving math problems such as confusion between two similar words, a problem in interpretation or dealing with carrying in case of addition. Having a problem in processing at present can interfere with other higher skills in the future such as time planning, short-term attention and organizing things. During the early years of school life, problems with reading, writing and solving math problems can be easily recognized. A learning disability is a lifelong challenge that cannot be cured but if learning disabled(LD) student gets appropriate support, he/she can get success in his/her academics. This paper presents the instructional framework for an Intelligent Tutoring System(ITS) which deals with children having learning disabilities -Dyslexia(DL), Dysgraphia(DG) and Dyscalculia(DC). In the proposed ITS, 2 or 3 sub-problems of each learning disability has been taken and strength of a particular type of a learner has been found through the literature survey. On the basis of the strength of a learner, mode of learning content is decided that is audio, video or text representation. In this instructive framework, a unique mapping model has been discussed in which a unique instruction plan(IP) has been developed for each category of learner.

Index Terms: Instruction Plan, Instructive framework, Intelligent Tutoring System, Learning Disabled.

I. INTRODUCTION

As per today's lifestyle and busy schedule, everyone is dependent on technology to do their everyday work and computers have become an important part of a student's life. Every learner is different from another learner, each learner has his own preferred learning style, environment, and learning speed, but in traditional classroom environment, all learners are bound to learn in one environment that does not match with their preferred style or speed. If we talk about learners with learning difficulty, then it is more inconvenient for them to learn in a classroom environment. For learning properly and understanding basic concepts, learner requires a one to one environment which is created only for him/her while fulfilling all the requirements. Intelligent Tutoring System provides this one to one environment to the learner which is unique for all learner created while considering his/her problem.

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ITS is a system that helps in improving a learner's learning process when a physical instructor is not necessarily involved in the teaching-learning process. As a learner with learning disabilities has special needs such as focusing problem, interpretation problem or identification problem, hence the ITS developed for such learners should be able to fulfill these needs. The rules that are being used in the pedagogical module should be able to tackle these needs. ITS for LD is different from other ITS, such ITS keeps track of learner's performance, provides feedback and hints during the session. It collects the information about the learner's performance and suggests additional work while considering his/her strength and weaknesses. The main goal of an ITS is to motivate learners to gain skills for solving any problem, acquire knowledge and make them able to work independently [1].

In [2], authors have proposed an adaptive ITS that diagnose student's learning problem and provide content according to their need. In this paper, a concept map has been designed, where nodes represent concept and links are representing the relationship between the concepts. The concept map is used to enforce learners to understand and learn the key concept which he skipped during the learning process. Here, the teachers can also check their student's performance.

In this paper, an instructional framework has been designed that deals with LD students. Each LD student has a different problem. One may feel problem in reading, and another one may read and speak well but face problem in writing thoughts or may feel problem in solving math problems. The impact of the learning disability can be lessened by using an appropriate strategy and instructional intervention. While working with LD students, their disability type should be diagnosed carefully and provide learning content according to their need. In our proposed framework, we have taken a 4-10 age group of students and categorized their disability based on the pre-test result and related content has been developed according to the need of the learner.

B. Component of ITS

ITS contains four basic modules, these are: domain module, student module, pedagogical module and user interface module.

Domain module This module contains the Instruction Plan(IP) and learning content to teach. It also contains the



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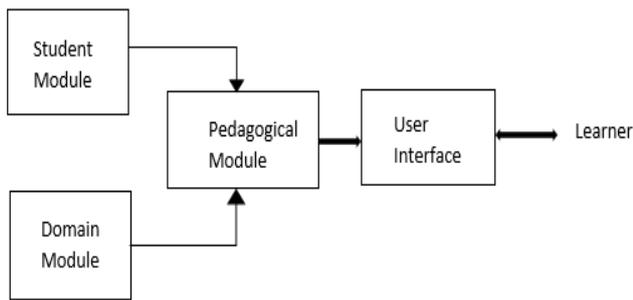


Fig. 1. The basic architecture of ITS

application of that IP to solve the related problem.

Student module This module stores the learner profile and learning behaviour of each learner based on his/her pre-test performance.

Pedagogical Module This module is responsible for showing content to the learner, it takes learner's preferred style from the student module, then chooses respective content from Domain module.

User Interface module It controls the interaction process between ITS and the learner. It is responsible for the presentation of the teaching material. It also updates the student module based on the user performance during the learning process.

II. LITERATURE SURVEY

Swanson (2012), demonstrated that learners who require extra processing time to understand a problem, may require more time to respond, such learners can get help from an instructor who is aware that such learners should not be demoralized. Another way to help such learners is by providing shorter assignments, more evaluation time or even short breaks [3]. Another interpretation of giving more time can be, providing additional time for any segment of the problem or an idea. It is observed that providing more opportunity to give answers increases the commitment of the learner towards solving the problem and diminishes academic and behavioural problem (Gardner, Heward, and Grossi, 1994; Lambert, Cartledge, Heward, and Ya-yu, 2006). This idea has extended time spent align well with a multi-tactile way to deal with Spanish instruction [4-5].

Klienert et al. (2007), visual content can fulfill all distinctive purposes and needs of a learner. For average level learners, all the thing taught in a classroom can appear as visual resources which will make it easy to understand, made by either instructor or learner [6]. For secondary learners, visual resources used to practice more complex content, "similar to the gendering or pluralizing of Spanish nouns". In the first case, it can possibly be done on paper or with electronic resources, for example, Glogster (edu.glogster.com). Electronic resources have the advantage of being accessible on the web and in an arrangement familiar to the contemporary learner. According to Medina's (2008) affirmations about immersive experiences and learning, both paper and electronic strategies may benefit learners, as far as they are getting auspicious feedback from the instructor when it is required [7].

Kleinert et al. (2007), examined learning content for phonics and vocabulary issue and demonstrated that the LD who are suffering from word decoding problem of dyslexia, the color-coded phonics card will be helpful in learning. Plenty of phonics cards supports LD in practicing phonics, and mastery of vowels through a multisensory approach. For instance, an individual shade can be assigned to each vowel out of the five vowels, and each time the vowel is used, the related shade will be used. Learners can build their own vocabulary cards; this arrangement of colour coding could be fused into the process. The pairing of consonant and vowels follow this pattern, and while presenting one consonant at any given moment and presenting blends with each vowel out of the five vowels [8]. An outstanding element of the Spanish language is its phonetic friendliness; for instance, each vowel has basically a steady pronunciation. Not at all like English, in which learning words by locating is suitable, the express direction in Spanish phonics can give an establishment to rectify pronunciation and early comfort.

In read-along strategy, learners are provided learning content with a visual story and an ongoing audio recording. It is regularly used for LD learners [9]. This is particularly beneficial for individual LD, with the choice of using earphones, and could likewise possibly be used for the group of LD who have the same problem. The audio devices already available with printed text as a commercially software-, for example, the Spanish-language adaptations of learners books which are packaged with audio content offered by School management (2012).

Gregory and Chapman et. al. (2002), the learning procedure includes the instance such as how the learner used the content, learning style of learner will be determined on the basis of the learning interactions (e.g., is this learner used auditory perception for learning, visual learner, a learner who required demonstration.). The decent variety of learning styles and preferences are demonstrated by today's learner; the separate classroom will be required for understanding the need of different learners [10].

Luria (1961), the level of language learning of instructional framework proposes an experience that builds up motor learning skill and perceptual learning and simultaneously development of these learning styles or skills. Including the motor learning skills, is fundamentally the acquisition of instructional framework. In all cases, the learner figures out how to interact with his environment, consequently, all language learning adapts at various levels of stimulus and reaction complexity [11].

Koehler & Mishra (2005), developed an instructional framework that seamlessly integrated with technology, content, and pedagogy strategies for developing and delivering various types of learning content, called as technological pedagogical content knowledge, or TPACK. TPACK is an extended form of Shulman's (1987) classic design of pedagogical learning content knowledge.

TPACK is a helpful instructional framework design for literacy, perception learning. The role of technology for delivering literacy instruction while teaching learners with LD through all the phases of an RTI model [12].



Leu, Torgesen et al., (2000), Teaching learners with LD - at any stage or content area - is a hard task for any instructor. This unpredictability is supported and sustained, by the deictic idea of IT and literacy. Instructors have the ability to be guided by hypothetical standards for instructional design framework can look to empirically study to reinforce existing instructing learning that works for literacy learning [13]. Evidence-based assessment for literacy learning (e.g., an instructional framework (e.g., TPACK, UDL; Mayer's CTML) is helpful for guiding the technology-based assessment and instructional learning for learners with LD [14].

(Bulgren and Scanlon, 1998; Pressley and McCormick, 1995), The essential duty of instructors at the auxiliary level is to present the learning content. The learners are concerned about executing the expected skills to take in the content, yet numerous learners with learning issues experience issues drawing in the procedures of learning. They frequently neglect to viably utilize addressing strategies, analogic thought or perceive the structure of explanatory connections. effective instructors at the optional level utilize express encouraging schedules to improve learners learning. This is expert by disclosing to the learner the reason for the showing gadget and routine alongside utilizing indistinguishable showing routine from a continuous piece of the guidance [15].

In [16], authors proposed a game-based ITS in which learner is motivated to learn new things with minimal human intervention. The system is designed in such a way that learner get instant feedback and hint during the game which motivates the learner to develop quality of decision making and facing challenge.

In this paper, we propose an architecture of the ITS that deal a set of learning content and learner profile and provide suitable learning content to each user according to his/her need. The set of content is reusable in nature. And afterward, change the learning content as indicated by the system.

III. THE ARCHITECTURE OF INSTRUCTIVE FRAMEWORK

The architecture of the proposed framework contains the following module and works as follows:

- On the basis of pre-test, a user profile is created. It contains disability type, the degree of disability and strength of the user. It is stored in the student module.
- Domain module contains content which is developed to teach learner and exercises to assess learner.
- The pedagogy module is responsible for generating the IP. It takes the learner profile as input and creates IP while taking related learning content from the domain module and provide it to the learner.
- After displaying each content, one quiz is displayed to assess learner in order to check whether the learner is able to gain knowledge or not. This interaction is tracked by Dialog Management.
- Learners behaviour is stored in Interaction Traces Base.
- If learner receives negative marks in the interaction quiz, interaction traces base forwards the result to the Traces Management System, which updates the user profile in the student module and forwards it to the pedagogy module. The pedagogy module changes the IP or style if required.

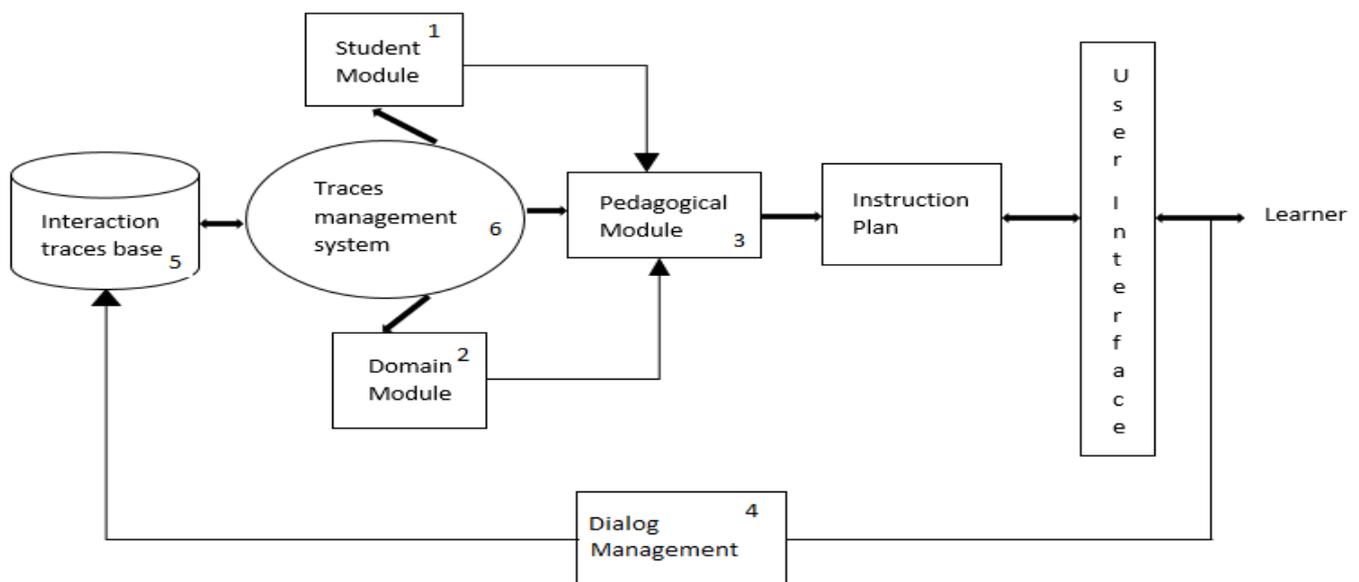


Fig 2. The Proposed architecture of ITS

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IV. THE IMPLICATION OF INSTRUCTIVE FRAMEWORK

In the system, we have created two type of user profiles-learner profile and educator profile. Learner profile deals with the learner. Educator profile is added for the physical instructor of a learner as the target age group is 4-10 year and the learners are LD. So we are taking help of the educator in order to assign grade according to the level of the learner, help learner in operating the system such as registration and login to the system, and checking result of the learner to see his performance. There are two grades specified in this ITS:

A. Grade 1

Grade 1 represents initial learners who may feel problem in one or more fields from the problem domain, which are: alphabets, alphabet sound, blending, syllables, easy patterns, counting, place value, number in words, order, number of lines, basic addition and subtraction, 2D shapes, and basic series.

B. Grade 2

Grade 2 represents learners having basic knowledge of alphabets, counting, basic sentence structure, addition, subtraction, easy patterns, and 2D shapes. And may feel problem in one or many fields of the problem domain, which are: blending, digraphs, rhyming, parts of speech, singular-plural, gender, synonym-antonym, sentence structure, capitalization-punctuation, addition-subtraction (with carrying), multiplication-division, money and time-related problem, 3D shapes, and basic fraction.

The framework contains the following steps for providing unique IP according to the learner's profile and grade of the learner (grade 1 and grade 2):

- Whenever a new learner enters the system, he/she is directed to 'grade 1', only those learners who have assigned 'grade 2' by the teacher, are directed to 'grade 2'.
- In the proposed instructional framework, we have taken learner's profile as input which contains the information about the learner such as the type of learning disability, the degree of learning disability and strength of the user. The system first checks if the learner is LD or not.
- If the learner is not having any learning disability, he/she gets the universal instruction plan as the system also support universal design.
- If the learner is LD, then the type of disability has checked either learner is dyslexia(DL) or dysgraphia(DG) or dyscalculia(DC) or a combination.
- After checking the type of disability, the system checks for the degree of disability. Here two type of degree are defined: less and more and strength is used to decide the presentation style of the learning content.

Let's take a case where teacher assigned 'grade 1' to the learner A and pre-test shows that he is dyslexic and having a problem with literacy skills, as there is only one problem

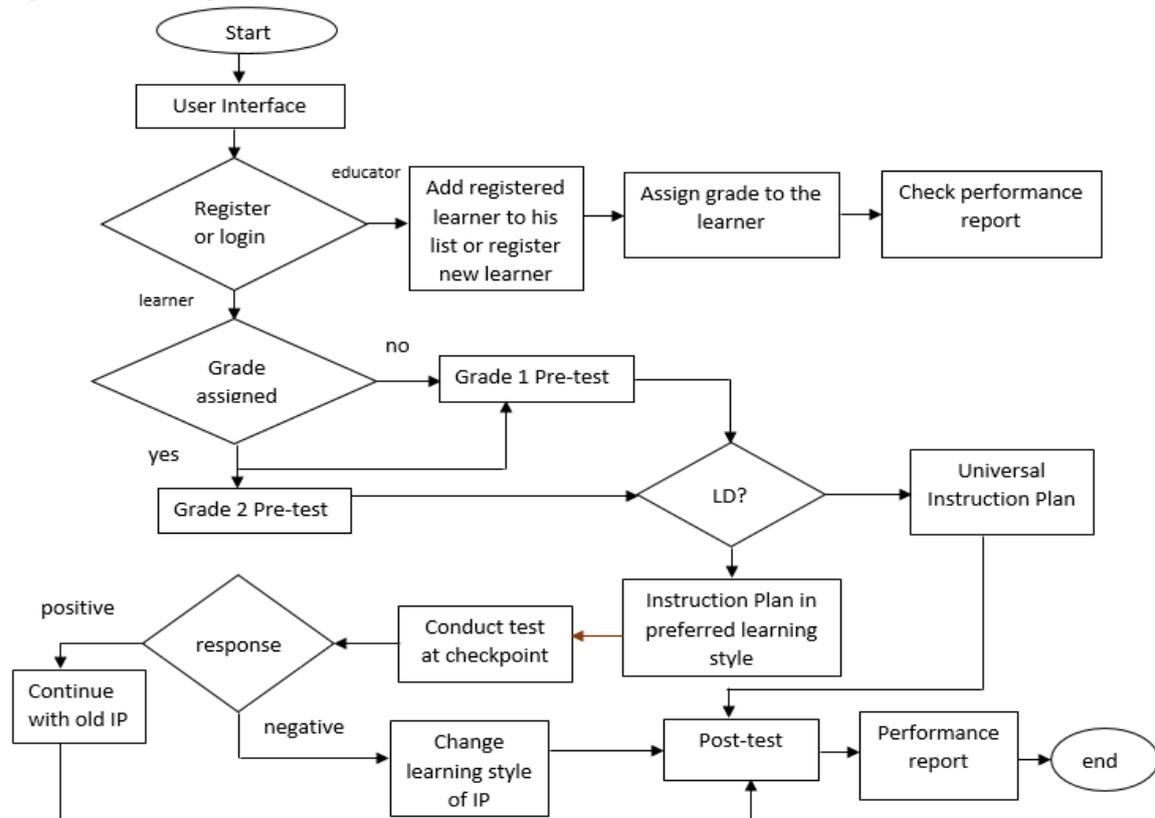


Fig 3. Flowchart of proposed ITS

associated then the degree is less dyslexia and the type of learner's category is Literacy Skills (LS). As the learner is having a problem with his literacy skill, the content developed for this type of learner include knowledge of alphabetic uppercase and lowercase (AUC & ALC), alphabet phonic sound (APS) and alphabet blending and segmentation (ABS). Same work is done for all categories and all the IP, containing content for all problems, are stored in the domain module.

Let's take another case where learner B is new and no teacher has provided grade related information about the learner so this learner would be considered in grade 1. The result of the pre-test shows that B is less dyslexic and more dyscalculic. The problem associated with less dyslexia is Phonological Awareness(PA) and problem associated with more dyscalculia are counting and basic calculation (CN & BC). As learner is a combination type, the pedagogical module would generate IP containing learning material for both the problems.

- For the problem PA in dyslexia learner would be provided learning material related to the topics alphabet phonic sound(APS), rhyming and syllables. The content is developed in video mode.
- For the problem CN & BC in dyscalculia learner would be provided learning material in two steps. In the first step, learning material includes topics related to counting, comparison of digits(COD), and place value system (PVS). The second step includes topics related to addition, subtraction, number in digits and words(NDW), and mixed problem(MP). The content is developed in video mode using story representation.

The pedagogical module generates a unique IP for each learner according to the type of problem. All the learning material is stored in the domain module according to its category (or the type of the problem it is developed for). Pedagogy module checks the learner profile and picks the learning material specified for the problems mentioned in the profile and generates IP.

A. Instructive Plan for grade 1 learner

For meeting LD's specific educational need, a system requires appropriate instructional material. In the proposed framework, it is reviewed from the past ITS and LD tools that learner with disabilities such as DL, DG, and DC mostly prefer learning content made in the auditory and visual mode so we have developed content in auditory and visual mode. The strength is observed in the survey and literature review.

The learner is divided into multiple categories based on their problems which are as follows:

Literacy Skills(LS): Learner under this category falls under less dyslexia and feels problem in remembering spelling or understanding the concept behind the spelling and they may feel problem in differentiating between alphabet uppercase and lowercase. The learning material for this problem includes knowledge of alphabet uppercase and lowercase (AUC & ALC), alphabet phonic sound (APS) and alphabet blending and segmentation(ABS).

Phonological Awareness(PA): Learner under this category falls under less dyslexia and feels problem in hearing and playing with the sound of any word, they feel problem in creating new words based on these sound. The learning content developed for this category includes alphabet phonic sound(APS), rhyming, and syllables.

Phonological Awareness and Literacy Skills (PA & LA): Learner under this category falls under more dyslexia, and feels a problem with both literacy skills and phonological awareness. Learning material is provided in two steps. In the first step, material related to AUC & ALC, APS and rhyming is provided. After learner is comfortable with these topics then in the second step, material related to ABS and syllable is provided.

Spelling & Written Expression(SW): Learner under this category falls under less dysgraphia and feels problem in writing spelling, where to use capital letters and punctuations. The learning material developed for this category include capitalization, punctuation and simple sentence structure(SSS).

Visual Spatial Response(VS): Learner under this category falls under less dysgraphia and feels in locating objects position and differentiating between left and right. The learning material includes locating object position(LOP) and left right identification(LRI).

Spelling & Written Expression and Visual Spatial Response (SW & VS): Learner under this category falls under more dysgraphia and feels problem in sentence structure as well as locating objects and left-right identification. The learning material is provided in two steps. The first step include capitalization, LOP, and LRI. After these topics are clear, in second step topics related to punctuation and SSS are provided.

Counting Numbers(CN): Learner under this category falls under less dyscalculia and feels in digit comparison and lesser and greater number. The learning content includes counting, comparison of digits(COD) and number in digits and words(NDW).

Basic Calculation(BC): Learner under this category falls under less dyscalculia and feels problem in basic addition, subtraction and place value. The learning material includes topics related to place value system(PVS), addition and subtraction.

Directions: Learner under this category falls under less dyscalculia and feels problem in identifying left-right or directions. The learning material includes topic related to left-right identification(LRI).

Counting Numbers and Basic Calculation (CN & BC): Learner under this category falls under more dyscalculia and feels problem in the calculation, direction, and counting numbers. Two-step learning is used. In the first step, learning material includes topics related to counting, COD, and PVS. The second step includes topics related to addition, subtraction, NDW, and mixed problem.

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Universal Instruction Plan (UIP): This instruction plan is developed for regular learners who don't have any learning disability. The learning material includes topics related to singular and plural(S&P), masculine and feminine(M&F), SSS, sentences in question form(SQF), mixed problem(MP), pattern and series(PAS), and shapes.

B. Instructive Plan for grade 2 learner

The learner is divided into the following categories:

Literacy Skills(LS): Learner under this category falls under less dyslexia and feels problem in blending alphabets and use of noun and pronoun. The learning material for this problem includes ABS, noun, pronoun, and verb.

Phonological Awareness(PA): Learner under this category falls under less dyslexia and feels problem in rhyming words, synonyms and antonyms. The learning content developed for this category include rhyming, antonyms and synonyms.

Phonological Awareness and Literacy Skills (PA & LA): Learner under this category falls under more dyslexia, and feels problem with both literacy skills and phonological awareness. The learning material is provided in two steps. In the first step, material related to ABS, rhyming, noun, and pronoun is provided. After learner is comfortable with these topics then in the second step, material related to verb, synonym, and antonym is provided.

Spelling & Written Expression(SW): Learner under this category falls under less dysgraphia and feels a problem in alphabet blending and recognizing patterns. The learning material developed for this category includes ABS and patterns.

Sentence Structure(SS): Learner under this category falls under less dysgraphia and feels problem in sentence formation and use of capital and small letters. The learning material include topics related to capitalization and punctuation, LRI and SSS.

Spelling & Written Expression and Sentence Structure (SW and SS): Learner under this category falls under more dysgraphia and the problem associated with this category are spelling & written expression & sentence structure. In the first step, learning material include topics related to capitalization and punctuation, LRI and SSS. In second step topics related to patterns and ABS are included.

Addition and Multiplication(AM): Learner under this category falls under less dyscalculia and feels problem in addition & multiplication. The learning material includes topics of addition and multiplication.

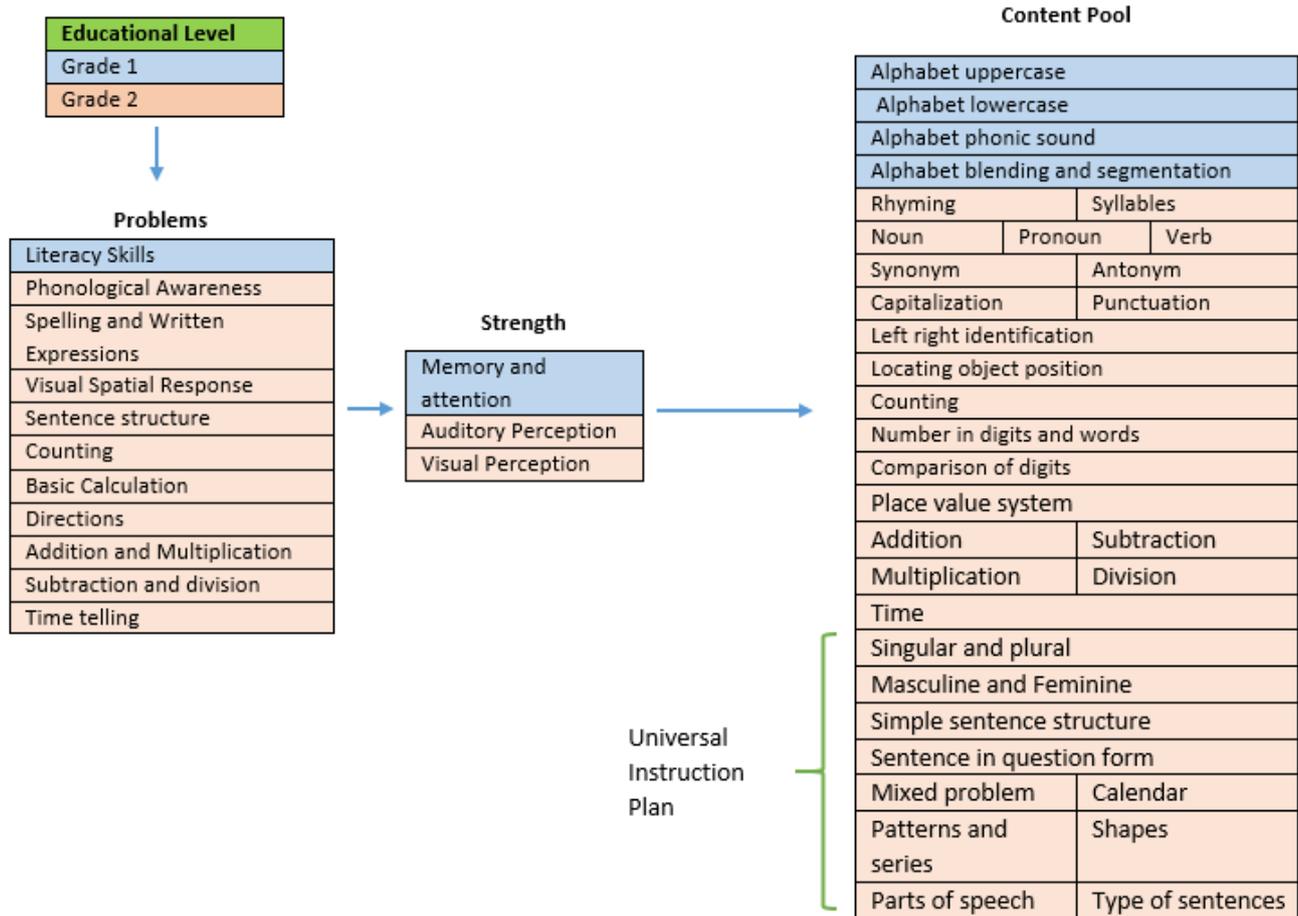


Fig 4. Instruction Plan for learner

Subtraction and Division(SD): Learner under this category falls under less dyscalculia and feels problem in subtraction & division. The learning material includes topics related to subtraction and division.

Time Telling(TT): Learner under this category falls under less dyscalculia and feels problem in time telling. The learning material includes topics related to time and calendar.

Addition & Multiplication, Subtraction & Division and Time Telling (AM, SD, and TT): Learner under this category falls under more dyscalculia feels problem in addition & multiplication, subtraction & division, time telling. In the first step, learning material include topics related to addition, subtraction and time. In second step topics are multiplication, division, and calendar.

Universal Instruction Plan (UIP): This instruction plan is developed for regular learners who don't have any learning disability. The learning material includes topics related to singular and plural(S&P), masculine and feminine(M&F), Parts of speech (POS), SSS, type of sentences(TOS), patterns, Sequences and Series(SAS) and calendar.

V.CONCLUSION

ITS are basically about learning and knowledge gain: domain module represents knowledge that ITS contain and this is the knowledge which is delivered to the learner, and student module represents knowledge about the learner profile. The main focus of this proposed work is to utilize this knowledge base properly and derive a useful system that helps LD in gaining knowledge while considering their preferred learning style. The proposed framework helps learner understanding concepts in an easy way and spend more time in the learning process.

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