

Morphophonemic parser: A study of teachers and students



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ABSTRACT

The objectives of this study were to design a morphophonemic parser (MPP) and to get feedback from teachers and students after using the designed parser. Drastic changes have occurred in the field of education after the advancement of technology. New methods and techniques with digital content are widely used in this field. One of them is the use of parsers in educational institutions. Parser is a tool that helps to facilitate teaching and learning. The MPP is a parser that can be used in the teaching and learning process. The study used a mixed mode of research which includes qualitative and quantitative research methods. 400 school teachers and students were selected as informants for this study using a simple random sampling method. The study used a questionnaire as a data collection tool and analyzed using the survey analysis method. The main findings of the study are, that an MPP is designed with a set of morphophonemic rules and most of the teachers and students are satisfied and excited to use the designed MPP in their teaching and learning. The results show that 87% of the teachers and students strongly agree that they are satisfied and 64.5% of them said that the parser helps them to learn easily. These results suggest the use of MPPs in educational institutions.

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1. Introduction

Technology has minimized the works of the world. Education has utilized the technology because of its ease, speed, and time-saving. Educational institutions are implementing various new methods and techniques with the help of modern technology. Parsing is one such method. Parsing is a process of analyzing a set of symbols in natural language processing with a set of rules (Khurana et al., 2023). Teachers started to teach and students started to learn through software, applications, e-books, etc. in many educational institutions. Moreover, the concept of technology-augmented classrooms is becoming increasingly popular due to the proliferation of mobile computing and the availability of high-speed internet connections (Bramantoro et al., 2020). Hence, due to the availability of Internet facilities in many schools, they started to use smart classrooms. Even parsers, applications, software, etc. entered the classrooms.

The morphophonemic parser (MPP) is a parser that can be used in schools and colleges. Morphophonemics is one of the branches of linguistics. Payne (2012) identified that when a morpheme changes its shape in response to the sounds that surround it in a particular context; linguists often call the variation as Morphophonemics. The morphophonemics in the Tamil language are complex (Gray et al., 2018). Learning grammar rules for the Tamil language is very difficult as they have a very rich morphological structure which is agglutinative (Dhanalakshmi et al., 2010). Each and every word combination in the Tamil language determines a rule called as Morphophonemic rule or Sandhi rule. These rules are always confusing and the learners find them difficult at the syntactic level which is the problem among students and teachers. In order to overcome such a problem, an MPP is essential and it's the need of the study. When grammar is given, the tool or parser generates multiple-choice questions for concepts related to parsing and it evaluates students' attempts and provides hints for incorrect attempts (Karkare and Agrawal, 2016). Likewise, the parser has grammar and it provides hints for the teachers and students when they use it. The designed parser must be implemented and evaluated in the classroom. Oliver (2000) clarified that evaluation,

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put simply, is the process by which people make value judgments about things. In the context of learning technology, these judgments usually concern the educational value of innovations. During the evaluation, feedback, recommendations, and suggestions are important.

The present study was conducted based on two main objectives. They are to design an MPP for teaching and learning and to get feedback from teachers and students while using the designed MPP. The research questions are: How to generate an MPP with grammatical rules? And, what is the feedback from teachers and students after using the MPP? The significance of the study is that the morphophonemic rules provided in the designed parser are easy and can be used by both teachers and students. Also, the responses of teachers and students after using the parser will create awareness and enthusiasm among educators.

2. Literature review

A study was conducted by [Castro-Schez et al. \(2021\)](#) on predictive parsing learning. In this study, the researchers have proposed an Intelligent Tutoring System (ITS). This system is proposed to encourage students to learn by experimenting and proposing tasks on their own initiative, which develops the skills, abilities tools and knowledge needed to solve them successfully. Moreover, this system is designed, developed and applied for learning with predictive parsing techniques for computer science students during their academic courses. This system works in two approaches. In the first approach, the system extracts exercises from a source and proposes them to the student for solving. After the student completes the exercise, the system checks how correct the solution given by the student is and proposes new exercises to the student. These exercises are based on different criteria and according to the performance of the previous exercises. In the second approach, the system presents an exercise that gives step-by-step information with work examples and shows the student how to solve it. Probably the system creates many exercises by changing data and solving them with the already learned steps. After several such teaching stages, the system will gradually fade out the worked examples and finally, the students will be able to explain how to solve the exercise on their own. This system helps students to learn predictive parsing algorithms, which are a type of exercises found in compiler design and formal language processing courses included in the curricula for computer science degrees at the university level. Since this system is designed for computer science students, it cannot be used by students of other courses, especially language courses, which is the weakness of this study.

Further, [Ramasamy and Zabokrtsky \(2011\)](#) have developed a rule-based parser for the Tamil language. It has been implemented using corpus-based approaches. They have designed the parser

with annotation scheme based on Prague Dependency Treebank and with dependency relations. It works on manually annotated Tamil data for about 3000 words. Moreover, the researchers have used a set of linguistic rules including resolution of coordination, complementation, predicate identification and many more. The rule-based parser is used to analyze and process the textual data. With the rules given to the parser, it automatically analyzes the sentences, phrases, and words and provides accurate information, which is the major strength of this rule-based parser. The researchers say that this parser worked automatically without any errors for about 74% and the remaining 26% didn't work accurately due to unlabeled words. Although this study is implemented with corpus-based approaches, it works only on manually annotated words, which is the weakness of this study.

In addition, [Dhanalakshmi et al. \(2010\)](#) developed grammar teaching tools for students. It is based on Tamil grammar. The researchers claim that grammar plays an important role in good communication. Computer assisted grammar teaching tool makes the students to learn faster and faster. Keeping this in mind, the researchers developed a grammar teaching tool with sentence and word analyzing levels for Tamil language. Tools like POS tagger (Parts of Speech), chunking, dependency parser for sentence level, morphological analyzer, and generator for word level analysis are developed using machine learning based technology. The POS tagger reads the text of Tamil language and automatically assigns parts of speech to all the words like nouns, verbs, adjectives, adverbs, etc. found in the text. Further, chunking analyzes the sentences to identify constituents such as noun phrases, verb phrases, etc. In short, chunking breaks down sentences into phrases. The dependency parser analyzes the grammatical structure of a given sentence to identify the relationship between words. And, the morphological analyzer is designed to analyze the words of Tamil language. During this analyzing process, the parser analyzes the given word with all the information like, the root/stem, tense marker, person-number-gender, plural, case and other markers which is the strength of this study. The researchers say that the grammar teaching tools were useful for second language learners to understand the sentence construction. The only weakness of the tool is that it doesn't annotate the sentences because it works at the morphological level.

The present study differs from these studies. The previous studies focus on teaching and learning through predictive parsing learning, a rule-based parser, and grammar teaching tools. Moreover, these studies lack feedback during the implementation of these parsers in a real teaching and learning situation. If such feedback is collected from the teachers and learners, new versions can be designed according to their needs and the parser can be improved by eliminating the problems pointed out.

The researchers, [Duncanson et al. \(2020\)](#) stated that written feedback on research-related writing is an important educational component of novice researcher development. The present study has designed a parser and collected feedback or responses from educators and learners.

3. Method of research

The methodology is a theoretical justification of a research in a chosen subject, which includes principles, approaches, philosophies and models. Mixed mode of research method is implemented in this study. It is a mixture of common methods such as qualitative and quantitative. In order to narrate the design of the intended parser and to calculate the data collected from the students and teachers with different elements, mixed research mode is selected. Qualitative research is descriptive with the data collected from different sources. A researcher who follows a qualitative research approach observes, interviews, summarizes, describes, analyzes, and interprets phenomena in their real dimension ([Basias and Pollalis, 2018](#)). The quantitative research approach gives rise to many designs; experimental, quasi-experimental, and non-experimental designs ([Farghaly, 2018](#)). The study is conducted to incorporate both methods in a thoughtful manner in order to design the parser and to get feedback from the teachers and students. Both the research methods are used in this study to achieve the objectives of the study. The first objective of the study is achieved using the qualitative method and the second objective is achieved using the quantitative method. A well prepared questionnaire is used as an instrument for this study and the questionnaire is verified by an educationist. The questionnaire consists of items with yes or no options and a Likert scale response format. Likert scale is used as one of the most basic and widely used psychometric tools in educational and social science research ([Joshi et al., 2015](#)). The study is limited to only students and teachers of 5 educational institutions in Malaysia. The names of educational institutions are strictly confidential. Moreover, the study is conducted on a public university-funded research grant. Data is collected using a questionnaire from 350 students and 50 teachers from renowned schools in Malaysia. A simple random sampling method is used to select the informants for the study. [Noor et al. \(2022\)](#) investigated that simple random sampling is a probability sampling method that provides researchers with an opportunity to select participants for their study randomly and without bias. Moreover, they mention simple random sampling is a widely utilized sampling method in quantitative studies with survey instruments. The collected data through the questionnaire are analyzed using survey analysis method and the results are shown in [Figs. 1-3](#) and [Tables 1-3](#). Microsoft Excel and the website are used for this study to calculate.



Fig. 1: MPP

4. Results and discussions

The design of the planned parser is narrated in the initial part of this section and later the analysis of the collected data from 350 students and 50 teachers is described. The gender classification and the responses through the questionnaire are presented. Discussions and comments are also included.

4.1. Design of the MPP

Language plays an important role in education and society. Four basic skills are important to master a language: listening, speaking, reading, and writing. To speak and write, correct grammar should be followed. Grammar is a set of rules and these rules, especially morphophonemic rules, are not easy for a student to memorize. Therefore, a parser is designed. Parsing is a normal technique that can be used in the field of natural language processing. In a language like Tamil, parsing should be done on two linguistic levels morphological level and syntactic level. The former linguistic level deals at word level and the latter deals at sentence level linguistically. The morphological parser is designed at the syntactic level. The MPP can parse a sentence level with a set of morphophonemic rules. These rules are collected from the ancient Tamil grammar books *Tholkappiyam* and *Nanuul*. These rules are fed to the parser with information about the sentences. The dependency parser called *ThamizhiUDp* ([Sarveswaran and Dias, 2020](#)) is designed with these grammar books to parse at the morphological level.

The parser MPP is designed with rule-based and machine language approaches. The collected morphophonemic rules are incorporated into the system using machine language. Sentence by sentence morphophonemic rules are generated and incorporated. The morphophonemic rules of the Tamil language are categorized into four, namely, addition, deletion/loss, change and regular (no change). In this parser, only three categories addition, deletion/loss, and change are incorporated. With the built-in rules, the parser identifies the sentence and informs which morphophonemic rule was found in that particular sentence. For example, if addition rule is found in the sentence, it informs the viewer (student/teacher). It is easy for teachers to use this parser. Once the parser is opened, a large number of sentences of different types (simple, compound and complex sentences) are displayed. When the teacher moves the mouse cursor over any sentence, the morphophonemic rule of that sentence

is immediately displayed. In this way, the teacher can easily teach and learn the morphophonemic rules. When the designed MPP was tested in the Language Technological laboratory, Raj Technologies, India, it showed 100% success. Fig. 1 shows the internal look of the designed parser.

4.2. Responses of the informants

As mentioned earlier, data are collected from 400 informants. All the informants actively participated

in the data collection process to fill out the questionnaire and submit it on time. A total number of 400 responses were received. Both the students and teachers are provided with a similar questionnaire since the MPP is used for the first time in their schools. Table 1 given below shows the details of the informants’ responses. The mean and standard deviation of the responses and no response samples are also calculated.

Table 1: Responses

No.	Type of informant	Response	No response	Percentage	Mean	Standard deviation
1	Students	350	0	100%	175	247.48737
2.	Teachers	50	0	100%	25	35.355339

4.3. Classification of informants on gender

From the selected 350 student population, 280 females and 70 males are selected as informants in the study. And all the selected 50 teachers population are female. Most of the schools have more number of female students and teachers as

compared to male students and teachers. This is the reason for selecting more female informants for this study. Moreover, the informants are selected randomly. This is shown in Table 2. The mean and standard deviation of the female and male students and teachers samples are also calculated.

Table 2: Gender

No.	Gender	Students	Teachers	Mean	Standard deviation
1	Female	280	50	165	162.63456
2.	Male	70	0	35	49.497475
	Total	350	50		

4.4. Use of MPP in schools

The information gathered through the questionnaire is given here. Taherdoost (2022) in the study mentions that, Yes or No options can be appropriate in case of gathering quite definite answers and such answers can provide adequate information. In order to get adequate information Yes or No responses are received through the element, did you teach or learn using MPP in your schools? The majority of the informants replied No and a few answered Yes. In brief, out of the total 400 informants, 369 responded as No and 31 as Yes. When further questioned by the informants who replied Yes, they responded that they used a parser which is related to word formation. Fig. 2 shows the details of the respondents.

said Yes or in other words all the 400 informants responded positively. This shows that, all the informants are excited and eager to use the parser in their schools. The details are shown in Fig. 3.

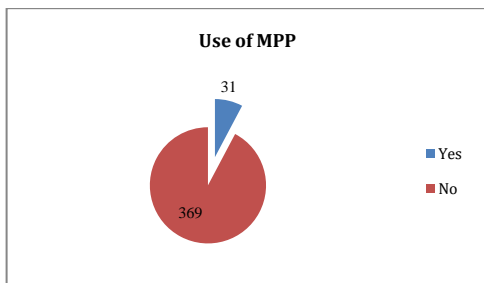


Fig. 2: Use of MPP

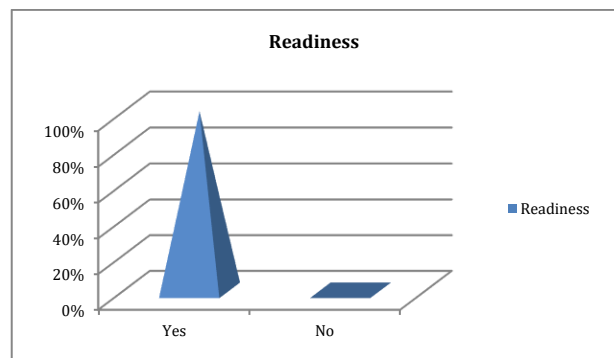


Fig. 3: Readiness

4.5. Readiness to use MPP in schools

The next element is about the readiness to use MPP in their schools. Fig. 2 shows the responses of the data of willingness to use MPP. All the informants

4.6. Responses for the elements

Subsequent to the initial query phase with participants, the research team presented the MPP for evaluation. This parser comprises a series of sentences governed by specific morphophonemic regulations, which are categorized into processes of addition, deletion/loss, and modification in relation to the sentences. Following this exposition, an empirical investigation employing the MPP was conducted among students and educators. The study utilized a Likert scale response format, encompassing a range of verbal anchors from satisfaction to dissatisfaction and agreement to disagreement. The scale included options such as

Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

The gathered data, upon evaluation of the questionnaire items pertinent to the MPP, revealed a spectrum of responses. Concerning the ease of accessing and utilizing the MPP, the responses were as follows: 224 participants indicated Strongly Agree, 136 Agree, 28 Neutral, and 12 Disagree. Regarding the legibility of sentences and rules within the MPP, a predominant majority (288 respondents) selected Strongly Agree, with 110 opting for Agree, and a mere 2 remaining Neutral. In terms of the structural organization of the morphophonemic rules, the responses were distributed as 122 Strongly Agree, 209 Agree, and 69 Neutral. Additionally, the comprehensibility of the provided samples in the MPP elicited 147 responses for Strongly Agree and 253 for Agree.

Furthermore, when inquired about the inclusion of all three categories (addition, deletion/loss, and change) in the MPP, the distribution of responses was 96 Strongly Agree, 98 Agree, 122 Neutral, 80

Disagree, and 4 Strongly Disagree. In the assessment of the MPP's overall functionality, the response was overwhelmingly positive with 369 Strongly Agree, 30 Agree, and 1 Strongly Disagree from a total of 400 participants. For the query regarding the MPP's efficacy in facilitating learning or teaching, the responses were 41 Strongly Agree, 258 Agree, 79 Neutral, 20 Disagree, and 2 Strongly Disagree. Lastly, regarding satisfaction with the MPP, 348 participants indicated Strongly Agree, 51 Agree, and 1 Neutral.

These findings indicate a predominant inclination towards agreement (Strongly Agree and Agree) among the participants, with a relatively minor proportion expressing disagreement (Disagree and Strongly Disagree). Vargas-Cuentas et al. (2023) in their study say that the participants expressed their satisfaction with the research experience and acknowledged their program. Similarly, as the data of the study shows, the informants expressed their satisfaction with the MPP. Table 3 provides the details with mean and standard deviation.

Table 3: Elements

No.	Elements	SA	A	N	D	SD	Mean	Standard deviation
1	Easiness to open and use the MPP	224	136	28	12	-	100	99.331096
2	Sentences and rules are readable in the MPP	288	110	2	-	-	113.3	113.03687
3	The morphophonemic rules are well-structured	122	209	69	-	-	133.3	70.684746
4	Samples are understandable	147	253	-	-	-	200	74.953319
5	All three categories such as addition, deletion/loss, and change are provided	96	98	122	80	4	80	45.055521
6	MPP works well	369	30	-	-	1	133.3	204.60775
7	MPP helps to learn/teach effectively	41	258	79	20	2	80	103.54951
8	Are you satisfied with the MPP?	348	51	1	-	-	133.3	187.58021

SA: Strongly agree; A: Agree; D: Disagree; SD: Strongly disagree

4.7. Suggestions for improvement

In the process of eliciting feedback for the enhancement of the MPP, four distinct categories of recommendations were received from the participants. These suggestions include (1) the incorporation of a greater number of exemplary sentences within the MPP; (2) the sequential arrangement of morphophonemic rules, commencing with the more fundamental ones; (3) the development of the MPP as an application, thereby enabling its accessibility via smart devices such as smartphones and tablets; and (4) the systematic organization of sentence patterns, including simple, compound, and complex structures, within the MPP. These insightful recommendations provided by the participants are being duly considered and are slated for integration into the forthcoming iteration of the MPP.

The current research undertook the creation of a parser, embedded with morphophonemic rules, specifically tailored to the Tamil language. This endeavor was aimed at achieving the initial objective of the study. Subsequently, a comprehensive survey was conducted, gathering responses from school-based participants, in order to fulfill the secondary objective of the investigation. In a study on survey, Li et al. (2022) mentioned that parsing contains several tasks, including connectives detection, argument labeling and discourse relation recognition, attribute

labeling. According to the researchers Premjith et al. (2018), morphophonemic (sandhi) splitting is important in a language analysis. Their study supports the idea about a parser with splitting a sentence with morphophonemic rules. Hence, the designed MPP is incorporated with these rules. Next is regarding the responses which are based on the second objective. The current study reveals that an MPP is essential in a school environment to learn and to teach the morphophonemic rules of Tamil language. Besides, the data show that most of the informants are willing to use it in their teaching and learning processes and they are satisfied. Suggestions are also provided by the informants for the further improvement of the parser. Dhabeekar et al. (2022) conducted a survey on English parsing sentences and concluded that many suggested for an online system for parsing sentences. In this study too, the informants suggested to design the parser as application so that it can used with latest technology with smart. Even the finding of a study conducted by Kumar et al. (2023) discloses the importance of using technology in educational institutions.

5. Conclusion

The present article delineates a comprehensive study on a specifically designed MPP and articulates the feedback and recommendations offered by selected participants concerning this parser. The

analysis of the collected data reveals a predominant affirmation of the parser's efficacy and user satisfaction. Specifically, a substantial number of respondents, totaling 369 and 348, strongly agreed with the parser's effective functioning and expressed satisfaction, respectively. Furthermore, 258 participants acknowledged the utility of the MPP in enhancing their teaching or learning experiences.

Significant insights emerged from the suggestions proffered by the participants, aimed at augmenting the functionality of the parser. The overarching conclusions of this study underscore the parser's successful performance. A majority of educators and students expressed gratification and enthusiasm in integrating the parser into their pedagogical and learning methodologies. The design of the MPP facilitates its application in educational settings, enabling the simplified acquisition and teaching of morphophonemic rules. The parser is crafted to ensure accessibility, requiring minimal guidance, as delineated in the accompanying help menu.

Looking ahead, the scope for further research in educational institutions is vast, particularly in evaluating the impact of integrating technological tools, such as parsers, compact discs, and online dictionaries, in teaching and learning environments. Such investigations aim to foster awareness and enthusiasm among educators. Additionally, expansive studies involving a diverse and larger sample size from various schools are suggested, particularly post-implementation of the designed MPP, to further assess its effectiveness and applicability in educational contexts.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

- Basias N and Pollalis Y (2018). Quantitative and qualitative research in business and technology: Justifying a suitable research methodology. *Review of Integrative Business and Economics Research*, 7(1): 91-105.
- Bramantoro A, Alzahrani AA, Bahaddad AA, and Alfakeeh AS (2020). Cloud-based learning service platform for multilingual smart class. *International Journal of Advanced and Applied Sciences*, 7(7): 83-91.
<https://doi.org/10.21833/ijaas.2020.07.010>
- Castro-Schez JJ, Glez-Morcillo C, Albusac J, and Vallejo D (2021). An intelligent tutoring system for supporting active learning: A case study on predictive parsing learning. *Information Sciences*, 544: 446-468.
<https://doi.org/10.1016/j.ins.2020.08.079>
PMid:32958966 PMCID:PMC7495305
- Dhabekar H, Rathi C, Mundhra H, Helge P, and Rajput K (2022). A survey paper for parsing of English sentences using context-free grammar.
<https://doi.org/10.20944/preprints202204.0047.v1>
- Dhanalakshmi V, Kumar MA, Rekha RU, Soman KP, and Rajendran S (2010). Grammar teaching tools for Tamil language. In the 2010 International Conference on Technology for Education, IEEE, Mumbai, India: 85-88.
<https://doi.org/10.1109/T4E.2010.5550056>
- Duncanson K, Schmidt D, and Webster E (2020). Giving and receiving written feedback on research reports: A narrative review and guidance for supervisors and students. *Health Education in Practice: Journal of Research for Professional Learning*, 3(2): 6-26.
<https://doi.org/10.33966/hepj.3.2.14767>
- Farghaly A (2018). Comparing and contrasting quantitative and qualitative research approaches in education: The peculiar situation of medical education. *Education in Medicine Journal*, 10(1): 3-11. <https://doi.org/10.21315/eimj2018.10.1.2>
- Gray SH, Ehri LC, and Locke JL (2018). Morpho-phonemic analysis boosts word reading for adult struggling readers. *Reading and Writing*, 31: 75-98.
<https://doi.org/10.1007/s11145-017-9774-9>
PMid:29367806 PMCID:PMC5752731
- Joshi A, Kale S, Chandel S, and Pal DK (2015). Likert scale: Explored and explained. *British Journal of Applied Science and Technology*, 7(4): 396-403.
<https://doi.org/10.9734/BJAST/2015/14975>
- Karkare A and Agrawal N (2016). Parseit: A tool for teaching parsing techniques. In the Proceedings of the 47th ACM Technical Symposium on Computing Science Education, Memphis, USA: 590-590.
<https://doi.org/10.1145/2839509.2850513>
- Khurana D, Koli A, Khatter K, and Singh S (2023). Natural language processing: State of the art, current trends and challenges. *Multimedia Tools and Applications*, 82(3): 3713-3744.
<https://doi.org/10.1007/s11042-022-13428-4>
PMid:35855771 PMCID:PMC9281254
- Kumar M, Selistust FTJ, and Ponniah K (2023). A study on utilizing SPALT technology in the classroom. *International Journal of Advanced and Applied Sciences*, 10(3): 130-135.
<https://doi.org/10.21833/ijaas.2023.03.017>
- Li J, Liu M, Qin B, and Liu T (2022). A survey of discourse parsing. *Frontiers of Computer Science*, 16(5): 165329.
<https://doi.org/10.1007/s11704-021-0500-z>
- Noor S, Tajik O, and Golzar J (2022). Simple random sampling. *International Journal of Education and Language Studies*, 1(2): 78-82.
- Oliver M (2000). An introduction to the evaluation of learning technology. *Journal of Educational Technology and Society*, 3(4): 20-30.
- Payne T (2006). *Exploring language structure: A student's guide*. Cambridge University Press, Cambridge, UK.
<https://doi.org/10.1017/CB09780511806483>

- Premjith B, Soman KP, and Kumar MA (2018). A deep learning approach for Malayalam morphological analysis at character level. *Procedia Computer Science*, 132: 47-54. <https://doi.org/10.1016/j.procs.2018.05.058>
- Ramasamy L and Žabokrtský Z (2011). Tamil dependency parsing: Results using rule-based and corpus-based approaches. In *the Computational Linguistics and Intelligent Text Processing: 12th International Conference*, Springer Berlin Heidelberg, Tokyo, Japan: 82-95. https://doi.org/10.1007/978-3-642-19400-9_7
- Sarveswaran K and Dias G (2020). ThamizhiUDp: A dependency parser for Tamil. *ArXiv Preprint ArXiv:2012.13436*. <https://doi.org/10.48550/arXiv.2012.13436>
- Taherdoost H (2022). Designing a questionnaire for a research paper: A comprehensive guide to design and develop an effective questionnaire. *Asian Journal of Managerial Science*, 11(1): 8-16. <https://doi.org/10.51983/ajms-2022.11.1.3087>
- Vargas-Cuentas NI, Martinez E, Gonzalez M, and Leon I (2023). Evaluating the outcomes of a scientific seedbed program for enhancing research capacities in young students. *International Journal of Advanced and Applied Sciences*, 10(5): 211-220. <https://doi.org/10.21833/ijaas.2023.05.025>