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REALIZATION OF 3D VIRTUAL WORLD PLATFORM FOR THE BASIC EDUCATION OF ADULT ILLITERATES

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Illiteracy is a dilemma, around more than 700 million adults in the world are illiterate. Along with the traditional approaches, technology has been used for last three decades for literacy programs. These techno-literacy solutions exploited two-dimensional (2D) spaces with multimodal interfaces to augment learning for illiterates. These multimodal interfaces offer audio and visual features, recommended in learning theories. However many other features such as self-presence, social-presence, situated-learning, embodied environment etc suggested in these learning theories are yet to be included in these techno-literacy solutions to further their learning. In present era, emerging three-dimensional (3D) Virtual Worlds (VW) have potential to provide these lacking features and many others. These 3D VWs have already proved their importance in other disciplines such as higher education and business; however never been investigated for Adult Basic Education (ABE). In this paper, we explore how the benefits of 3D emergent technologies like Second Life (SL) are exploited in coherence with traditional theories for ABE. We present an immersive learning platform based on Multiple Intelligences (MI) Theory. We design and discuss an adaptive learning scenario for ABE in the SL. Finally we scrutinize the proposed platform to get an overview of the strengths and weaknesses in the intended area of application.

Key words: Adult Basic Education, Techno-literacy, 3D Virtual World (VW), Adaptive Interface
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1 Introduction

The movement against adult illiteracy is not new; rather it has a deep foundation of more than 55 years [67]. In order to eradicate illiteracy, technology, along with the traditional approaches, is also being

exploited. Role of technology as supportive solution and as techno-literacy solution has been discussed in numerous research studies for illiterates [2, 13, 16, 32, 42, 50, 51, 63, 68, 57]. In order to provide access to the information available on the internet, multimodal interfaces such as tangible and audio-visual interfaces, have been practiced for the support of illiterates [2, 13, 42, 50, 51, 63, 68]. These technological solutions come under the category of supportive solution for illiterate to make them able to access the information. On the other hand, to further the effectiveness of literacy programs, use of technology, along with the traditional approaches, is a second important role of technology for illiterate community. These techno-literacy solutions have been used in many literacy programs and positive impact is reported [23, 28, 45], because these techno-literacy solutions offer those features important for learning and recommended in traditional learning theories and research studies [5, 14, 18, 22, 26, 36, 37, 39]. However these applications are lacking some other important features such as self-presence, social-presence, situated-learning, embodied environment and learning by doing suggested in these learning theories. Use of blogs [11] and wikis [70] in adult education although addressed the issue of collaborative learning and sense of social presence but still others are missing. Furthermore, these resources exploit 2D spaces and main theme of these resources is text-based, consequently it may not suitable for those who are not comfortable with reading and comprehension. Also, the content presentation style in most of these computer-supported online applications seem more inclined towards children instead of adults. It leads towards the need of content personalization keeping in view the learner's prior knowledge and interest. These underlined problems, hoist the need of such systems that are customized for the adult illiterates and augmented with immersion to provide situated learning, sense of self and social presence with embodied feelings of learning by doing things. According to Director General of UNESCO, "Literacy rates are rising, and there is a stronger awareness that literacy needs everywhere are changing and must be addressed in innovative ways" [55]. This statement not only supports the highlighted need of customized and immersive systems but further recommends for innovative ways. What are those innovative ways, would they be able to improve the learning experiences and what justification of their use is in theoretical perspective, are the main questions needed to be answered.

In this paper, we identify the features that are important for adult literacy environments and map them to the traits of emergent three-dimensional (3D) virtual world (VW). We explore the question of whether and how the benefits of emergent technologies like 3D VWs are exploited in coherence with traditional theories for Adult Basic Education (ABE). These findings guide us to present an immersive learning platform based on MI Theory [22]. Second Life (SL) [58], a 3D VW is qualified to implement this platform. We design and discuss an adaptive learning scenario for ABE in the SL to get an overview of the strengths and weaknesses of these 3D VWs for ABE programs.

In the next section basic concepts and related work is described. Section 3 defines the target users of the proposed learning platform and section 4 explains the motivation of target users. How 3D platforms better server illiterates is answered in section 5. Selection of SL as learning environment and architecture of the proposed platform is explained in Section 6 and 7 respectively. In Section 8 a learning scenario for Adult Basic Education is presented. Section 9 evaluates the proposed platform in theoretical perspective. Section 10 gives a comparison of the learning platform with presently available solutions. The last section concludes the paper.

2 Basic Concepts & Background

2.1. Theoretical Perspective

Learning is an inevitable fact of life; it keeps on going throughout in one's life [62]. Herod defines learning as "Learning is the cognitive/ physical/ affective acquisition and processing of skills/ knowledge to varying depths" [24]. Some theorist argued that child and adult learning is fundamentally the same [30] as cited in [62], where as some others stated adult learning is different from child learning [34]. In this section, literature landscape is revisited to understand basic concepts and to find notions, important for adult learning.

2.1.1. Andragogy Vs Pedagogy

Adult educationists point out that the term "pedagogy" means "child" or "lead to", that comes up with meanings "to lead the child". It is also referred as Directed-Learning [24]. On the other hand the term "andragogy" in contrast to the "pedagogy" is defined as "art and science of teaching adults" [35]. This andragogy approach also called as Facilitated-Learning [24]. According to Knowles theory of andragogy [35], adult learners come up with some experiences; they are self motivated; they want to learn in independent fashion; they need problem oriented learning; and they want to know why they are learning. So the compelling contrast between andragogy and pedagogy appears as; 1) adult learners comes with life experiences however child learners have little or no experience, 2) adults are self motivated while child learners need motivation, 3) adults prefer to learner in independent fashion in contrast to child learners, 4) adult learners want problem-oriented learning whereas child learning is subject-oriented, and finally 5) adult learners want to know why they are learning some stuff in contrast to child learners [24]. All these contrasting arguments are sound to differentiate andragogy from pedagogy, however the way in which adults are characterized in andragogy is not as the actually adults are [33]. This is main criticism on andragogy. For example, it is possible that some children after little guidance are better able to learn things independently, in similar way, some adult even has past experience of life, self-motivated but want learning under continuous supervision of instructors. Thus relating andragogy to adults learning and pedagogy to children learning is a false distinction [24].

Another adult educationist, Cyril Houle [30] explained the same findings that learning process of adults and children is basically the same, however in four different concerns it can be differentiated; these are 1) the characteristics of the learner, 2) the Goals to be achieved, 3) the Environment or context of learning, and 4) the techniques or ways of teaching or learning. The characteristics of adult learners, are well explained through Knowles's theory of andragogy [35] and contrast with child learners is drawn in [24]. According to authors, characteristics of the learners are important determinant for change in learning process, whereas change in learning process on the basis of categorization of adult and child is not justified. The goals to be achieved, is the second concern that differentiate adult and child learning. Following the Paulo Freire aim, Jack Mezirow's Transformation Theory [44] highlighted the goals raising consciousness in adults as cited in [62]. According to these theorists, goal of education is to raise consciousness of social inequities and motivating adults for action to achieve social transformation. This argument explains that different learning goals influence the leaning process. The third concern, the environment and context of learning, is well described by Lauren Resnick; author explained, how the change in learning environment influences the learning

process. To concretize the argument, author also described the reason that how learning environment vary within and out of school. Moreover Eberle and Robinson conducted a survey and reported preference of adults about their best learning place [17]; according to survey, 55% people preferred learning at home, 19% preferred learning at job place and only 3.5% adults desired to learn at school. However authors are not agreed that home is an ideal place for learning because of numerous family and social issues. These findings focus on the need of informal learning environment and non-school places for better learning experience for adult education. Some other studies also described that many adult illiterates have bad experiences with their school life so the similar milieu cannot entice them to go ahead and learn [17, 31]. Furthermore Laves and Wenger described in theory of Situated Learning that, "learning is embedded within activity, context and culture" [39]. According to situated learning theory, knowledge should be presented in valid context, in contrast to class room learning where knowledge is delivered out of context. The techniques and ways to teach the learners, is the last concern that differentiate adult and child learning. These techniques for adults education may includes traditional efforts that are being fostered from many year to eradicate the illiteracy from society or may encompasses some technology-based solution to further augment learning process. However whatever the techniques are being used, needs of adult and child learners matter a lot with consideration of their due respect.

Thus, instead of drawing a boundary line between andragogy for adults and pedagogy for children, the major distinction may be the objectives of learning. For example, in case of novice learners, where directed learning is more important to transmit surface knowledge, the pedagogy is best option; on the other hand for advance learners, where facilitated learning is required to transmit deeper knowledge, the andragogy is an appropriate choice [24]. Rather to consider, andragogy and pedagogy as two separate approaches, they are effectively viewed as teaching-learning continuum, with pedagogy at one end, and andragogy on the other end of the continuum [24], as shown in Figure 1.

2.1.2. Learning Approaches for Adults

To facilitate the learning in adult education, different theorist presented many approaches. Herod described four main approaches such as; self-directed learning, transformative learning, contextualized learning and experimental learning [24]. Almost similar approaches are suggested by Cyril Houle [30] while differentiating the ways of adult and child learning. Some other studies raised the importance of problem-based, discursive and, situated-learning environments for adult education [39, 62]. Also many studies highlighted the need of learner-centered environment [6, 24, 62]. In these environments, learner's preferences are considered and range of choices with different learning styles and modalities are provided; this continuum of modalities points toward use of mix of text, audio and visual support [62]. Moreover, Visual Literacy states that, "visual images are language" [1]. According to Burmark, curriculum that exploits images can reach more learners and in contrast to traditional text-based and verbal approach it can teach them better [7]. In this study author further highlighted the need of integration of art, music and drama into curriculum for better results. Eberle and Robinson, while describing their findings of study [17], stated that, when one of the illiterates during a study interviewed, he said, "I can listen. I learn things just by sitting and talking and listening to other people talk." It shows that people who can easily learn the things around them by listening, they should be provided with learning environment that also facilitate them learning by listening stuff. Similarly, support of real world problem solving milieu and situation-specific environments for problem-based

and contextualized learning respectively; and facility of synchronous (chat or discussion forums) and asynchronous (e-mail) communications for discursive learning justifies the need of technology. These conclusive findings from theories call upon technology-supported learning environments for adult education.

2.1.3. Multiple Intelligences and Learning

Another important factor that influences teaching-learning process is the role of learning style as discussed by [24]. This factor sets the foundation of learner-centered approach; where learner needs are focused because not all learners learn in the same way. In order to determine learning styles of learners, different learning style inventories such as physical and cognitive are discussed in [24]; however one of them gained popularity to nicely integrate cognitive, physical and affective domains [24]. It is Howard Gardner's multiple intelligences inventory [22]. In 1983, Howard Gardner presented the theory of Multiple Intelligences (MI). Gardner's MI theory, lists seven different intelligences that a human possesses and utilizes to learn, these are; 1) Linguistic, 2) Logical-Mathematical, 3) Visual-Spatial, 4) Musical-Rhythmic, 5) Body-Kinesthetic, 6) Interpersonal and 7) Intrapersonal. According to MI theory, for effective learning, all of these intelligences must be considered in teaching. Also the curriculum should have good balance to support for mentioned intelligence. The features that set foundation for different intelligences are described as follow;

Linguistics – uses spoken and written words. For learners who possess auditory skills, think in words, and prefer language to understand and express concepts.

Mathematical-logic – uses logic, reasoning ability, problem solving and numbers. Learners who think conceptually, like experiments and puzzle solving are better taught through this style.

Visual-spatial – uses pictures, 2D and 3D metaphors. Learners who think in term of pictures and physical space possess visual-spatial intelligence.

Musical – uses rhythms, melodies, tones and sounds. For learners who love music and sensitive to listening.

Body-kinesthetic – uses body movements, role playing and physical activities. Those learners who like movement, physical activities and learning by doing are target users of this learning style.

Interpersonal – uses interaction and group discussion. Learners who have ability to communicate with other people and love to learn through discussion possess interpersonal learning style.

Intrapersonal – Learner who prefer to live alone and feel shyness are taught through intrapersonal style.

All these theories and research studies have consensus to provide the learner with such learning environments that are able to facilitate them in, independent learning; contextualized learning; problem-based learning; discursive and collaborative learning; learner-centered learning; multimodal interfaces with textual, audio and visual-spatial support; music, art, drams based scenarios; listening features; image dominant curriculum and immersions to emulate body kinesthetic ; interpersonal and intrapersonal learning support. These studies not only describe the need of multi-sensory or multi-modalities in curriculum but also call for technology to better support these requirements. This theoretical perspective raises some critical questions like; 1) whether technologies are capable to provide learning platforms that are better than traditional milieu or not?, and 2) whether technologies has potential to provide learning environments with all these features raised in the theories and research studies or not? These questions are discussed in the next section.

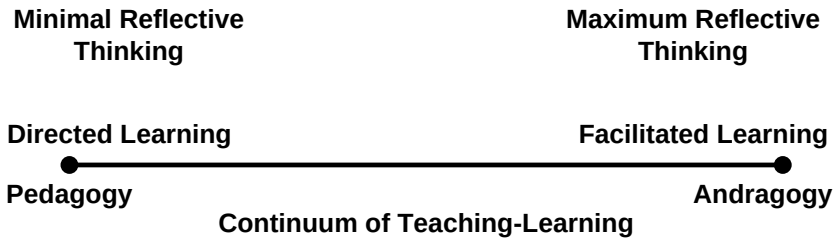

Figure 1 Continuum of Teaching-Learning and Learning Approaches.

2.2. Technological Perspective

Technology has never been used with its bursting potential, sometime because of funding constraints and sometime due to lack of vision [66]. Turner further extended his finding as;

> "Historically, literacy programs have been the last to access a new technology…….Failure to conceive how new technologies could be used in the classroom or tutoring situation often results in their arrival in literacy programs at the point when they were being discarded as obsolete by other educators. To be at forefront of advocating for new technologies in the literacy field, practitioners must be able to articulate what the potential of the new technologies is for their learners."

In the past, whenever technology is used, it was focused towards administrative activities. According to survey of Office of Technology as cited in [66], most of the technology-using programs used computers for administrative purposes and for report writings. This study shows that technology has been used very rarely for direct instructional purposes in adult education, and whenever it is used it was recognized obsolete in other disciplines. In this section, role of technology, its need for adult education and its contribution to-date are discussed.

2.2.1. Importance of Technology in Adult Learning

According to Hopey, technology has great potential to improve learning by adults; the only need is to exploit it in a smart and effective way [27]. In this study a process of integrating technology into adult education and its advantages on adult education programs are described in detail. In another study, Millar [45] emphasized the need of computer assisted instruction (CAI) in adult literacy programs. He conducted a research study to examine pros and cons of CAI in adult education programs. In the study, twelve advantages and eight disadvantages of CAI were hypothesized. In order to validate the result, first the data through questionnaire was collected by instructor and then validated by conducting an experiment to determine efficacy of computer assisted instructions. The result were not as hypothesized however, out of stated twelve advantages six were proved through experiments and four disadvantages were overcome, as shown in Table 1. Furthermore, Sivin-Kachala and Bialo [60] reported more than 1400 instructional software programs covering reading, writing, math and career-guidance for adult education as cited in [16]. In adult education, technology has many application areas. Ginsburg concretized four application areas of technology in adult education [23], these are technology as; 1) Curriculum, 2) Delivery Mechanism, 3) Complement to Instruction and 4) Instructional Tool. In the first application area, when technology is used as curriculum, the focus is on to teach computer skills to illiterates like, word-processing skills, spreadsheets skills, internet use and

surfing skills etc, apart from its numerous benefits to become familiar with technology, it does not consider those people who have other educational needs than technology only. In the second application area, when technology is used as delivery mechanism, it exploits Individualized Learning Systems (ILS) where customized contents are presented to learners, where learner needs are consider and these systems are accessible around the clock, however these system are customized and high-cost. In the third application area, when technology is used as complement to instructions, computers are used along with the traditional classroom learning as an additional learning support, it includes commercially developed software, however due to cost, high budget is required to acquire these software and sometimes instructor also have to rethink and modify the class contents and activities according to needs of these software. In the last application area, when technology is used as instructional tool, technology is exploited in classroom setting, as other tools in classrooms are used like blackboard, workbooks etc, instructor may use whenever it required, most promising benefit of this approach is that instructor is able to control the contents as per requirements of curriculum. While describing the pros and cons of each application area author stated that, "Instructional tool has the greatest impact on the classroom environment, learners and teachers" [23]. Furthermore, application of technology in adult education changes as one move on continuum of adult instruction from "training" to "teaching" to "self-directed learning" [62]. According to this study, "training" part of this continuum has been focal point for technology, where as technology use in "self-directed learning" has been less common. Thus use of technology as "Instructional Tool" and support of "self-directed learning" environment are important characteristics to be considered.

Other way around, Warschauer & Liaw [69] described technology use in adult education on the basis of its distinctive features such as 1) multimodal communication – it is meant to audio-visual features of technology, their application in adult literacy and language education, 2) collaborative writing – it uses blogs, wikis and forums for improving writing skills, 3) language analysis and structure - includes speech recognition, writing evaluation and online linguistic support to learners, 4) online networking - facilitate illiterates by providing virtual environment for immersion, social networking for contact and relationships, and multi-player online games to augment learning process, and 5) one-to-one mobile computing - foster the need of anytime, anywhere and anybody use by exploiting mobile tools like cell phones, notebooks.

These studies well explain important features of emergent technologies, their need and impact in adult literacy and application areas where technology with its full potential can better play its role in order to improve learning by adults.

2.2.2. Technology Used at a Glance

There are many instruction tool for adult literacy that help in learning by reading support such as WordCue [72], ReadPlease [54] and writing support such as FunBrain Spelling [21]. Numerous other web-based tools are available for literacy such as NewUSerTutorial [48], Wikihow.com [70], HOTCHALK [29], HippoCampus [25] etc. Furthermore, David J. Rosen a known educationist recommended some popular online sources for adult literacy [57]. Apart from these online tools, desktop applications are also practiced, such as intelligent Literacy Tool (iLIT) discussed in [16]. Audio-visual support is prominent feature of all these literacy solution, however content presentation style in most of these computer-supported online software seem more inclined towards children instead

of adults. Similarly main theme and approach of these online resources is text-based and it may suitable for those who come with little literacy but it is not suitable for absolute illiterates. According to Nevondo, text and image dominant internet is useful for people with high level of literacy where as it is disadvantage for persons with low level literacy [47]. However it does not meant to degrade importance of internet; rather pointed out that, the implications of the internet in adult basic education are not completely realized, it stipulate some changes [8]. Furthermore mobile technology is another alternative being used for educational purposes, for example mobile-based applications for ESL (English as a Second Language) learning [32]. It provides anytime, anywhere education, however due to the limitations of devices like small screen size and limited storage [61] these solutions are difficult to optimize. Although limited storage and small size is not an issue in present era, but it increases cost factor at other end. Apart from pure literacy solutions, there are many other technology-based or computer supported applications facilitate illiterates in their day to day lives. For instance, job information systems, basic health systems, city navigation systems, government portals and agriculture information systems [2, 13, 42, 50, 51, 63, 68]. These resources also exploit the same features of technology such as audio-visual and pictorial support. Moreover, use of World Wide Telecom Web (WWTW) for illiterates and semi-illiterates is another example of technology-based supportive solutions [52].

Table 1 Potential Features of Learning Environment.

Second Life with Robbins's Taxonomy		
Number of Users: ***"Multi-User"***	Object Ownership: ***"Private Ownership"***	
Dominant Content Form: ***"Image Dominant"***	User Identity: ***"Custom"***	
Type of Network: ***"WAN"***	Environment Access: ***"Public"***	
Persistence of Environment: ***"Persistent, Non-persistent***"	User's Relationship with other users: ***"Collaborative"***	
Stigmergy: ***"Stigmergy"***	User's Relationship with the Environment: ***"Collaborative"***	
Communication channels: ***"text-chat, voice-chat"***		

Advantages Claimed		**Disadvantages Claimed**		**Potential Features**
1.Reading achievement gain **		1.Shyness +		1.Authoring (2D)
2.Positive attitude **		2.Change in computer technology +		2.Adult-oriented (2D)
3.Increased self-esteem **		3.Technical difficulties +		3.Audio component (2D)
4.Gain in computer skills +		4.High cost **		4.Sense of self-presence (3D)
5.Cost effectiveness**		5.Training requirement **		5.Social presence (3D)
6.Privacy +	+	6.Incompatibility with learner centered adult education **	+	6.Collaboration (2D)
7.Prestige +		7.Integration problems with curriculum **		7.One-to-one and one-to-many interaction (2D)
8.Individualization **		8.Change in teacher's and student's role +		8.Embodied environment (3D)
9.Learning Control **				9.Learning by doing (3D)
10.Fast feedback +				10. Problem centered learning (2D)
11.Flexibility and **				11. Independence (2D)
12.Records management **				12. Situated learning (3D)

(+) Represents advantages achieved and disadvantages overcame
(**) Represents advantages not achieved and disadvantages still problematic

(2D) supported by 2D web-based platforms
(3D) supported by 3D web-based platforms

These research studies concretized the important role of technology for adult education in different eras and how the advancement in technology in different era changed the literacy solutions from text, to audio, to audio-visual, to text-free, to mobile-based. There is still need to exploit emerging technologies; to provide better learning environment; to augment learning practice; under the umbrella of facts proved and presented by learning theories in Section 2.1.

3 Target Users

In broader perspective, illiterates are categorized as absolute illiterates and functional illiterates. Those who are unable to read and write are referred as absolute illiterates [9, 49, 73]. Whereas those, who can recognize the letter of the alphabet and have small vocabulary of words but unable to comprehend the sentences are referred as functional illiterates [73]. Moreover keeping in view the reasons of illiteracy of these misfortunes, such as family problem, bad experiences of learning in past, lack of opportunities etc as discussed in [10, 17, 32, 55, 71]; we can divide them on the basis of these reasons and their intensity as shown in Table 2. We see, Group A, Group B, and Group D require serious attention; especially first two groups are more vulnerable. The Group C however, comes under the umbrella of English as Second Language (ESL) Learning and Cultural Learning [10, 71]. In this study, absolute illiterates are more important, however change in curriculum make able this environment equally valuable for functional illiterates.

Table 2 Categories of target users.

Groups of Illiterates	Definition	Want to learn/ Don't want to learn
A	Those, who are reluctant to go to formal environments for learning	Don't want to learn
B	Those, who do not find opportunity of education	Want to learn
C	Those, who move across countries	Want to learn
D	Those, who unable to get education due to family background	Don't want to learn

4 What Motivates the Illiterates?

Motivation is core to every action performed by the human being. It is an enticing force bind with external or internal rewards and hence categorized as extrinsic and intrinsic motivation respectively.

Eberle & Robinson [17] highlighted the needs of illiterates; such as illiterates desire to learn reading and writing but avoid exposing themselves to others. They wish to get rid of dependency. Literacy makes them able to read and write to better serve their roles as parent, as employee, as employer, as buyer, as seller, as husband, as wife and as active citizen of society. Furthermore literacy also makes them able to read street/sign boards while travelling, telephone numbers and names, health information circulars and medicines' names, utility bills and different official correspondence. These needs seem to be very ordinary but are very important and worthy for target community. Askov and Eunice [3] state, these immediate needs determine their interest and participation in literacy programs. However it is important to remember that, literacy does not mean to award degree to someone rather it has strong potential to help someone in solving problems in daily life [17].

These studies concretize that beyond the physiological needs, there are many other needs and motivational stimuli for illiterate to attract them towards literacy programs [59].

Table 3 Mapping Robbins's Taxonomy to Potential Features of Learning Environments.

Robbins's Second Life Taxonomy/ Derived Traits **	**(+) Advantages & Potential features provided/ (#)Disadvantages overcame**	**Remarks**
Multi-user	Collaboration^{+}, 1-to-1 & 1-to-m interaction^{+}	
Image dominant / Immersive	sense of self-presence^{+}, social presence^{+}, Embodied Environment^{+}, Learning by doing^{+}, situated Learning^{+}	
Online environment	Training requirements$^{\#}$, incompatibility with learner centered adult education approach$^{\#}$, flexibility^{+}, 1-to-1 & 1-to-m interaction^{+}, authoring^{+} ⟶ curriculum integration problems$^{\#}$	Because of an online nature, 1) technology expert are able to train the teacher as mentor, remotely. 2) teacher-centered approach is now switching to learner-centered style of learning. 3) authoring is possible that overcomes curriculum integration problem
Public Access	Shyness$^{\#}$, (Immersive-nature, collaborative) ⟶ self-esteem^{+}	Immersive nature and collaboration provides self-esteem
Customized Scenarios **	Learning Control^{+}, Adult-Oriented^{+}, Problem- centered Learning^{+}	
Voice-chat	Supports Absolute illiterates, Audio Component^{+}	
Text-chat	Supports Functional Illiterates	
(User Identity, Stigmergy, Object-Ownership)→Adaptivity **	Reading achievement gain^{+}, individualization^{+}, Fast Feedback^{+}	User Identity, Stigmerg & Object-Ownership take part in Adaptivity

5 Can 3D-Platforms Serve Illiterates?

Text-based learning and communication applications are no longer acceptable in the present era of visual literacy [1]. Visual Literacy states that, "visual images are language" [1]. Curriculum that exploits images can reach more learners and in contrast to traditional text-based and verbal approach it can better teach them. Furthermore, addition of art, music and drama in curriculum augment learning process [7]. Also the features that are considered critical for learning highlighted by the theories and different research studies [5, 14, 18, 22, 26, 36, 37, 38, 39] in Section 2.1 are essential to be considered. These features are contextualized learning; independent learning; problem-based learning; collaborative learning; learner-centered learning; multimodal interfaces; listening features; image dominant curriculum and immersions to emulate body kinesthetic; interpersonal, intrapersonal learning etc. Robbins's Taxonomy [56] for SL describes that, 3D virtual environments like SL has numerous peculiarities that are suitable to achieve the said features. We, in this study explain how these peculiarities of 3D environment can be exploited to make available these critical learning features for adults. Because technology has great potential to improve learning by adults; the only need is to exploit it in a smart and effective way [27]. At the same time, we need to realize that "this is not to say that 3D games with their powerful graphical interface have become the panacea to learning rather thoughtful design and application of computer games determine effective digital learning environment" [53]. Table 3 gives a brief picture of Robbins's Taxonomy for SL and mapping of some features considered critical for learning in adult education (see Table 1 for these features). Apart from the said features, these 3D virtual environments have potential to overcome the disadvantage of past studies and to achieve the advantages claimed in past studies but could not be realized [45]. According

to MI theory [22], for effective learning, all of seven intelligences must be considered in teaching. Furthermore, in order to provide the enhanced learning environment, Andragogy (Facilitated Learning) [24] and Pedagogy (Direct Learning) [24] set some features of physical domain. These theories raise one critical question, whether the present computer-supported solution for adult basic education are considering these features or not? The answer is not so simple but, many of the said critical learning features such as adult-orientation, audio-components, collaboration, one-to-one and one-to-many interaction, problem-centered and independent learning, are possible and part of one or other present computer-supported solutions for adult education as discussed in Section 2.2. However other important features such as sense of self-presence, social presence, embodied environment, learning by doing and situated learning are only possible through 3D environments. We believe that emerging technologies such as 3D virtual environments are not only able to provide the critical learning features but also able to set the innovative ways to further the learning process suggested in [55].

6 Second Life for Illiterates

SL [58] is an open access 3D Multi-User Virtual Environment (MUVE). It was first made available for public access in 2003 by Linden Research Inc. In last three years, this 3D MUVE widely being used by educational institutions for advanced education [46]. Educational institutions exploited the features of SL and presented learning scenarios for distance and blended learning [46]. We explore the SL as a learning platform for Adult Basic Education. We followed Robbins's taxonomy [56] for SL to identify traits of this 3D VW. The taxonomy of SL highlights affordance of this VW as discussed in section 5 and shown in Table 3.

Realizing the learning theories discussed in Section 2.1, we exploited this 3D VW for Adult Basic Education because the interface it provides, offers almost all learning features and has strong coherence with MI theory [22] that explains seven different intelligences, a human possesses and utilizes to learn. Thus according to Robbins's Taxonomy and potential feature of SL environment, it offers a range of channels to augment interface and provoke learners with different intelligences for learning enhanced experiences. The proposed platforms for adult basic education provides immersive learning environment. Each and every metaphor used as Learning Object (LO) is 3D in nature and provides the visual-spatial support in learning. LOs are presented as written alphabetic characters with audio support that aid linguistic intelligence. Support of text and voice chats augment interpersonal learning and provide opportunity to develop relationships. Learners' avatar through their motions, actions and sense of self-presence emulate the body-kinesthetic. Intrapersonal concerns are addressed using adaptive support through recording learner's usage data. Learning scenarios offer background music while learning that helps the learner with musical-rhythmic intelligence.

The proposed learning platform for ABE presents different learning scenarios. These learning scenarios for target learners are categorized into 1) Linguistic Scenarios, 2) Numeracy Scenarios and 3) Game Scenarios. The first category includes scenarios for linguistic learning such as, alphabets, words and sentences. In the second category, scenarios are presented to learn numbers and basic mathematical skills, such as, addition, subtraction etc. The last category consists of game-based learning activities for both linguistic and numeracy. It also serves for implicit evaluation of learners. All three learning scenarios designed in SL are adaptive in nature and offer learning contents according to learners' background and domain knowledge.

7 Platform Architecture

In this section, we present architecture of the proposed platform for adult basic education. It consists of seven components; three of these seven components are part of client side 3D space, where as four components combine to make server side of the architecture, as shown in Figure 2. These components are described in following sections.

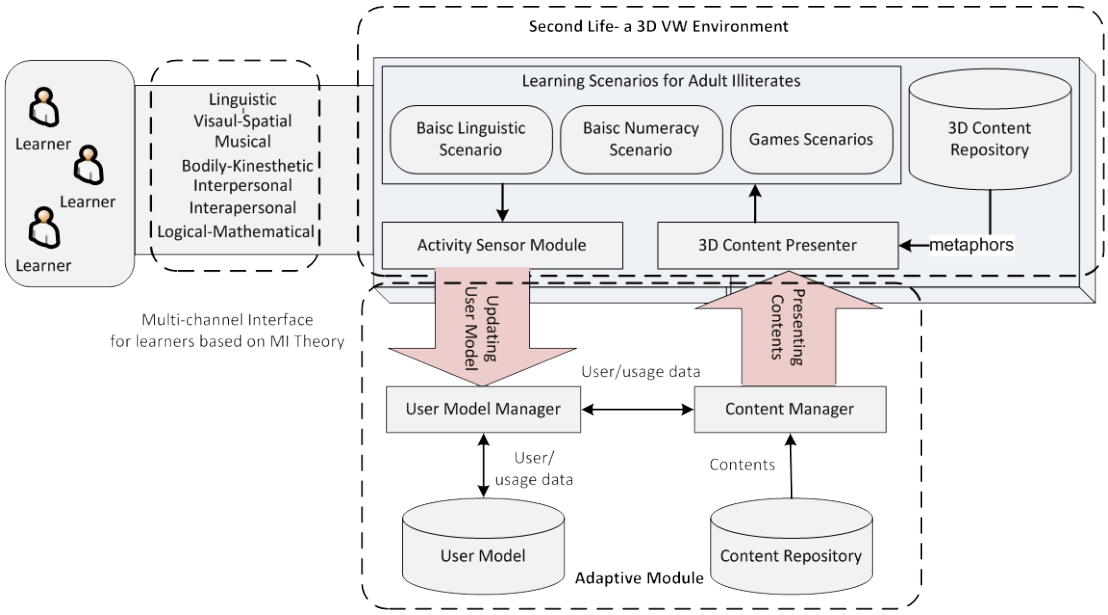

Figure 2 Platform Architecture.

7.1. Activity Sensor Module

This module is responsible to sense and collect users' interactions in Second Life environment. It is part of client-side 3D space. It is developed in Linden Scripting Language (LSL). This module sense the presence of learner, when he appear is learning zone after login in SL. Important events that it sense are 1) identification of learner's avatar, 2) position of learner's avatar in learning zone, 3) distance of avatar from LO, 4) touch event when avatar touches to the LO, and 5) details about the LO being touched by the avatar. Activity Sensor Module exploits this information and sends it to server-side of the architecture using HTTP request. It is also responsible to initiate request for contents. How touch_start() function sense the learner's activity data and a request from client side is initiated using llHTTPReqeust() is described through a code segment as shown in Figure 4.

7.2. User Model Manager

This module is located on server-side. It receives users' activity data sent by the Activity Sensor Module. Using PHP scripts this module stores this data to the User Model on the server-side (a repository for user data).

7.3. Content Repository

Content Repository is a database created in MySQL is responsible to store text-based contents. It contains textual details about the contents to be presented in 3D learning Zone. However, it does not have any information about metaphoric representation of these contents that are actually presented in the learning zone.

7.4. User Model

User Model is an important part of server-side application. It is created in MySQL; it is responsible to store the personal and usage data of all the learners, using this learning zone.

7.5. Content Manager

This module is responsible to select and forward list of content to the 3D learning zone. When the Content Manager receives request from client side with learner's name, it first send request to User Model Manager for user data, and after receiving this information, this module send request to the Content Repository for textual contents according to the profile of user. Finally after a series of queries it selects contents and forwards these textual details of contents to the client-side component that is 3D Content Presenter. It includes content detail, content texture, content virtual world position, content language, difficulty level and information about content belongs to.

7.6. 3D Content Repository

Unlike the Content Repository on server-side, this 3D Content Repository on client-side is responsible to store 3D metaphors of all contents. These 3D metaphors are not loaded automatically, however instructor or user with administrative right are able to load them manually in parallel to the content that are loaded in the Content Repository on server-side.

7.7. 3D Content Presenter

This module is also located on client side. Content Manager forwards textual detail of contents to this 3D Content Presenter. It matches this textual detail with metaphors' description in 3D Content Repository and finally presents the selected content in 3D learning zone for learners. http_response() function is responsible to handle the textual data comes from server side as shown in Figure 4.

8 A 3D Learning Scenario for ABE

For Adult Basic Education, Learning Scenarios are designed to educate the target users in the areas of linguistics and numeracy. In linguistic, target users are able to learn alphabets, words and sentences in different languages. However as a first step we considered English language for learning in the proposed solution. Numeracy learning scenario includes learning of numbers and basic mathematical operations, such as, addition, subtraction etc.

For the evaluation of the learners, a game-based scenario is designed that serves for the implicit evaluation of learners. All these scenarios are designed considering the MI theory, so that learners with different intelligences feel comfortable while learning.

This paper focuses upon the linguistic learning and game-based evaluation scenarios. Linguistic learning scenario contains 3D LOs (see Figure 3) as alphabetic character and metaphor relevant to that alphabetic character, for instance metaphor of "Apple" for alphabetic character "A". These metaphors are selected on the basis of domain knowledge and background of the learners because adult learners want to learn only those things they need to know [43]. Furthermore Curtis [12] stresses that the ability to comprehend and acquire new vocabulary is influenced by the domain knowledge. Thus in proposed adaptive environment metaphors may vary for different learners against same alphabetic character considering the learner's domain knowledge and interest. Whenever an avatar (in SL) of a learner (in Real Life) passes nearby a LO (alphabetic character and its metaphor), it speaks aloud. For example, when an avatar passes nearby a LO "A", this LO generates voice of "A" and then of relevant metaphor "Apple" for a learner. A certain range is specified around each LO called effective circle, upon entering into it that LO first vibrates to get the attention of a learner's avatar and loudly pronounces that alphabetic character (like "A" produce voice of "A") and its metaphor (produce voice of "Apple"). Until an avatar resides in this effective circle of a particular LO, that LO speaks aloud again and again with specific gaps to avoid mixing and to enhance clarity. Once the learner has learnt that LO, he/she needs to click on it. This mouse click action is detected by Activity Sensor Module and sent to the server-side, where it is stored in user model to keep track of the knowledge of learner. Learner in the learning scenario can move by using four arrow keys on the keyboard and can click the LOs using simple mouse left-click. He/she needs not to deal with complex operations like mouse movement, drag and drop and menu selection.

The proposed environment offers a game-based scenario as an evaluation phase after the learning phase. In chronological order alphabetic characters are divided in six evaluation phases followed by learning phases. Consider the first evaluation phase following the first learning phase; it consists of Game-based scenario for implicit evaluation of learners because evaluating adult learners is not a recommended practice [17]. The inspiration of this game-based evaluation scenario is based on "Alphabet Scavenger Hunt" [40]. The game-based evaluation scenario consists of a room with a door used for entry and exit of avatars of learners. This room has several metaphors that are relevant to the alphabetic character that a learner has learned in the last learning phase. In addition to learned metaphors, the room has collection of some other metaphors to give the sense of selection to the learners. When a learner enters into the room, he/she listens a sound of one of the alphabetic characters that he/she has learned in last phase. The learner is asked to find relevant metaphor to this alphabetic character. After finding this metaphor in the room the learner needs to click on the metaphor. This mouse click action is reported to the learner model via Activity Sensor Module to update the learner's knowledge. The same process is repeated for all LOs, a learner learned in the last learning phase. After successfully finishing the evaluation phase the learner's avatar will again find itself in the next learning phase and this mechanism is repeated until visit of the learner in the linguistic learning scenario finishes however a learner can logout at anytime and resume the learning session. In case of logout, environment saves the learner present state and in next session provides him/her with same contents, LOs and metaphors.

Figure 3 Learning Environment in 3D Virtual World.

All the actions performed by the learner during learning for example mouse-clicks, navigation, interaction with LOs and evaluation data are detected by Activity Sensor Module and forwarded to learner Model that is used for personalization of learning environment.

9 Scrutinizing the Proposed Platform

In order to augment learning of students, educators are in course of redesigning learning experiences [65]. The rapid advances of technology stipulate change in present learning practices to further the learning experiences. However, the need is to exploit proper technology for right place on continuum of teaching-learning. According to Stites, type of theories and use of technology in support of adult education varies as one move on continuum from training to self-directed learning [62]. Thus theoretical perspective, as well as technological perspective highlights the need to exploit multimodal interfaces for adult education. It is believed that technology and multimodal learning regime are more effective than traditional and uni-modal learning, if exploited in smart ways [19, 27]. The need of use of technology as multimodal support for adult education raised in literature in Section 2.2 is considered in the proposed platform and it is scrutinized in the light of Dale' Cone of learning [14, 19] Gardner's theory of MI [22] and Mayer's principles of multimedia [41].

Edgar Dale a known educationist developed the Cone of learning and explained different styles of learning [14]. Dale stresses the importance of active style of learning by "saying" and "doing" things practically. The Cone of learning explained, as ones moves from the top to the bottom of the cone more senses are engaged; hence learner shifts from abstract to deep learning level. The proposed 3D VWs has potential to provide learning platform for ABE according to the continuum described by Dale because it provides most of the flavours for learning from "verbal symbols" to the "Purposeful experiences" such as, linguistic, verbal, audio, video, role-playing, and immersive, support for learning.

Furthermore association of discrete retention percentage with the Dale's cone of learning is falsified and concept of shift from abstract to deep learning along with the cone is considered more concrete [19]. Also it is revealed that "one size fit for all" is no more true. For effective learning, all of seven intelligences must be considered in teaching, is the notion of MI theory [22]. It points toward the use of 1) Linguistic, 2) Logical-Mathematical, 3) Visual-Spatial, 4) Musical-Rhythmic, 5) Body-

Kinesthetic, 6) Interpersonal and 7) Intrapersonal support in the learning platform. In order to respect the needs of adult learners with different preferences, the proposed environment has potential to offer support for all seven intelligences recommended in MI theory [22]. It provides immersive learning environment. Each and every metaphor used as Learning Object (LO) is 3D in nature and provides the visual-spatial support in learning. LOs are presented as written alphabetic characters with audio support that aid linguistic intelligence. Provision of text and voice chats augment interpersonal learning and provide opportunity to develop relationships. Learners' avatar through their motions, actions and sense of self-presence emulate the body-kinesthetic. Intrapersonal concerns are addressed using adaptive support through recording learner's usage data. Learning scenarios offer background music while learning that helps the learner with musical-rhythmic intelligence.

Finally it is important to consider the appropriate use of each potential feature of learning environment for different learners. As the offered features are multimodal interfaces and multimedia. We exploit Mayer's principles of multimedia to further scrutinize the learning platform. For the effective use of multimedia in learning, Mayer presented a set of principles [41]. In order to preserve the originality of this work, we present these principles as it is. These seven principles are listed below;

***Principle of Multimedia**:* People learn better from words and pictures than from words.

***Principle of Spatial Contiguity**:* People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.

***Principle of Temporal Contiguity**:* People learn better when words and pictures are presented simultaneously rather than successively.

***Principle of Coherence**:* People learn better when extraneous material is excluded rather than included.

***Principle of Modality**:* People can better learn from animation and narration than from animation and on-screen text; that is, people learn better when words in a multimedia message are presented as spoken text rather than printed text.

***Principle of Redundancy**:* People learn better from animation and narration than from animation, narration and text.

***Principle of Individual Differences**:* Design effects are stronger for low-prior knowledge learners than for high-prior knowledge learners and for high-spatial learners than for low-spatial learners.

Under the umbrella of multimedia principle [41], theory of MI [22] and Cone of learning [14], we in the proposed learning environment consider most of the needs of adult learners discussed in Section 2.1 and facilitated them accordingly as shown in the Table 3. Following the Robbins's taxonomy, the learning platform offers image dominant, multi-user and online environment with the support of text and voice chat. We design and present customized scenarios for linguistic learning. Keeping in the view, background knowledge of the learners, only related LOs are presented by following fourth and seventh principle of Mayer. Each learning object consists of textual, visual and audio support; hence comply with first principle of Mayer. In learning scenarios textual contents and pictorial content appear closer to each other that conforms second and third principle. However, as the environment is anticipated for adult basic education that is why textual, visual and audio support sometime appear together. This application although seems to violate fifth and sixth principle however finding in [19] allow the mix of these modalities for novice learners. Support of voice chat however in the first release is not provided to reduce the complexities of interface.

```
//LSL scripting at client-side
//function that requests server-side for adaptive contents
SendLearnerRequest()
{
 string url = "http://localhost/adaptiveApp/
 RequestContentv3.php?";
 url+= "learnerName="+ llEscapeURL(UserName);
 RequestContent = llHTTPRequest(url, [], "");
}
//start of default() state
default
{
//code that handles the received contents from server-side
http_response(key request_id, integer status, list metadata, string body)
  {
  if (request_id == RequestContent)
     {
      adaptiveContents =
      llParseString2List(body, [" "], []);
      //Step 1: code segment to extract data of interest from adaptiveContents
      //into two list i.e. contents and temp
      //Step 2: code to merge two extracted lists
     }
  }
//code segment for sensor module
touch_start(integer detected)
  {
     UserKey = llDetectedKey(0);
     UserName = llKey2Name(UserKey);
     llSay(0, "the User name is = " + UserName);
     LearnerDetails = llGetAgentInfo(UserKey);
     //calling function to request server-sider
     //for adaptive contents
     SendLearnerRequest();
  }
}
```

Figure 4 Client Side LSL Script (a code segment).

10 Discussion

Numerous online and desktop applications are available for literacy programs, for example; ReadPlease [54], FunBrain Spelling [21], FunBrain Math [20], TheLearningEdge [64], BrainPOP [4], etc. These applications with multimodal interfaces assist illiterates to enhance their reading, writing and mathematical skills. Audio-visual supports are prominent features of all these literacy solution. These features are also recommended in the learning theories to augment learning experiences. At the same time all these applications are lacking some other important features such as self-presence, social-presence, situated-learning, embodied environment and learning by doing suggested in these learning theories. Appearance of blogs [11] for adult education although addressed the issue of collaborative learning and sense of social presence but still others are missing. Also the main theme and approach of these online resources is text-based and it may not suitable for those who are not comfortable with reading and comprehension. Moreover, content presentation style in most of these computer-supported online applications seem more inclined towards children instead of adults.

However use of adaptive lessons according to prior knowledge of learner and his interest is highly recommended approach [19]. It means personalization of contents according to learners' needs is another factor to be included in the application designed for adult education. Furthermore "Instructional tool has the greatest impact on the classroom environment, learners and teachers". These instructional tools are recommended to be used whenever required as per need of curriculum like other tools in the class such as blackboard, chalk etc. It highlights the need of applications that are able to be customized whenever required. Our approach includes most of the features such as self-presence, social-presence, situated-learning, embodied environment recommended for learning by established theories as discussed in Section 2.1. Furthermore, adaptive module in our learning platform offers personalized content presentation in 3D space. Also the platform is able to be changed as per curriculum with little to moderate efforts.

11 Conclusion

In this paper, we recognized the importance of technology-based learning solutions for adult basic education. Based on the notions of established learning theories, salient features that set the foundation for effective learning environment for ABE are realized. Exploiting the significance of these salient features, need of use of emergent technology for ABE is justified. We used three dimensional (3D) multi-user virtual environment of Second Life as a learning platform for adult education. This prescribed learning platform offers many distinctive features such as, 3D immersive learning milieu with audio-visual and textual assistance, support of multi-user online virtual environment, text and voice chat; that are otherwise rarely realized in a single platform. These features help to achieve benefits; for instance, learning by doing, learning through role playing, situated learning, sense of self and social presence, collaborative learning, etc. The realized learning environment also presents an adaptive support in 3D virtual world to consider the learning needs of different learners and to provide personalized learning contents to augment learning of the target users of the systems.

Future work deals with investigation of behavioral data and activities performed by learners in 3D space to concretize important parameter to augment learning experience through adaptive support. We also plan to address the issues of content presentation and navigational support in 3D space for multi-users. These findings will assist us to enhance the learning platform and to extend this prototype version towards final implementation.

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