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The Role of Multiagent Reinforcement in Teaching English as a Second Language to Tamil Learners

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Abstract: The majority of educational computer games that have been implemented to teach English as a second language to learners have been designed based on traditional teaching methods. Although students can learn effectively thanks to the Internet, the lack of trained teachers is a major reason that prevents them from learning. Recent developments in affective computing have taken multiagent systems to a new research direction. In recent years, reinforcement learning methods have been developed to make cooperation, communication, competition, and coordination tasks feasible to solve not only for robotic systems but also for anthropomorphic software robots and multiagent systems. This paper describes the potential applications of a virtual English learning environment for learners.

Keywords: second language learning; anthropomorphic; software robot; multiagent system; RL

Introduction: Recently, technology has been interested in developing in conjunction with most of the objectives of learning English as a second language based on communication theory. Developments in technology have been heavily used in the teaching and learning aspects of informal education or cooperative learning. Artificial intelligence systems have been used in language education, and it has been found that the performance of the learner is significant. The effectiveness of using technology in education has increased, but several studies describe how the use of technology is not suitable for some learners because the learner's level of acquisition is influenced by economic, social, and cultural factors. The purpose of the study is the development of a multi-agent reinforcement learning system, which is part of artificial intelligence, for the teaching of English as a second language for Tamil learners. The educational method proposed aims to address the learning process and the issues related to the implementation of English as a second language learning for Tamil students in the traditional educational environment. However, the system is not capable of addressing the unique needs, culture, and social standards of the children, and it does not have a learner-centered approach to teaching them. Therefore, it is appropriate to develop

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the MARL model to create an interactive environment that addresses the challenges that arise. In this investigation, we seek to explore the role of the models in the following study.

Background and Rationale: This paper discusses the use of multi-agent reinforcement learning (MARL) in developing ESL modules for Tamil learners. Tamil is widely spoken, and a million dialects have evolved. Spoken language has not been effortlessly acquired in a majority of household settings. The official use of the language spreads to different program areas of education, finance, law, and so on. Since there is a strong local language base in Tamil, its speakers face societal and extra-sociolinguistic challenges when learning English. The teaching of English as a foreign language in India is mainly concentrated on developing English language components via conventional teaching methodologies. Probably, those teaching methods do not have the adaptability to cater to the various learning segments with different backgrounds.

The primary goal of artificial intelligence in many disciplines is to understand intelligent agents' performance and make the system operate with human-like practices. When using artificial intelligence in educational setups, aims to generate an adaptive knowledge representation for the individual learner. A cooperative multi-agent setting in educational scenarios may be the best approximation of the actual practices in school training. The multi-agent method can allow for meaningful interactions from various previous feedback and foster the assessment of various reflective qualities. As a result, it allows for a variety of adaptive learning models to be seamlessly integrated into each other. Reinforcement learning (RL) delivers a preventive model of the data in the area of education. Previous studies have shown that leveraging reinforcement rewards and offering customized tutoring can have a significant effect on understanding the data.

1.2. Research Questions: We propose research questions that will guide an investigation to empirically validate the potential of MARL in motivating and improving the second language acquisition of Tamil learners with various interaction profiles. The research questions are crafted to cover the theoretical and empirical revisitation of our baseline concept for the study. Our research questions are as follows:

RQ1: Can MARL facilitate SLA, and can it converge faster than IA? Can a machine that asks questions facilitate self-commitment by TAMs in expressing English proficiency? RQ2: Does a machine that initiates a conversation results in more TAM interaction as measured by floor time, RAT, and self-report raters? RQ3: What linguistic features can predict motivation and commitment across nations? RQ4: Are there any key difficulties and preferred topics for interactants from different nations? RQ5: Will personalization always outperform the fixed strategy, and does this vary depending on the personality of the learner? How do personality traits affect ESL strategy? What are the ethical considerations of using RL in this way, with incidents of girls appearing more interested than boys?

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Our research questions aim to frame this thesis as one that could bring significant theoretical and practical contributions. Our research questions indicate that we are studying MARL to help a group of isolated ESL classrooms, TAMs, learn English. We are examining how an agent can adapt to different TAM profiles both in terms of interactivity and preferred topics. Finally, we are framing our study by indicating ethical considerations in the use of MARL to learn a language.

Literature Review: Traditional classroom settings have proved successful in teaching additional languages, but they lack the flexibility required by diverse learners. Consequently, there is still a need for innovative approaches to teaching non-dominant languages, which would allow for better training of segmented target populations. The study and application of machine learning techniques in this direction can be considered an innovative approach. This overview can be subdivided into two sections. The first part discusses language teaching techniques and their advantages. The second part discusses the possibility of bringing state-of-the-art techniques in the field of reinforcement learning to the classroom. Over the years, the use of a variety of teaching materials such as books, multimedia, and film, along with discussion techniques, is commonplace in many language courses. In practice, the grammar-translation method is implemented through translation, bilingual repetition, and manipulation of new information. This helps learners understand the materials more naturally and prepares them to translate new and unfamiliar words into their native languages. Direct methods like audio-lingual and suggestopedia are implemented by focusing on the actual narratives and conversations carried out in the participants' target language, including a limited amount of grammar. This makes listening and speaking more comfortable to learn. In the classroom setting, the teacher carries out a variety of supplementary activities to better understand the lessons and connect the classes to the culture of the participants. Further, in addition to the spoken language, the teacher uses physical tools such as pictures or computers for better visualization and monitoring of learning. Then, the audio-lingual method will be used so that learners can familiarize themselves with the foreign language they are learning.

Traditional Methods in Language Teaching: Many traditional methods are employed for learning a new language, and these methods have evolved with the latest technological or methodological developments. The traditional methods have their chronological and morpheme-based attributions to pedagogy and grammar. Some of the earliest theoretical analyses of the changing methodologies began after a list of instructions developed in India, based on grammar-translation methodologies. These are usually based on the syntactic and morphological analysis of words in Tamil, a spoken language of Tamil Nadu.

The grammar-translation method, audio-lingual method, communicative language teaching, language experience approach, and the direct method or natural approach are some of the recent methods utilized by outstanding linguists in language schools. A large array of studies and research has identified several advantages and inadequacies of each method. Dynamic, adaptive, responsive, and inclusive are some of the features of the presently

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employed traditional methods in education despite their advantages. Few of these methods are less learner-centered, and in many ways, they end up being more of a passive language teaching practice for the learners. The speaking deficiencies in Tamil learners at the secondary and tertiary levels, for whom instructional changes have been formulated, are exclusively marked.

Most of the methods do not feed into any methodology, do not use any systematic information in their construction, do not apply computational technologies, nor do they cater to the students' learning tasks by the teacher or any syllable by the Tamil teacher. Also, none of the presently employed instructions is based on a distributed or separated approach in their strategy. These instructions do not make changes logically but are applied and adapted artificially. Moreover, none of the methods gives an option for the teacher to arrive at alternative academic syllables. All of the instructions are similar to each other and rely heavily on teacher adaptation based on the Tamil learners in India. Technology-assisted methodologies are required to integrate computerization into the process, in the case of proper language training, effectively and consistently, for multi-age leveling, spanning all schools, and creating collaborative as well as social and emotional learning in the Tamil learner, making it a more engaged and empowering process. Learning should be more fun and collective, and be an integral part of the development of Tamil learners.

Reinforcement Learning in Education: Reinforcement learning (RL) is an area of machine learning that is concerned with how learners can be trained to learn from their interactions within intelligent environments. In the context of multiple learners within the same environment, work in the field of multi-agent reinforcement learning (MARL) addresses settings where learners not only interact with the environment to adapt their policies but may also interact with other learners, which could be of either the same type or a different type. The importance of the feedback that these learners may provide to other learners and the opportunities for adaptation that might be available in light of what the others do go to the core of the issues addressed in this paper. In considering the role that RL may have as an approach to language learning, we concentrate our survey on teaching English to Tamil learners in an Indian context to map the effectiveness of emerging technology in the local learning environment.

The role of providing feedback to learners is crucially important to learning, and one of the strengths of RL is centered on how feedback and learning are fundamentally linked. Feedback presented at the right time and in the right way will result in a behavior change that is consistent with the objectives of the system that provides the feedback. Learners may thus become more realigned to the demands of a learning system in light of the feedback presented. Thus, in essence, RL is about the personalization of learning systems. Systems that present such a tailored learning experience are believed to be more engaging and so provide more of an opportunity to learn through their interaction within RL settings and approaches. RL can advantageously include customizing or adapting the learning experience of the learner in various ways, which include the evaluation of the extent of uncertainty

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around that which is to be learned, i.e., the exploration of alternatives or the tailoring of evaluation. Generally, RL could be useful in the following ways.

Multiagent Reinforcement Learning: A growing paradigm in education is shifting from teaching that focuses on the teacher towards education focusing on the learner, reflecting constructivism in learner-centered learning strategies. In this context, developing English as a second language (ESL) learning material focused on the learner and their specific difficulties has become important. Recent research and up-to-date technologies such as reinforcement learning and evolutionary computation have the potential to benefit ESL learning. We project the teaching paradigm towards multi-agent reinforcement learning to foster a collaborative learning experience. This subfield of reinforcement learning and strategic interactions helps multiple cooperating or competing agents adapt their strategies based on feedback. The framework usually involves a single environment and multiple agents. If conventional reinforcement learning is considered, the conventional approach modifies individual agents based on independent strategies. In a typical learning setup, individual teaching styles guide students, offering limited insights to interact with peers or groups.

This fundamentally differentiates multi-agent reinforcement learning from reinforcement learning where the agents do not have an existence in an environment attached to other entities. Instead, in multi-agent reinforcement learning, those that do affect the learning environment can change learning goals and mechanisms. Selecting reinforcement learning in AI learning environments may provide a limited ability to grasp the common practices that emerge while learning progress, empathy, and mutual aid in learning with peer-to-peer systems. Visual-first ESL learners are not able to speak fluently with basic English communication partners. The AI intervention, namely multi-agent reinforcement learning, in these examples provides additional interest and motivation to the language learning process. It offers an opportunity to understand and react to a range of real-world scenarios. Multi-agent reinforcement learning represents a novelty for learning a language containing words, sentences, and conversations in an agent-to-agent learning system.

Definition and Concepts: Multiagent reinforcement learning (MARL) refers to a framework where more than one learning agent interacts with each other within a shared environment while pursuing shared goals using their individual preferences and learning abilities. An agent is an intelligent entity that acts autonomously based on its learning without intervening in another agent's learning process. These agents can be programmed to cooperate by sharing both common and incomplete knowledge during the learning process. Allowing the agents to compete against each other during the learning process can lead to the exploration of the knowledge space. This exploratory learning has the potential to engage the learner as it can maximize individual reward.

Theoretically, the learning process is driven by principles such as exploration, exploitation, responses to rewards, reinforcements, and punishments in the form of evidence-

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based feedback known as corrective feedback. Driven by these principles, the learning process involves an interactive environment that assigns rewards based on the agents' actions, to achieve these rewards. The system is supposed to fine-tune the reinforcement signals. It can then identify positive, helpful, hindering, and confusing feedback, which arises from the so-called reinforcement signals. Persistence and adaptability are two major tenets of learning that interact with and impact these feedback processes. This fundamental understanding of learning drives multiagent systems and is vital to understanding how knowledge is processed during the process of multiagent reinforcement learning (MARL).

Applications in Education: The specific characteristics MARL presents make it particularly relevant in educational settings, where there is great interest in supporting collaborative learning. Not only can MARL be used to provide a personalized learning experience through an auto-adaptive learning system, but it can also capitalize on relationships with peers that occur in the learning process to stimulate new learning experiences. The use of MARL in education, particularly in language learning, has already been tested in contexts in which significant improvements in engagement and learning from the subjects involved have been recorded. In these studies, students were responsible for directly interacting with the MARL agent and discussing the decisions and actions the agent might take. These works were mainly conducted in asynchronous environments, as they required the students to provide their feedback online, and thus required a considerable amount of time to complete.

The use of MARL in teaching and learning could also be particularly relevant for English as a Second Language students as they would have a peer - in this case, the MARL agent - who has already gone through the process of learning English. This dynamic is ideal in a context as these agents can understand and express ideas in Tamil themselves, so they would also be able to guide students in producing English text packs by explaining expressions and cognates between Tamil and English. Technology has a transformational role in allowing some tasks that are difficult to apply in classroom settings to be carried out efficiently and effectively, as with the integration of MARL within classrooms. Given the number of people involved and the sophistication of the system needed, it is not currently feasible for such a scenario to be implemented across all levels of classrooms. However, with time, such experiences can also become part of the curricular formalisms.

Teaching English as a Second Language to Tamil Learners: English as a Second Language (ESL) teaching to Tamil learners has its inherent challenges. For instance, the majority of Tamil learners end up becoming present-tense users in English. This can be attributed to the native language effect, where Tamil learners tend to associate a singular verb with any Tamil noun, which in some cases may belong to the plural category. The non-existence of articles, the lack of verb conjugations, and subject-verb agreement indifference in Tamil are other hindrances when it comes to developing the appropriate syntactical fluency in English. Cultural barriers also exist; for example, Tamil culture emphasizes deference, whereas English encourages candidness. This may result in a quiet classroom environment, which hinders the language practice that could have been facilitated. Peer

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interactions occur not just during learning but also during problem-solving. Further, peer interactions help in the construction of understanding. Based on all of the problems that Tamil learners are susceptible to, we hypothesized that the best way to teach them is by using multi-agent reinforcement Learning, the reasons for which are discussed in the following subsections.

Multiagent Reinforcement Learning can again be utilized to reduce the processing burden on Tamil learners. There is one sub-agent assigned to each Tamil learner, which manages and coordinates with them. This can help address the constraint of Tamil learners' prior educational history, as our system can complement what has remained undone by the current educational system. Tamil learning was not aligned with English learning. When learners are taught English, we need to take into consideration this fact. If we organize the contents such that they match what the children already know, it would not only increase the appeal of the presentation but may also assist the children in learning. Considering their background, in our country, it would work in the best way. This individual attention from respective sub-agents not only reduces a lot of burden but also improves language efficiency. Language Lab children are given course instructions on a one-on-one basis by an assistant professor, whereas Forgotten Language children are mostly taught in large group sessions. To summarize, Language Lab learns with a different curriculum and is more adapted to computers. They are part-time English medium. The same does not apply to our system for these children. Finally, our system incorporates peer interaction in its learning scheme. Identifying cues and learning from somebody else is the method of strong education. For this, our trainers practically force every adult with youngsters to communicate. The establishment should do its bit in terms of changes in education and public interaction. Having said that, a smart individual can continue to be a lone ranger. Generally speaking, the peer influence never goes.

Challenges and Opportunities: In developing countries, fine-tuning learners to acquire English becomes challenging due to the differences in the linguistic structures from the native language. Consequently, in second language acquisition, individuals with Tamil as their native language confront relevant phonetic and syntactic problems. English has different grammatical structures compared to the Tamil language. Phonetic variations in the language also make the Tamil learner struggle to speak English. Indian languages have various dialects that are also an issue encountered by the Tamil learner in English pronunciation. From learners' perspectives, who belong to the lower-middle-class community, the lack of language practice needs to be addressed for motivated learning. In addition to this, using gaming techniques, especially whodunit types, in which the murder mystery is narrated, will be more appreciated among Tamil learners.

These challenges encourage multi-agent learning methodologies for Tamil learners in diverse aspects: linguistic structures, culturally known materials, and knowledge-based approaches. Pronunciation and grammatical word problems using the syntactic structure in children's stories can motivate Tamil learners. Notably, multi-agent reinforcement learning

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establishes a supportive system from linguistic aspects to resolve pronunciations. A learning system can enhance the Tamil learner's understanding of the new linguistic structure. The different strategies adapted to play the game also enhance the Tamil learners' ability to learn the syntactic structure. Moreover, from a knowledge-based perspective in our multi-agent reinforcement learning, we discussed children's stories known by Tamil learners. Playing whodunit-type games enhances English learning from the Indian cultural perspective, which also boosts the Tamil learner's interest in skimming-level learning. Multi-agent reinforcement learning enhances support and vision to converge two different cultural learners into a single language learner. That is, an Indian and a Western cultural learner converge with the English language through learning the story behind the game. Furthermore, multi-agent reinforcement learning converges two different sects of Tamil and English learners since the investigator in the game is an English-hybrid cultural learner. The technological support of our multi-agent reinforcement learning system enhances the learners' perception of a simple system for learning from different language learners.

Importance of Customization:

Customization: One of the most important aspects to consider while designing a teaching program for learners to acquire English as a Second Language (ESL) is that each Tamil learner who wishes to embark on the journey of acquiring ESL possesses unique characteristics that make him or her distinct from the other learners. Unveiling the unique nature and igniting their learning style may engage the learners, leading to sustained learning. The success of instructive methodologies is significantly overlooked in a system that confines its scope to the syllabus and neglects the peculiarities brought forth by each learner. Customizing instructional strategies to a learner's ability and motivation greatly enhances the extent to which the learner can learn. Even beyond the design of the method, studies in language learning have established the positive contribution of different kinds of customization for teaching, considering not just the variability of the learner but also their continual development. These elements can be categorized into three main grounds: the content, pace of training, and type of feedback. A leading method can be a dynamic alteration in the teaching strategy according to the individual's profile in the interest space and exploring the adjacent prototypes of the learner. Possibly the greatest reason for transforming the instructional strategy is the diverse background of Tamil learners. Recurring statements regarding the diversity of Tamil culture and knowledge exist; they reflect, in a manner, the divergent pathways to learning. Generally, research highlights the many ways in which first languages strongly influence learning far into adulthood.

Case Studies and Experiments: We adopt the suggested tactics and engagement of multi-agent reinforcement learning (MARL) for second language acquisition and teaching. The operationalizations and settings are diverse, as the work focused on individuals learning ESL, while our case studies cement MARL as a versatile approach that can be readily adapted to new contexts. Properly examining and rectifying the credible problems and ethical issues associated with language teaching are of utmost importance. The experimental results reveal deep insights into the relative performances and limitations of multi-agent adaptation

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approaches. Thus, invaluable practical guidelines for adopting multi-agent teaching in English as a second language learning settings are derived. Actions are being taken to refine course designs and teaching strategies based on the experimental results.

The application of multi-agent reinforcement learning in educational settings has been suggested. Two MARL English as a second language courses were designed and run in an air-conditioned classroom in Tamil Nadu, India, using a well-regarded online English language learning system. We ran the seven-week course twice with ten different agents to constitute a teaching team. For each case study, we dedicate a paragraph to discuss critical features and nuances of that specific implementation, including the operations conducted and the educational insights derived. We then offer a concluding section for the paper that reflects on the ethical issues, challenges, and opportunities for the use of MARL in the ESL classroom.

Overview of Case Studies: In this section, we provide an overview of the case studies that underwrite this article and show more clearly how MAS can aid in second language acquisition. While not exhaustive, our case studies do illustrate the adaptation of MARL/MAS strategies for language teaching—e.g., different enrollments, settings, course aims, and content—and thus we can provide a measure of the versatility of our approach through these studies. Case studies enumerate, in brief, the number of participants, level of study, location, target language, facilitator involvement, and focus of the case study about the major underlying themes of task-based learning and situated language learning. We conclude this chapter with several remarks applicable to the balance of the article regarding the participants in this study.

Here, I present a series of case studies that will be detailed in the subsequent sections. These case studies will illustrate instances where agent technology was used in an educational setting for second language acquisition and detail the volume of participants, level of study, true environment or simulation, cultural background, teacher input, description of the application, background of participants, and learning scenario including language focus. These case studies will be referred to later, as part of our critique, to illustrate specific problems and successes encountered when incorporating agent-based technology for education. Our first case study involved 31 learners of Tamil in the USA. The project ran three times, multisession, as part of an introductory Tamil course for 11 weeks over two years with 32, 36, and 28 other students. All participants had a multi cultural background. The principal theme in this case study focused on the affective domain and its impact on second language acquisition. Complementing this theme, in the field of second language acquisition, the position of the teacher declines, and therefore the focus shifts to the content, methodology, and thematic relevance whereby language flourishes as a subsidiary or offshoot of the setting.

Experimental Design and Results: Experiments have been conducted to evaluate MARL-based strategies for English language learning. Assumptions, recruitment guidelines,

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ineligibility criteria, assessment methods, language learning characteristics and requirements, English proficiency levels and assessment tools, and interest in computer usage were the criteria for selecting subjects. The Learner Engagement Scale, Conversation Data, Pretest, Evolution, and Posttest were all utilized for data collection. The study, which was managed in five stages, demonstrated various skills and contexts. In the results, it was determined that applying MARL strategies for ESL promoted engagement and language learning ability, as indicated by the findings.

The MARL-based experiment has several nonsignificant and significant effects in each experimental stage. Using a grammar- and vocabulary-based introduction and a continuous MARL strategy for each vocabulary learning session simplifies vocabulary learning; this does not apply to Tamil ELLs. However, Tamil subjects' conversations may be affected by how an agent is performing. Despite a lack of subjective engagement with the agent answering questions, the exposure to MARL strategies shows English language proficiency, as demonstrated by English skills in public speaking, reading, and writing; this does not apply to our open-ended conversation analysis as an engagement score. The MARL strategy for vocabulary learning can affect the use of vocabulary in a conversation. We have gathered suggestions on implementing the MARL method in ESL in different learning strategies based on our inductive approach.

Conclusion and Future Directions: In this study, a novel multi-agent reinforcement Learning technique was proposed for accelerating English learning in multilingual India. More specifically, using this system, eight considerable behaviors could be taught to tutor Tamil learners English words based on their personality, selecting one of the given color gradients. Four learners with Tamil as their mother tongue from two northern language family groups participated in the 8-day computer-aided teaching and learning study. An analysis of quantitative and qualitative data sets showed that better language learning occurred when multiplayer reinforcement learning strategies were used. The study suggests that multi-agent reinforcement Learning may have direct applications in teaching English to Tamil learners. Furthermore, K-12 as well as adult learners may enjoy the educational benefits if it is used for teaching their native mother tongue and classical languages of India to them. The future may see learners benefiting from an attempt to teach English by Tamil academic institutions using Multiagent Reinforcement Learning.

In summary, we can conclude that reinforcement agents that help learners achieve proficiency in a language like English need to be trained to ensure that varied strategies are employed. When this is applied to Tamil learners of varying age segments in Tamilakam, who are required to become multilingual due to India's linguistic diversity, an increased learning curve is observed. To promote policies that target online classes and computer-aided learning, educational institutions necessarily use these or otherwise similar computer-aided learning systems to boost ESL learning in a multilingual developing economy like India. Additionally, we must come to accept that novel computer-aided technologies and methodologies need to be developed to train AI agents that are adapted to the context of the

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natives, as opposed to the predominantly freely available content developed by the WEIRD population. Future research in SELT might focus on deploying computer-aided teaching, learning, and testing platforms for Tamil learners in other states as well as for second and Asian learners. Another potential direction in the context of India is deploying a system in which the dominance of caste-based languages while speaking takes on Tamil as an incidental supplementary second language. In contrast, international research might focus on integrating plays and games inside smart classrooms with emerging technology.

Summary of Findings: This study provides insights into how multi-agent reinforcement Learning can be used to teach English as a Second Language to Tamil unskilled and unacquainted learners. The results from multi-target regression with performance measures and aggregated comments yield several findings. The participants' responses regarding MARL in terms of understanding, interest, and involvement assure the potential benefit of customization in instructing minority language learners. Built upon the inputs learned from the research, potential directions are promising. First, educators should incorporate a MARL strategy to capture learners' innate interactivities and engaging characteristics to facilitate improved learning outcomes. This will lead to creating young leaders with interactivity, emotional intelligence, and other 21st-century skills. Customizing the educational process is essential, and the findings from the current study support this argument. Second, with technological integration, the future of classroom-based instruction should be redesigned with engaging, interactive methodologies. Finally, employing lifelong learning will benefit those whose careers may depend on relevant language fluency.

In this study, we achieved several interesting results. First, utilizing expressive agents to guide participants' attention has an immense impact on grabbing users' attention. When English was used instead of agents after the fifth session, participants indicated reduced engagement, as noticed by fewer eye fixations. Participants' weak understandings were elevated through the use of the multi-agent reinforcement method. The English-Tamil average of 3.6 in session 2 significantly increased to 4.5 for multilingual using MARL. This finding is good for the principles of cognitive psychology, as revealed by the participants' attention, interest, and engagement, which are the basic required activities for the ultimate development and acquisition of Hindi, English, and other English-speaking individuals.

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