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Using TreeForm for Enhancing English Language Majors' EFL Syntactic Competence

MARWA SAID MUSTAFA EL-GARAWANY
Faculty of Archaeology and Languages, Matrouh University, Egypt
Author email: marwaal-garwani@mau.edu.eg

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Abstract

Despite its importance for their academic achievement, many English Language majors find syntax a challenging subject matter, causing many syntactic inadequacies in their oral and written examinations. Tree diagrams have been used in syntactic analysis because of their distinct advantages in syntactic representation and organization. Computer-based tree diagrams could provide a useful means to visually communicate students' understanding of syntactic concepts, providing a wide range of affordances. This study investigated the effect of using TreeForm on enhancing English Language majors' EFL syntactic competence. Participants (N = 30) were second-year students in the Department of English Language and Literature, Faculty of Archaeology and Languages, Matrouh University, during the first semester of the 2022-2023 academic year. They were randomly divided into two groups: a control group (n = 15) which received traditional instruction and an experimental group (n = 15) which used TreeForm for six weeks. An EFL syntactic competence test was developed and administered after experimentation. Additionally, semi-structured interviews were conducted to explore students' perceptions of using TreeForm in enhancing their syntactic skills. During the experiment, students created syntax trees using the TreeForm features to analyze the assigned sentences applying the phrase structure rules, peer-reviewed, edited, and saved them for publication and use in other assignments. Results revealed that the experimental group significantly outperformed the control group in EFL syntactic competence. Thus, using TreeForm had a positive effect on enhancing English Language majors' EFL syntactic competence. The students also had largely positive perceptions toward its use. Such results suggest that TreeForm might be used to promote syntactic competence among EFL learners.

INTRODUCTION

Originated from the Ancient Greek *sýntaxis*, meaning 'setting out together' or 'arrangement', the term syntax refers to the branch of linguistics which studies sentence structure: the rules or principles that govern how words are put together to build well-formed phrases and sentences to create meaning within a particular language (Miller, 2002; Richards & Schmidt, 2010; Sportiche et al., 2014; Tallerman, 2020; Valin, 2004). In this use, syntax is distinguished

from morphology, the study of word internal structure- how words are formed out of smaller units (i.e., morphemes). Both syntax and morphology constitute the two main divisions of what is traditionally referred to as grammar (Radford, 2009). Thus, avoiding the term 'word', syntax is "the study of the interrelationships between elements of sentence structure, and of the rules governing the arrangement of sentences in sequences" (Crystal, 2008, p. 471). Similarly, Brown and Miller (2013, p. 431) define syntax as "the analysis of the arrangements of words in phrases, phrases in clauses, and clauses in sentences and the grammatical relations between them. It deals with the order of constituents, syntactic linkage, and dependency relations". This regular framework permits the automatic processing and production of information and the marking of certain grammatical categories that have developed over time through repeated usage (Genetti, 2019).

Concerning the concept of sentence structure and its elements, Chomsky in his *Syntactic Structures* in 1957, devised and disseminated the concept of transformational generative grammar, which is the predominant approach to syntax today (VanPatten & Benati, 2010). It aims to define a language analysis system that acknowledges the relationships between various sentence elements and describe these relationships using a small and finite (i.e., limited) set of rules or principles (some of which are called transformations) that will be capable of generating or producing a large and infinite (i.e., unlimited) number of well-formed word sequences or sentences (Crystal, 2008; Richards & Schmidt, 2010; Yule, 2014). This approach assumes universal language properties and parameters which establish the various dimensions on which languages vary. Syntactic research, therefore, aims to uncover these principles and parameters to justify language behavior (VanPatten & Benati, 2010). According to Chomsky (2002), the central idea of this approach is that there is a distinction between surface structure and deep structure. Thus, there must be some underlying similarity relating to these two superficially different sentences: *Farida broke the fence* and *The fence was broken by Farida.* In traditional grammar, the former is called an active sentence, focusing on what *Farida* did, and the second is a passive one, focusing on *The fence* and what happened to it. They differ in their surface structure, that is, the different syntactic forms they have as individual sentences. Despite this superficial difference, they are very closely related, even identical, at their underlying level which is called their deep structure. It is an abstract level of structural organization in which all the elements determining structural interpretation are depicted. That deep structure can yield many other surface structures such as *It was Farida who broke the fence* and *Was the fence broken by Farida?* In brief, the grammar must show how a single underlying structure can turn into different surface structures (Yule, 2014). "Deep and surface structures can be represented by phrase-markers. Transformational rules apply to underlying phrase-markers to give derived or surface phrase-markers" (Fowler, 2017, p. 15). The most convenient mode of such representation is called a tree diagram (Kroeger, 2005; Richards & Schmidt, 2010; Valin, 2004).

In syntax instruction, a tree diagram enables students to identify the structure of a sentence and analyze it based on its surface and deep structures. The ability to draw tree diagrams can therefore provide a measure of students' ability to analyze sentences and sentence structures. Proper representation of sentence elements in a tree diagram can indicate that students have a thorough comprehension of each element, from the word level to the phrase level. However,

research in this area is limited, revealing that EFL students find drawing tree diagrams problematic, especially without sufficient knowledge and practice (Ali et al., 2023; Wang, 2010). Wang (2010) reviewed students' examination papers and explored the difficulties encountered when constructing tree diagrams. Common problems included using ternary branching, improper marking of syntactic categories, ill-formed structural hierarchy, projection from incorrect heads, misrepresentation of different clauses, and mistreatment of adverbials. Likewise, Ali et al. (2023) examined students' test and survey responses and found that students had difficulties in determining phrase structure rules and word classes, placing words or phrases based on their syntactic categories, identifying ambiguous sentences, and pulling arrows on their tree diagrams. Thus, tree diagrams should be included in a lecturer's repertoire of syntax teaching practices with a detailed explanation on how to draw them (Wang, 2010), specifically using a computer to facilitate students' learning and assessment where missing or incorrectly placed nodes could be easily recognized and acted upon accordingly (Derrick & Archambault, 2010; Yin, 2012).

Context of the problem

With the widespread outbreaks of the COVID-19 pandemic and owing to the recent calls for the digital transformation of higher education institutions, all Egyptian universities were closed in the second semester of the 2019-2020 academic year in mid-March 2020 and online learning was applied till the end of the second semester of the 2020-2021 academic year as an alternative to the ordinary face-to-face leaning. Thus, English Language majors at the Faculty of Archaeology and Languages, Matrouh University, were given their courses online using Microsoft Teams to upload materials, facilitate course delivery, monitor students' progression, and keep communicating with them. Regarding students' assessment in "English Syntax I" and "English Syntax II" courses, they were required to submit their weekly assignments virtually after attending their online sessions. Some of the required assignments were devoted to applying the phrase structure rules and analyzing given sentences using tree diagrams. Hence, students drew their trees by hand, scanned, and uploaded them to the platform. Those hand-drawn trees showed poor readability and incompleteness, making them difficult for interpretation and evaluation. Besides, students' performance in such dimensions like understanding grammatical terms, constructing syntactically correct phrases and sentences, applying affix attachment and subject-verb agreement, detecting ambiguous sentences, and identifying and correcting grammatical mistakes was unsatisfactory, even after returning to face-to-face learning as the pandemic receded. These inaccuracies negatively affected the students' spoken and written discourse, causing poor academic achievement in their final examinations which were barely passed (gaining a score above 60%). This inefficiency in EFL syntactic competence may be due to (a) the negative habits transfer and interlingual interference; Arabic uses the verb-subject-object (V-S-O) pattern which is different from English that follows the subject-verb-object (S-V-O) word order, (b) the insufficient knowledge of English grammar, especially syntax, and (c) the minimal and inadequate grammar instruction students received prior to entering the tertiary level (Al-Hamzi et al., 2023; Al-Shahrani, 2018; Al-Shallakh et al., 2021; Al-Sofi, 2022; El-Mahdy, 2023; Faraj, 2023; Sadouk, 2020).

To document this problem, the researcher conducted semi-structured interviews with 14 second-year English Language majors during the second semester of the 2021-2022 academic year to explore students' perceptions relating to syntax, which has been a daunting and difficult subject matter despite its importance. The results revealed that most respondents rated the ability to analyze and construct correct phrases and sentences as average and below average. They also mentioned that using lecturing, paper-based tree diagramming, and teacher corrective feedback were not effective enough for their syntactic development. Thus, the present study was designed to help students to improve their EFL syntactic competence through using the computer-based tree diagramming tool TreeForm which was selected because of its availability, convenient installation, and empowering affordances. Unlike LaTeX and other labelled bracket notation tools, it provides a user-friendly drag-and-drop feature to build syntax trees without previously defined rewrite rules that linguists and students often struggle with. It permits them to edit tree structure and syntactic features till reaching the intended output. It generates high-resolution graphic files that can be inserted into various word processors and used in other related activities (Carnie, 2021; Derrick & Archambault, 2010; Kiss & Alexiadou, 2015). Therefore, this study contributes to the advancement of syntax instruction research by providing EFL university lecturers and curriculum planners with an innovative intervention based on using TreeForm to enhance students' syntactic skills.

Questions

The present study addressed the following research questions:

RQ1: What is the effect of using TreeForm on enhancing second-year English Language majors' EFL syntactic competence?

RQ2: What are the perceptions of second-year English Language majors regarding using TreeForm in enhancing their EFL syntactic competence?

LITERATURE REVIEW AND RELATED STUDIES

Syntactic competence

According to Yule (2014, p. 291), syntactic competence is "the ability to use words and structures accurately as part of communicative competence", since human communication involves knowledge of how to form syntactic structures and knowledge of how to use these structures in specific communicative contexts (Meyer, 2009). For Lightbown and Spada (2021), it is the ability to understand and construct grammatically correct phrases and sentences. Nur'aeni et al. (2020) define it as the ability to produce acceptable sentences whose components are arranged according to the rules of the sentence formation system. It focuses on characterizing the grammatical/well-formed sentences and distinguishing them from ungrammatical/ill-formed sentences. "Grammatical sentences are those that are in accord with the rules and principles of the syntax of a particular language, while ungrammatical sentences violate one or more syntactic rules or principles" (Valin, 2004, p. 3).

The syntactic structure of sentences can be divided into two distinct but interrelated aspects: relational structure and constituent/phrase structure. Relational structure encompasses not only grammatical relations such as subject and direct object but also relationships like modifier-modified, e.g., *historic building or move slowly* (*historic, slowly* = modifier, *building, move* = modified) and possessor-possessed, e.g., *Adam's house* (*Adam's* = possessor, *house* = possessed). Constituent structure is concerned with the hierarchical organization of the units (constituents) into which the words in a sentence are combined. For example, in the sentence *the scholar read a journal in the library*, the unit/constituent *the scholar* composed of a noun and an article/determiner is called a noun phrase (NP). The preposition *in* and the NP *the library* following it also form a constituent called a prepositional phrase (PP). The constituent *read a journal* composed of a verb plus an NP is called a verb phrase (VP). Using labelled bracketing, the constituent structure of this sentence can be represented as follows: [NP The [N scholar]] [VP [V read] [NP a [N journal]] [PP [P in] [NP the [N library]] PP] VP] (Valin, 2004). An adverbial phrase (Advl P) contains an obligatory adverb, optionally preceded by an intensifier which specifies the degree to which an adverb will apply. For instance, in the sentence *the student works very quickly*, the constituent *very quickly* is an Advl P. The adjective phrase (AP), like the Advl P, contains an optional intensifier and an obligatory adjective. Unlike the Advl P, it may also take an optional PP. In the sentence *Sarah is very fond of cats*, the constituent *very fond of cats* is an AP (Larsen-Freeman & Celce-Murcia, 2016). Nouns, verbs, adjectives, adverbs, and prepositions are traditionally termed as parts of speech or word classes; in contemporary linguistics they are called lexical categories. They are divided into open class categories from which new words can be formed (i.e., nouns, verbs, adjectives, and adverbs) and closed class categories such as prepositions, determiners, auxiliaries, complementizers, coordinators, and modals (Kroeger, 2005; Valin, 2004).

Constituent structure is merely formal as specified in terms of the paradigmatic (substitution) and the syntagmatic (cooccurrence) properties of constituents rather than their semantic properties. Formal criteria include (a) internal structure, indicating that a particular constituent contains certain elements but not others, and (b) external distribution, meaning that a particular constituent can occur in a specific range of morpho-syntactic contexts. The internal structure criterion is paradigmatic since certain elements may substitute one another within certain types of constituents but no other types. A pronoun, for instance, can replace the elements in an NP, but not in a VP, AP, or PP. On the other hand, the external structure criterion is syntagmatic since each type of constituents has a distinct set of possibilities for cooccurring with other elements in morpho-syntactic contexts. For example, an AP can cooccur with a noun inside an NP or with the copula BE within a VP but not with a preposition in a PP. An NP, in contrast, can occur in all three of these grammatical contexts (Aarts et al., 2014; Morrish, 2015; Valin, 2004).

Breaking sentences down into their constituents to uncover their structure is known as parsing or constituent analysis, while the specification of their structure involves the formulation of phrase structure rules. These rules are arranged in a hierarchy so that the first rule tells what the largest unit, namely the sentence (S), is composed of. The next rule takes one of the constituents of the sentence and further breaks it down to reveal its composition (Larsen-Freeman & Celce-Murcia, 2016). Summary of the phrase structure rules is introduced in Appendix A.

For example, the formulation of a simple sentence like *the mongoose attacked the snake* demonstrates that it contains an NP (*the mongoose*) and a VP (*attacked the snake*). The NP contains a determiner (*the*) and a noun (*mongoose*) whilst the VP contains a verb (*attacked*) and another NP (*the snake*). In the syntax-learning process, the conscious (explicit) knowledge of such rules and their representations provides the scaffolding for the unconscious (implicit) knowledge on which language speakers can create any number of different sentences automatically. It allows them to substitute different words but retain the same structure so that sentences *like the boy kicked the ball* and *the cat chased the mouse* would also qualify as sentences with the same structure (Harmer, 2001; Kroeger, 2005; Purpura, 2004). Operationally, explicit syntactic knowledge refers to students' explanations of the phrase structure rules and is utilized when analyzing sentences while implicit syntactic knowledge means applying these rules "in some kind of performance involving either judging the grammaticality of sentences or actual language use" (Ellis, 2008. p. 147). Converting explicit knowledge into implicit knowledge involves three simultaneous processes, namely input processing, system change, and output processing. First, input processing illustrates how students understand the meaning of grammatical concepts and how form-meaning associations are made, transforming input into intake. Second, system change describes how students accommodate or incorporate new syntactic structures into their interlanguage and how this change restructures the implicit system of language. Third, output processing involves how students access the newly acquired syntax to produce meaningful sentences/utterances spontaneously (Lee & VanPatten, 2003). Knowledge and application of the phrase structure rules (frequently called syntactic competence) should therefore be presented and taught to English Language majors in their linguistics and syntax courses to achieve the desired academic and career success (Harmer, 2001).

Syntax tree diagrams/ TreeForm

Tree diagrams, also called hierarchies, are graphical techniques for visualizing hierarchically ordered information (Hanewald & Ifenthaler, 2014; Smet & de Vries, 2008). They are also useful in facilitating assimilation of new information, as proposed by Mayer's (1979 as cited in Amadieu & Salmerón, 2014, p. 45) assimilation encoding hypothesis since they "supply an anchoring structure allowing the encoding of information on the basis of the structure". Paivio's (1986 as cited in Amadieu & Salmerón, 2014) dual-coding model suggests they mobilize working memory resources since texts are processed verbally, and diagrams are perceived visually, constructing internal visual images without causing cognitive overload. In linguistics and natural language processing, linguists usually describe their syntactic models through rooted tree diagrams (also called parse trees or concrete syntax trees), which are regarded "as the most appropriate tool for representing static knowledge" (Ng & Hanewald, 2010, p. 83) to transform it into a dynamic system (Larsen-Freeman, 2014). The topmost point of the tree diagram is the root, containing the initial symbol S, from which branches descend in accordance with the syntactic categories delineated by the rules (e.g., NP, VP). To describe the internal relationships among parts of the tree, family tree terminology is used. If two categories are combined by a single node, they are referred to as daughters and sisters of the same mother node (Crystal, 2008). Syntax trees do not allow "cross lines from mother to daughter and each node after the root must be the daughter of exactly one other node" (Kroeger, 2005, p. 41). They provide a visually appealing demonstration of the phrase structure rules. They can

represent the structural ambiguities in sentence and word meaning, and illustrate the arrangement of words, phrases, and sentences from their constituent components. They can also display movement, coreference, and feature association (Derrick & Archambault, 2010).

Tree diagrams can be drawn by hand, but it is difficult to modify them to fix mistakes which requires being engaged in a chaotic and time-consuming task of manually erasing or rewriting them (Hanewald & Ifenthaler, 2014). These trees are not suitable for publication. Thus, linguists sometimes utilize general-purpose word processors drawing tools to draw lines and triangles, which is an excessively slow and laborious process but can produce better results (Derrick & Archambault, 2010). LaTex, an open-source typesetting system, also has many automatic tree drawing macros including synttree (van Zulijen, 2009) and Qtree (Siskind & Dimitriadis, 2008). However, its effectiveness may be deterred as it requires a complex modification of labelled brackets to be translated into visual trees and does not allow for direct manipulation. Besides, many linguists do not use LaTeX and have little or no experience encoding (Derrick & Archambault, 2010). Some web-based tools enable users to submit simpler labelled brackets with roman text only, generating syntax trees that can be saved as pictures or copied and pasted into word-processing documents. These tools include Syntax Tree Drawer (Ruter, 2004), phpSyntaxTree (Eisenbach & Eisenbach, 2005), and RSyntaxTree (Hasebe, 2009). Other graphical tools also require users to input a set of phrase structure rules from which the visual structures can be generated. These include the Syntax Student's Companion (Max, 2004) and the commercial product Trees 3. They both produce elegant trees but limit the node text and do not export high-resolution images (Derrick & Archambault, 2010).

In response to this, TreeForm (https://sourceforge.net/projects/treeform/) emerged in 2006 and was updated to its current system in 2010 by Derrick and Archambault. Its design is based on presenting a graphical tool for generating multi-lingual syntax trees without obligatory phrase structure rules and providing maximum flexibility for modifying the shape of the tree as it is being generated using a drag-and-drop metaphor. It contains a multiple document interface, providing icons for well-known syntactic structures. These objects can be dragged into the document pane to start drawing a new tree or add to an existing one. Editing text in tree structures resembles editing text in a word processor. Movement arrows can be inserted by dragging a node over another node. Users can also add any number of case and feature roles by dragging and dropping these onto tree nodes. Users can copy a tree and paste it into an editing program or word processor. They can also print their trees to a printer, or directly to a PDF file. These files are produced as vector graphics, and therefore maintain a smooth, high-quality appearance even when printed on large posters. To examine its advantages, TreeForm developers conducted a comparison between the output of TreeForm and that of four programs, namely synttree, Qtree, RSyntaxTree, and Syntax Student's Companion, which produce the most usable output in their categories. The tree produced by TreeForm was compact and elegant whereas the ones produced by the other programs were non-compact and lopsided. In terms of movement lines, comparison with Qtree revealed that Qtree lines did not allow for text below the nodes, whereas TreeFom did (Derrick & Archambault, 2010).

Several studies have used tree diagrams in syntactic analysis (Ismahani et al., 2024; Kristianingsih et al., 2023; Mumrikoh et al., 2019; Pertiwi et al., 2022; Putri et al., 2022; Rahmawati et al., 2022;

Rahmawati & Rachmi, 2022; Slamet & Sulistyaningsih, 2019). To the researcher's knowledge, a limited number of empirical studies have investigated the instructional effects of tree diagrams in EFL settings. Some of these studies used the paper-based tree diagram to improve students' syntactic skills in analyzing texts and determining the phrase structure rules (Syarif, 2017), acquisition and translation of noun clauses (Chaiyapho & Kijpoonphol, 2018), grammatical abilities in reading and writing tasks (Huang, 2019), vocabulary performance in comprehending the forms and functions of words (Lim et al., 2020), and translation of simple and complex sentences into Arabic (Abdullah, 2020). Others have tackled the usability of computer-based tree diagrams. For example, in the study of Larson (1996), Syntactica produced a high level of engagement by allowing students to build grammars and then asking the program to generate trees for them. In another study, the Syntax Student's Companion was evaluated through informal feedback which was gathered as users downloaded and experimented with the software in teaching and presentation contexts. Suggested exercises included drawing a given sentence, identifying the correct representation of an ambiguous sentence, and modifying incorrect built trees. Some teachers reported technical difficulties in downloading the program and in adding and editing the categories defined (Max, 2004). Derrick and Archambault (2010) conducted a cognitive walkthrough to examine TreeForm usability. Six linguists (three professors and three graduate students) were instructed to build and modify syntax trees to better reflect the intended structures. They had some initial difficulties with performing the drag-and-drop operations, hitting small targets, and adding movement lines or associations. With guided practice, they were successful with these procedures. Recently, two studies examined the effect of using computer-based tree diagrams on teaching syntax (Dzakiah & Asmawati, 2023; Sirait & Lingga, 2021). Sirait and Lingga (2021) described the 12-week experiment that was implemented on 30 fifth-semester university students during virtual learning through using Syntax Tree Editor. The results of the final assignment and close-ended questionnaires revealed the efficacy of Syntax Tree Editor in teaching and learning syntax virtually and raising students' motivation toward syntax. Dzakiah and Asmawati (2023) investigated the impact of using Syntactic Tree Diagram application for six weeks on developing sixth-semester university students' EFL syntactic performance and their interest in using the application. Students were divided into two groups: a control group (n = 18) which received regular instruction and an experimental group (n = 18) which used the application. The results of the pre-post 20-sentence error identification test revealed that the experimental group performed significantly better than the control group. Regarding the results of the interest questionnaire, it was found that most students had high interest toward the use of the application.

METHOD AND PROCEDURES

Design and participants

The present study adopted a mixed-methods approach using a posttest-only control-group experimental research design, illustrated in Figure 1. Quantitively, one test was administered after experimentation to measure the impact of using TreeForm on the students' EFL syntactic competence. Qualitatively, a semi-structured interview was conducted to gain deeper and broader insights into the students' perceptions of using TreeForm, thereby strengthening the

credibility of the results. The study participants (*N* = 30) were second-year students in the Department of English Language and Literature, Faculty of Archaeology and Languages, Matrouh University, during the first semester of the 2022-2023 academic year. They were randomly assigned to a control group (*n* = 15) which received traditional tree diagramming instruction and an experimental group (*n* = 15) which employed TreeForm. Based on students' records, their ages ranged from 18 to 19 years old. They were at an approximately intermediate level of English proficiency, as indicated by their English language scores on the first-year entrance examination. In this test, students' syntactic ability was measured in the grammar section by means of 50 multiple-choice items, and in the writing and speaking sections where grammar was a separately scored part of the test scoring rubric. Besides, they were computer literate and comparable in terms of their L1, education, and subject-matter knowledge who had studied EFL for about 10 years before entering tertiary education.

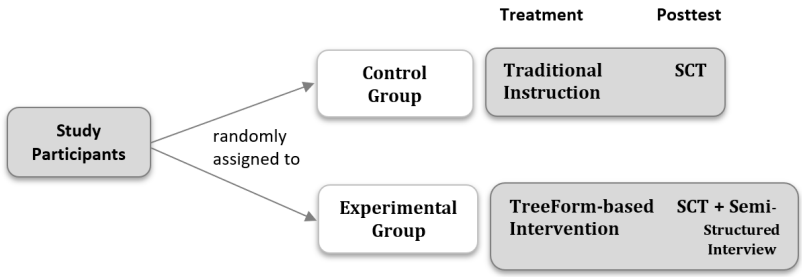


Figure 1 The two-group posttest-only control-group design of the present study

The EFL syntactic competence test (SCT)

The EFL syntactic competence test (SCT) was used as a post-test (see Appendix B). It consisted of two parts, including both limited- and extended-production questions to assess students' explicit and implicit knowledge of syntax (Purpura, 2004). Part One contained four questions. In the first question, students were asked to provide original sentences illustrating 15 grammatical concepts and to underline the pertinent word(s) in their sentences. In the second question, students were required to draw six tree diagrams for six sentences, applying the phrase structure rules learnt, the affix transformation to the outputs of the generated trees, subject-verb agreement, and morphological rules to derive the surface structure of the sentences. As for the third question, students were given two items. Each item contained a syntactically ambiguous sentence with two possible interpretations, each reflecting a different syntactic structure. They were asked to draw two tree diagrams indicating the two different possible structures, giving explanation. Regarding the fourth question, students were asked to identify the errors in 15 ungrammatical sentences and correct them. Materials for constructing this part were taken from Celce-Murcia and Larsen-Freeman's *The grammar book: An ESL/EFL teacher's course (2nd ed.)* (1999), Larsen-Freeman and Celce-Murcia's *The grammar book: Form, meaning and use for English language teachers (3rd ed.)* (2016), and Genetti's *Syntax: Words in combination* (2019), as they include multiple item types that align with the learning objectives and overarching content of the intervention. Concerning Part Two, it included two questions. In the first question, students were asked to write a descriptive paragraph that is syntactically accurate and meaningful of at least 150 words on only one of three given topics. In the second question,

students were shown a picture, and their task was to give an oral description that is syntactically accurate and meaningful about it of at least 10 sentences. They had one minute to familiarize themselves with the picture and to plan their description before speaking. Similarly, they were given one minute to speak, and their spoken samples were audio-recorded. The inclusion of this part aimed to assess the students' syntactic competence in communicative contexts, determining if their explicit knowledge of syntax was successfully converted into their implicit knowledge of syntax, specifically by evaluating their accurate application of the phrase structure rules in actual language use (Meyer, 2009; Purpura, 2004; Yule, 2014). Materials for constructing this part were taken from Savage et al.'s *Effective academic writing 1: The paragraph (2nd ed.)* (2012).

To determine its content validity, the SCT- with its scoring rubrics- was submitted to a panel of jurors comprising eight Egyptian university professors and lecturers of linguistics and applied linguistics/TEFL. They were requested to evaluate the test in terms of consistency with the objective it aimed to measure, clarity of its items, and suitability to the students' academic level. They revealed that the test could be considered a valid measure of EFL syntactic competence. As two raters graded it, the inter-rater reliability was conducted on a group of 14 second-year English Language majors- out of the study sample- during the second semester of the 2021-2022 academic year. The two sets of data were correlated using Pearson's correlation coefficient, which was 0.889, thereby indicating the test reliability. The SCT was piloted to check clarity, readability, and test time. The estimated time required for answering Part One questions was two hours. This time was assigned by computing the means of the times spent by the students of the pilot study. Likewise, the estimated time required for answering the first question of Part Two was 20 minutes.

To ensure the objectivity of scoring, two raters (the researcher and another lecturer of Linguistics) assessed the students' EFL syntactic competence in the posttest and calculated the mean. The two raters had the same teaching experience and qualifications (PhD in Applied Linguistics/TEFL and courses in language assessment). They used the EFL syntactic competence scoring rubrics prepared by the researcher to measure the students' EFL syntactic competence (see Appendix C). Regarding Part One of the SCT, the rubric included two main dimensions for only the second and third questions. Each item of these questions was measured on a five-point rating scale (1 = *poor*, 2 = *below average*, 3 = *average*, 4 = *above average*, and 5 = *excellent*). As for the first question, students were given two points on each item for full correct response; one point for producing a well-formed sentence based on the specified grammatical term and one point for accurate underlining. Each item in the fourth question was also given two points; one point for identifying the grammatical error and one point for correcting it. Thus, the total score of this part was 100. Concerning Part Two of the SCT, the rubric was used for the two questions. It included five skills suitable for the purpose of the study: communicative meaningfulness, sentence structure, word order, subject-verb agreement and morphological rules, and parts of speech, only addressing syntactic competence in writing and oral performance. Other dimensions of writing (e.g., organization, mechanics) and speaking (e.g., pronunciation, fluency) were not assessed in this study. Each of these skills was measured on a five-point rating scale (1 = *poor*, 2 = *below average*, 3 = *average*, 4 = *above average*, and 5 = *excellent*). The scores for each question ranged from five to 25. Thus, the score range for the second part of the SCT was from 10 to 50.

The semi-structured interview

To collect qualitative data, the semi-structured interview was used to obtain in-depth information about the perceived usefulness of TreeForm. Thus, the researcher prepared an interview guide (see Appendix D), comprising four open-ended questions to explore the students' perceptions regarding the use of TreeForm in enhancing their EFL syntactic competence and the specific benefits they experienced from using it. To establish its content validity, it was submitted to the same panel of jurors who evaluated the SCT. As the researcher solicited voluntary participation, nine students agreed to be interviewed. They were provided with a comfortable environment to openly express their thoughts and experiences. They were also given sufficient time to answer each question. The researcher listened carefully to the ideas conveyed by the students and attempted not to lead the interviews in any direction. The interviews, which were audio-recorded, ranged in length from 15-20 minutes. The data collected was meaningfully segmented and coded. To enhance the reliability of the coding process, the inter-coder reliability was employed where two coders (the same raters of the SCT) coded the data, identified themes, compared their analyses, and resolved any discrepancies.

Experimental procedures

The experiment of this study was conducted as part of the "English Syntax I" course offered to second-year English Language majors who met with the researcher for four hours of face-to-face teaching each week. Experimentation lasted for six weeks. During this time, students studied various topics: word order and the phrase structure rules (see Appendix A) for the subject of a sentence (NPs, APs, and PPs), the predicate of a sentence (the auxiliary, and VPs), sentence-final adverbials with its ordering, and negation. In the first week, and after the four-hour class period, a one-hour orientation session was given to the experimental group to familiarize them with the suggested software through presentation, teacher modeling, and guided practice. Students were trained on how to (a) download TreeForm, (b) build a syntax tree using its features, (c) drag and drop new nodes, (d) add or remove syntactic features and movement lines, (e) edit or delete text in tree structures, (f) copy and paste the generated trees into Microsoft Word, (g) save/export images of those trees, and (h) print them to a printer or directly to a PDF file. To facilitate software training, a video tutorial and various handouts were provided and made available for reviewing purposes. Then, they engaged in a TreeForm-based activity to practice drawing a tree diagram for a given sentence. They were also trained on how to make use of the developed rubric which outlined the required components of their generated trees (see Appendix E). Besides, a WhatsApp group, containing the researcher and the experimental group students, was created to share materials, students' generated trees, and Microsoft Word files and to provide constructive feedback. Henceforward, students engaged in out-of-class TreeForm-based activities to do their homework assignments where they constructed and analyzed various affirmative and negative sentences, disambiguated ambiguous sentences, and corrected ungrammatical sentences by drawing tree diagrams applying the phrase structure rules learnt. The procedures of the experiment are summarized in Figure 2.

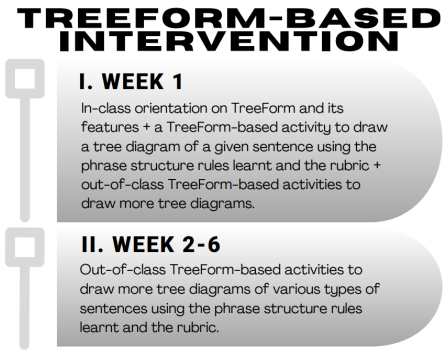
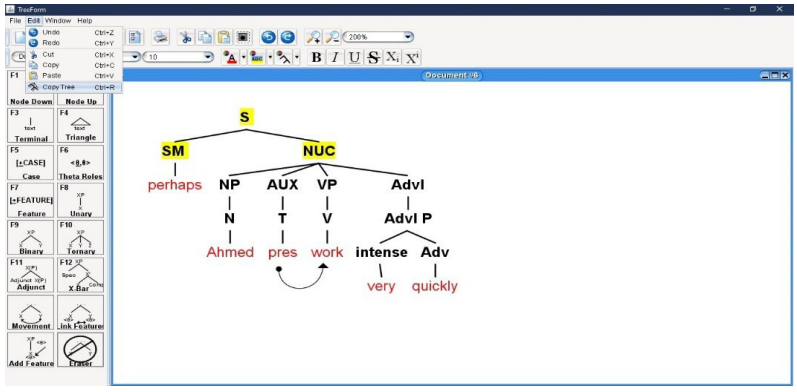


Figure 2 The experimental procedures of the TreeForm-based intervention

At the end of each week, students were required to attach their trees and Microsoft Word files and provide personalized feedback to their peers on the WhatsApp group about merits, demerits, and areas of future improvement. The researcher also participated in giving feedback and commenting on their posts. Accordingly, students edited their trees and files and then posted the enhanced ones again. During experimentation, some students were initially frustrated with technical problems when using the software and creating their trees. By the end of the experiment, they became more familiar with the syntactic features of TreeForm and generated their trees with relative ease. Figure 3 provides some examples of students' work using TreeForm. As for the control group students, they received the same face-to-face instruction with the same homework assignments to be done, but using the traditional paper-based tree diagrams which were handed in to the researcher in the following week. The researcher marked the errors, corrected them on paper, and left them for students the next day. Finally, and after a six-week experiment, the researcher post-tested both groups using the SCT on 21st November 2022. In a subsequent session, the researcher conducted semi-structured interviews with the nine volunteer students from the experimental group. Owing to the small sample size, students' scores on the post-administration were analyzed using the non-parametric Mann-Whitney U Test to compare the differences between the control and experimental groups' mean ranks on the post-administration of the SCT to examine the effect of using TreeForm. Besides, textual data from the semi-structured interviews were analyzed using conventional content analysis to identify themes related to the TreeForm-based intervention.



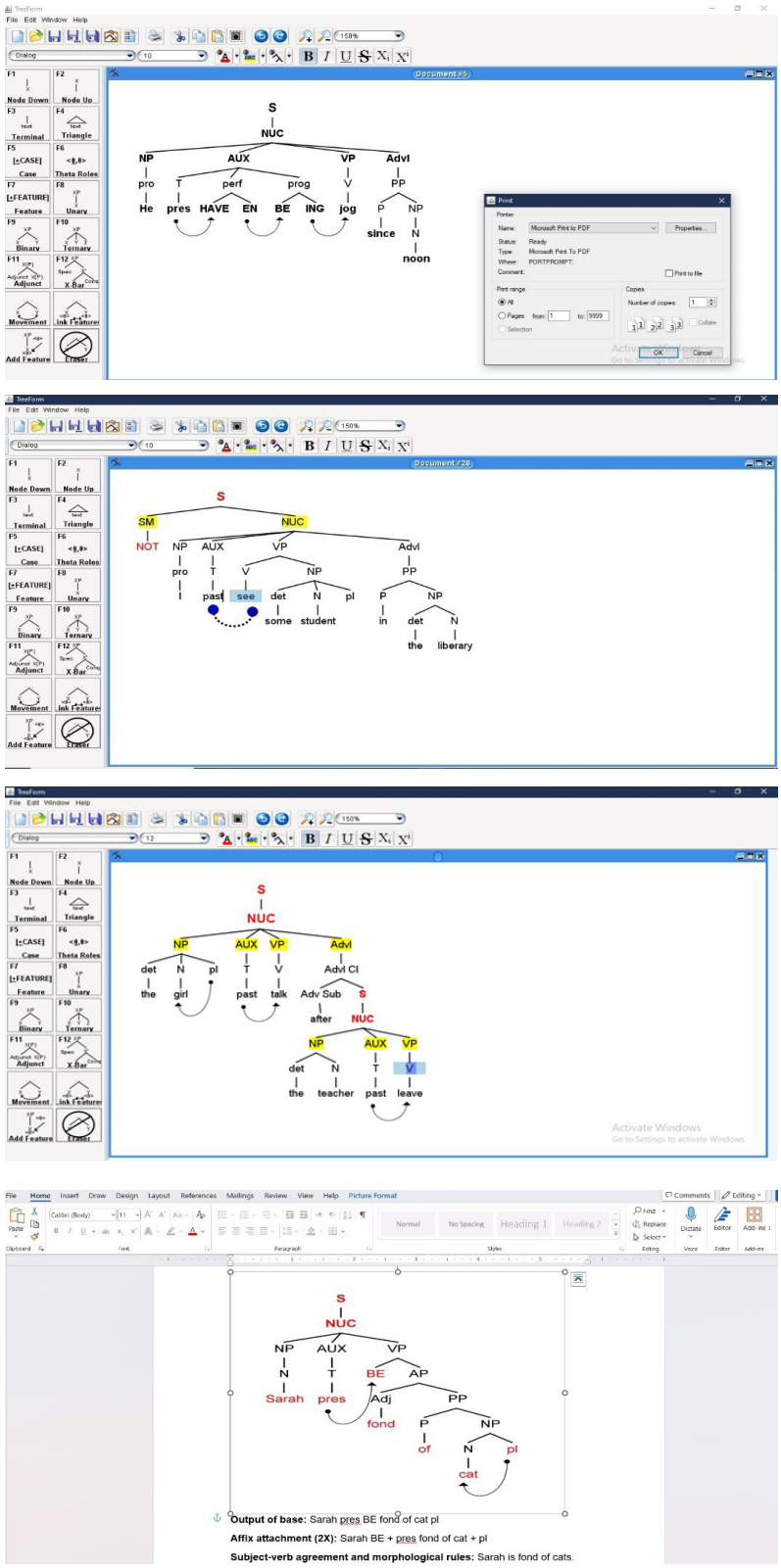


Figure 3 Examples of students' work using TreeForm

RESULTS AND DISCUSSION

RQ1: What is the effect of using TreeForm on enhancing second-year English Language majors' EFL syntactic competence?

Table 1 provides the mean scores and the *U*-values for the differences between the control and experimental groups' mean ranks of the EFL syntactic competence post-administration. The mean scores of the experimental group were higher than those of the control group, thereby indicating the positive effect of using TreeForm. Table 1 also shows that there were statistically significant differences at the 0.01 level between the control and experimental groups' mean ranks on the EFL syntactic competence post-administration in each dimension and in overall EFL syntactic competence skills in favor of the experimental group ($U = 0$, $p < 0.01$). Thus, the experimental group students achieved significant improvement in EFL syntactic competence on the post-administration. This improvement could be related to the use of TreeFom.

Besides, the effect size was computed using Cohen's d to measure the magnitude of the mean differences between the control and experimental groups. The adopted cut-offs were 0.2 for small, 0.5 for medium, and 0.8 for large effect sizes. Table 1 shows that the mean scores of both groups in each dimension were very different, as indicated by the very large effect sizes. Similarly, the mean scores of both groups in overall EFL syntactic competence skills were also very different ($d = 4.0146$). Using TreeForm might have contributed to such a positive effect.

Table 1

Mann-Whitney U test results comparing the control and experimental groups' mean ranks of the EFL syntactic competence post-administration

Dimension	Group	*N*	*M*	*SD*	*Mean Rank*	*Sum of Ranks*	*U*	Sig.*	Effect Size
PART ONE									
1. Constructing original sentences, illustrating grammatical concepts	Control	15	18.07	1.361	15.5	465	0	0.01	3.7852 Very Large
	Exp.	15	23.13	1.315					
2. Drawing tree diagrams using the phrase structure rules, applying the affix transformation, subject-verb agreement, and morphological rules	Control	15	20.83	1.029	15.5	465	7	0.01	2.2688 Very Large
	Exp.	15	23.67	1.435					
3. Drawing tree diagrams of syntactically ambiguous sentences, giving explanation	Control	15	6.47	0.399	15.5	465	4	0.01	2.6290 Very Large
	Exp.	15	7.83	0.617					
4. Identifying and correcting ungrammatical errors	Control	15	21.13	1.575	15.5	465	1.5	0.01	2.4610 Very Large
	Exp.	**15**	**24.40**	**1.021**					

Dimension	Group	N	M	SD	Mean Rank	Sum of Ranks	U	Sig.*	Effect Size
PART TWO									
1. Writing a syntactically accurate and meaningful descriptive paragraph	Control	15	16.67	0.994	15.5	465	0	0.01	3.7173 Very Large
	Exp.	15	19.97	0.767					
2. Giving a syntactically accurate and meaningful oral description	Control	15	15.87	0.667	15.5	465	0	0.01	3.7588 Very Large
	Exp.	15	18.77	0.863					
EFL syntactic competence (total)	**Control**	**15**	**99.03**	**4.502**	**15.5**	**465**	**0**	**0.01**	**4.0146 Very Large**
	Exp.	**15**	**117.77**	**4.825**					

*Note. *All p-values are significant at p < 0.01.*

This significant improvement in students' overall syntactic competence skills indicates that using TreeFrorm might have been more effective than the paper-based tree diagramming practiced in the control group. This might be attributed to several reasons: TreeForm features, the process of incorporating TreeForm, and the positive transfer of students' explicit syntactic knowledge into implicit syntactic knowledge. Concerning the first reason, the accessible and visually appealing layout of TreeForm might have contributed to such a result which could be explained from a cognitive load theory (Sweller et al., 2011) perspective. For students learning syntax with the help of technology, when the technical skills related to the tool become familiar and its use is automatized, they do not have to split their attention between the technological aspects of utilizing the tool and processing the new information. This can reduce the extraneous load, enabling students to focus on the grammatical concepts to be learnt. Since drawing syntax trees using TreeForm required little technical skills, the students were able to focus entirely on the given task (Ng, 2015). Besides, students did not have to grapple with the challenge of representing the given sentences in their assignments through labelled bracketing to show the sentence structure or the grammatical categories of words and then entering them to the program to generate their trees. They simply implemented drag-and-drop operations to draw hierarchies, applying the phrase structure rules by adding nodes, syntactic features, or movement lines when needed. This is because TreeForm utilizes a well-established graph drawing algorithm along with representations for syntactic features. According to Derrick and Archambault (2010, p. 59), this algorithm "displays trees in linear time and requires slight modification to work with nodes of varying sizes and heights to accommodate the differing text sizes present in node labels". It also uses color highlighting for distinguishing terminals and non-terminals and offers control over the thickness, stippling, and color of movement lines and other typesetting features to enhance the aesthetic appeal of TreeForm, making it more useful in high-quality publications.

Using TreeForm characteristics was fundamental in helping students to build, change, and edit their tree diagrams and files until they submitted their final work successfully, demonstrating their constructed syntactic knowledge and skills. Since TreeForm produces compact and symmetrical trees where all the lines to daughters originate under the center of a mother, students were able to produce accurately drawn and readable tree diagrams using appropriately labeled nodes and branches where relationships were easily understood. They were successful

in using and distinguishing between the non-terminal and terminal nodes. They experimented with the software settings to find the formatting they preferred. They enhanced the visual representation of their trees by adjusting the node spacing, font size, and color. Their trees were well-organized and clearly displayed the hierarchical structure of the given sentences which was effectively analyzed demonstrating a thorough understanding of the phrase structure rules learnt. Affix attachment was effectively integrated into their trees, where the movement was clearly indicated with an arrow. It was apparent where the movement started and where it ended to show how every dependent auxiliary inflection (e.g., tense (T), EN, ING) was attached to the immediately following lexical element to produce an inflected lexical item. The subject-verb agreement, and morphological rules were accurately applied to derive the surface structure of the sentences. This enabled their audience to easily read and evaluate the trees and Word files. Furthermore, students drew neat trees to represent the syntactic ambiguity of the given sentences, indicating the possible structures for them. They also identified and corrected grammatical errors by drawing accurate subtrees of the specified constituents which contained the errors. Moreover, they were able to construct grammatically correct and meaningful example sentences to illustrate the given grammatical concepts which were properly displayed in their trees and files during the experiment.

Regarding the second reason, utilizing syntax drawing programs without well-defined tasks and sufficient practice and feedback may render them ineffective (Max, 2004). In this regard, existing learning theories such as constructivism, social constructivism, and constructionism can explain how students learn syntax in technologically enhanced environments. Constructivism suggests that knowledge is constructed when students are actively engaged in the learning process, operationally they are engaged in physical manipulations (technically creating syntax trees) and cognitively they are processing new information and stimuli (comprehending and applying the phrase structure rules) (Richards & Schmidt, 2010). Furthermore, social constructivism claims that social interactions between the student and the teacher/peers promote cognitive development. The teacher provides a scaffold to learning by using appropriate technology to teach concepts and engages students in creating knowledge artefacts (tree diagrams) to demonstrate what they have learnt with the help of the tool and their peers (Vygotsky, 1978). Related to this, constructionism asserts that students become more motivated and engaged in learning when they are constructing tangible artefacts that others can see and evaluate through online avenues (Papert, 1980) using relevant criteria (Liu & Carless, 2006). Thus, students' syntactic improvement might be ascribed to the different procedures and assigned activities of the TreeForm-based intervention. Students might have benefited from teacher modeling and guided practice in the in-class orientation session and performing the required out-of-class TreeForm-based activities. Likewise, they might have benefited from the peer and teacher-led feedback. They conducted peer reviewing before submitting their final tree diagrams and files. They rated their progress and the performance of other students using the developed rubric and the WhatsApp chat-based features. Such peer reflection enabled them to detect the strengths, weaknesses, and areas of improvement of their peers' trees and files, which in turn raised their motivation to improve them. The teacher constructive feedback and comments on students' trees and files might have promoted their syntactic competence as well, since combining peer review and teacher feedback produces positive effects on EFL learning (El-Garawany, 2021; Tai et al., 2015).

Relating to the third reason, not only did the experimental group students analyze and construct grammatically correct example sentences to explain the given grammatical concepts (explicit knowledge), but they also produced a series of connected sentences to form paragraphs and oral descriptions (implicit knowledge), indicating that syntax learning was positively transferred. This aligns with previous results that showed positive transfer of the syntactic structures studied using explicit instruction into students' oral (Hussien, 2017) and writing performance, demonstrating their ability to apply the internalized rules to new language contexts (Mekalaa et al., 2016). Each week, the TreeForm-based activities provided students with sufficient practice as they spent significant time (an average of eight hours) outside the classroom to understand and apply the phrase structure rules using TreeForm syntactic features and allowed for more revisions (three-five times) to their trees until the deep structure of sentences was properly displayed. Using TreeForm movement lines enabled students to apply and demonstrate affix attachment accurately to derive the surface structure. These factors enabled students to improve their explicit knowledge as they comprehended and processed the input correctly which led to richer intake. Gradually, this knowledge became automatized and moved to their implicit knowledge as indicated by their high scores on Part Two of the SCT. In their paragraphs and oral descriptions, the syntactic meaning of the sentences/ utterances was conveyed, and the intended message was relevant and valid. The syntactic precision was also evident when they used varied and well-constructed sentences, correct word order and subject-verb agreement, and wide and sophisticated range of parts of speech. Marked with participants' identifiers (e.g., P1, P2, …, P15), some instances from students' written production included "*I am a keen admirer of Nelson Mandela because he was a strong leader. He fought for what he believed in and united South Africa.*", "*I enjoy the scenery when I sit next to the window. I can make friends with people I meet on trains.*", and "*My favorite place to visit is the countryside because of some reasons. I can get away from the bustle of the town. I can enjoy the natural beauty of its open fields.*" by P1, P2, and P7 respectively. Other examples from their oral utterances comprised "*He is submerged in deep blue water, facing a shark.*", "*He is wearing a full-body diving suit, and he is holding a camera and flashlight to capture an image of the shark.*", "*The water is filled with bubbles from the diver's breather.*", and "*This picture sparks my curiosity. The diver is filming the shark in peace. He is calm and focused*." by P1, P3, P9, and P12 respectively.

In contrast, the control group students underperformed their experimental group counterparts in overall syntactic skills. Their performance in such dimensions like constructing sentences to illustrate grammatical concepts and identifying and correcting grammatical errors was considered average. For analyzing sentences, their tree diagrams were drawn with less accuracy and readability using somewhat properly labeled nodes and branches where relationships were difficult to understand in some areas. They partly displayed the hierarchical structure of the given sentences, demonstrating a basic understanding of the phrase structure rules. Affix transformation, subject-verb agreement, and morphological rules were applied with noticeable omissions or errors. Moreover, their trees partly represented the syntactic ambiguity of the given sentences, showing some understanding of the possible structures for them. In their written and oral responses, the syntactic meaning was partially conveyed, and the intended message was somewhat relevant. Students demonstrated basic command of sentence structure, displaying some variety. Besides, there were frequent errors in word order and subject-verb

agreement, but did not impede understanding. On the other hand, their errors related to parts of speech did impact the clarity of meaning.

Thus, the quantitative analysis showed that the experimental group significantly outperformed the control group in EFL syntactic competence, indicating the positive effect of using TreeForm. This result concurs with the findings of studies by Dzakiah and Asmawati (2023) and Sirait and Lingga (2021) who concluded that using syntax tree drawing tools supports students' EFL syntactic abilities and provides an effective medium for developing them with the help of their syntactic features.

RQ2: What are the perceptions of second-year English Language majors regarding using TreeForm in enhancing their EFL syntactic competence?

The content analysis of the data obtained from the semi-structured interviews revealed six significant themes. In this section, the identified themes along with some representative excerpts from the participants are presented. The excerpts were tagged with participants' identifiers (e.g., P1, P2, …, P9) for clarity and reference.

Theme 1: Perceived usefulness of TreeForm

The nine participants acknowledged TreeForm as an effective tool for improving their EFL syntactic competence. Notably, they highlighted that it allowed them to build and modify their syntax trees until the resultant trees reflected the intended structures. For example, P1 stated that "*I found TreeForm useful in building and editing my tree diagrams to represent the phrase structure rules. I kept playing with its features until my trees looked right*". P2 noted that "*It was most useful in displaying the hierarchical structure of sentences in an organized manner which made me differentiate between their deep (output of base) and surface structures after applying the affix attachment, subject-verb agreement, and morphological rules*". Moreover, some students expressed initial skepticism, but reported positive outcomes after utilizing TreeForm, as observed by P7 who mentioned that "*TreeForm was very useful in creating and modifying my trees. It made me better understand the grammatical concepts and the phrase structure rules because of the balanced symmetry it offers which helped me to clearly see the relationships between the nodes. In the beginning, I was a bit skeptical about its use, but after a few sessions, I could see an obvious improvement in my syntactic skills*".

Theme 2: Enjoyment and motivation

Eight participants reported that the TreeForm-based intervention provided a more enjoyable and motivating experience to learn syntax. They appreciated the peer review aspect of it and the provided teacher feedback, as described by P2 who stated, "*It made learning syntax more enjoyable than just doing the ordinary assignments. When submitting my trees and files on the WhatsApp group, my colleagues and you [the researcher] suggested making some modifications. So, I modified the trees and files and reattached them. I was very happy to see that my enhanced work received positive comments from my colleagues and you [the researcher]*". P5 also stated that "*I enjoyed using the features of TreeForm and getting involved in each stage*

of the new method especially when we attached our trees and files on the WhatsApp group and peer reviewed them to improve their accuracy. I was very satisfied with my final products and the progress I achieved each week". Likewise, P7 mentioned that "*Seeing my continuous improvement pleased and motivated me to keep practicing*".

Theme 3: Effective transfer of learning

Seven participants believed that their explicit knowledge of syntax gained from the TreeForm-based intervention was successfully transferred into their writing and speaking. For example, P2 stated that "*I think that the grammatical concepts and rules I learnt improved my speaking and writing. I was able to analyze sentences and distinguish between their surface and deep structures using TreeForm. Thus, my ability to produce similar sentences was improved when expressing my ideas*". Likewise, P4 noted that "*I was able to produce sentences with the right word order in my speaking and writing because I learnt the rules and how to represent them on TreeForm to analyze sentences and comprehended the different functions of them*". P7 concluded that "*When my syntactic skills improved, my speaking and writing improved, too. TreeForm features helped me spot my grammatical mistakes and the missing elements of the trees easily and correct them to complete the representation of the sentences to match the rules. I learnt how correct sentences are built*".

Theme 4: Preference of TreeForm

Seven participants preferred TreeForm-based tree diagrams to paper-based ones for creating their trees and found them more effective in enhancing their syntactic skills and accomplishing their assignments. P1 mentioned that "*I loved TreeForm because I love technology, and I prefer to learn using it. I was happy that you [the researcher] introduced us to the digital tool TreeFrom. It was more effective because it displayed my trees, especially of long sentences, in a better way than the paper-based trees and I could insert them into the Word files and complete my assignments in a short time*". Similarly, P7 stated that "*For me, I prefer using a computer rather than paper and pencil. TreeForm was more effective because it made me produce well-organized trees easily and quickly*". P8 also noted that "*I preferred TreeForm because its features helped me in adding and deleting items easily, presenting the phrase structure rules in a more arranged way, and making the relationships between the nodes more obvious. I used the different fonts and colors to compare the output of base (deep structure) and the surface structure of sentences*".

Theme 5: Perceived ease of use

Six participants found TreeForm easy to use as it required little technological skills and time to create elegant and readable syntax trees, as noted by P2 who remarked, "*From my experience, I can create and edit my trees easily using the TreeForm drag-and-drop design which helped in speeding up this process and accomplishing my assignments more quickly*". Similarly, P3 stated that "*TreeForm was user-friendly. I did not need much time or advanced tech skills to be able to use its features. By just dragging and dropping objects, I was able to draw my trees quickly to reflect the grammar*". Moreover, P5 mentioned that "*Its implementation was simple, and it was easy for me to become skillful at using TreeForm*".

Theme 6: Technical problems

Four participants reported some technical problems related to downloading the program, creating their trees, and pasting them to Microsoft Word. For instance, P4 stated that "*I encountered difficulty when I was downloading TreeForm on my laptop. I needed to make a few updates to operate it successfully*". Moreover, P6 stated that "*At first, I had difficulties in building my trees, especially in dragging and dropping nodes, distinguishing between the terminal and non-terminal ones, and putting the movement lines in the right place until I got familiar with the TreeForm features*". P9 mentioned that "*I had some technical problems in exporting the trees and pasting them into Microsoft Word. So, I had to make some updates to my system*".

According to this analysis, the participants had largely favorable perceptions toward the TreeForm-based intervention. Specifically, the number of positive comments was greater than those remarks that were negative. All students reported that TreeForm can be an effective tool for improving their syntactic skills. They perceived it as a motivating and easy-to-use application that allowed them to focus on enhancing their trees and syntactic mistakes with the help of its features and their peers. Most of them indicated that it assisted them in improving their speaking and writing because the gained explicit knowledge facilitated the process of acquiring implicit knowledge. They also preferred using TreeForm to paper-based tree diagramming. Such preference might be due to their frequent engagement with technological devices which have evolved to be more powerful and affordable. Twenty-first-century learners, also called digital natives, and the current generation entering tertiary education worldwide, are especially interested in technology and influenced by it. They are constantly using it and often expect their instructors to provide learning experiences using social media and digital apps they can access on their laptops and smartphones (Prensky, 2010; Sartor, 2020; Turner, 2015). Furthermore, the perceived usefulness and accessibility of TreeForm might have contributed to the students' acceptance of the tool as hypothesized by the technology acceptance model (Davis, 1989). These qualitative results complement the quantitative findings and might explain why using TreeForm had a positive effect on the experimental group students' overall syntactic competence skills. Though, a few technical issues were identified with the software. Besides, some students were initially skeptical about its efficacy in developing their syntax. Hence, when introducing TreeForm to students, it might be helpful to inform them about its positive impacts on their syntactic skills while referring to relevant literature. These results from the qualitative phase of the current study agree with the findings of studies by Sirait and Lingga (2021) and Dzakiah and Asmawati (2023) who reported students' positive attitudes toward syntax tree drawing tools.

CONCLUSION

The present study investigated the effect of using TreeForm on enhancing English Language majors' EFL syntactic competence. Results of the quantitative analysis revealed that the experimental group significantly outperformed the control group in EFL syntactic competence after using TreeForm. The qualitative analysis also showed that students found it helpful in

enhancing their syntactic skills. Based on these results, it could be concluded that using TreeForm proved to have a positive effect on developing the experimental group students' EFL syntactic competence. During the implementation, some students expressed concerns about technological problems and frustration when using TreeForm, which is largely consistent with Derrick and Archambault's (2010) findings. Despite such difficulties, by the end of the experiment, students had become more familiar with the interface of TreeForm and gained various benefits from using it, reflected in their syntactic competence. Therefore, using TreeForm is recommended for teaching syntax to university students majoring in English Language and Literature.

However, some limitations can affect the generalizability of the study results. Not including a pretest, which might have offered another reference for comparison, could be justified because of the control it provides to the potential threats to internal validity of testing (Johnson & Christensen, 2019). It was suspected that pretesting might bias the findings of posttesting- perhaps because the students could gain a negative attitude toward the proposed intervention since they had not previously been exposed to phrase structural rules and their representations on tree diagrams before the experiment. Another limitation was the small sample size which comprised the total number of enrolled students in the Department of English Language and Literature at the time of experimentation. Thus, the present study may serve as a starting point for further research that would include a larger sample size. Moreover, since most of the activities were performed outside the class, future studies may be conducted in class for better observance and data analysis. Other suggestions include replicating the present study deploying other syntax tree drawing tools and examining the effect of using TreeForm on promoting syntactic self-efficacy, vocabulary acquisition, academic writing, and autonomous learning.

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THE AUTHOR

Marwa Said Mustafa El-Garawany serves as a lecturer of Linguistics at the Department of English Language and Literature, Faculty of Archaeology and Languages, Matrouh University, Egypt. Her research interests include Computer-assisted Language Learning (CALL), English for Specific Purposes (ESP), speaking, writing, and translation. She has published on these topics in such journals as *ESP Today, Language Teaching Research Quarterly (LTRQ), and Sohag University Journal of Education*.
marwaal-garwani@mau.edu.eg

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Appendix A
Summary of the Phrase Structure Rules

1. S → $(SM)^n$ NUC
2. NUC → NP AUX VP $(Advl)^n$

3. NP → { $(det)^3$ $(AP)^n$ N (pl) (PP) ; pro }

4. AUX → { { T ; M } (PM) (perf) (prog) ; IMPER }

5. T → { past ; pres }

6. perf → HAVE ….. EN
7. prog → BE …..ING

8. VP → { BE { NP ; AP ; PP } ; V (NP) (PP) }

9. Advl → { Advl Cl ; PP ; Advl P }

10. Advl Cl → Adv Sub S
11. PP → P NP
12. Advl P → $(intens)^n$ Adv
13. AP → $(intens)^n$ Adj (PP)

Symbol	Meaning
S	Sentence
SM	Sentence modifier
NUC	Sentence nucleus
NP	Noun phrase
AUX	Auxiliary
VP	Verb phrase
Advl	Adverbial
det	Determiner
pro	Pronoun
N	Noun
pl	Plural
T	Tense
M	Modal
IMPER	Imperative
PM	Periphrastic modal
perf	Perfective aspect
prog	Progressive aspect

Symbol	Meaning
past	Past
pres	Present
AP	Adjective phrase
PP	Prepositional phrase
Advl Cl	Adverbial clause
Advl P	Adverbial phrase
Adv Sub	Adverbial subordinator
P	Preposition
intense	Intensifier
Adv	Adverb
Adj	Adjective
→	consists of/ rewrites as
( )	Optional element/constituent
{ }	One and only one of these elements/constituents must be used

Appendix B
The EFL Syntactic Competence Test

Answer the following questions:
PART ONE:
I. Provide original sentences, illustrating each of the following concepts. **Underline the pertinent word(s)** in your examples. (30 points)

1. sentence modifier	**2.** adverbial of purpose	**3.** adverbial of frequency
4. adverbial of manner	**5.** adverbial of direction	**6.** negative indefinite pronoun
7. adverbial clause of time	**8.** intensifier	**9.** deletable preposition
10. imperative	**11.** adjective phrase	**12.** word-level negation
13. DO support	**14.** NOT contraction	**15.** sentence-level negation

II. Draw tree diagrams for the following sentences using the phrase structure rules learnt. **Apply the affix transformation** to the outputs of the generated trees (and **specify how many times** it is applied in each case). Then, **apply the subject-verb agreement and morphological rules (when needed)** to derive the surface structure of the sentences. Do not use triangles. (30 points)

1. Surely, these big corporations are getting into trouble.
2. They postponed her trail because the judge was very sick.
3. Ahmed will be able to pass the exam with ease.
4. We have had no rain since February.
5. The value of the house has doubled quite recently.
6. Alice did not want any sandwiches.

III. There are two possible interpretations for each of the following syntactically ambiguous sentences, each interpretation reflecting a different syntactic structure, although the word order remains the same. **Draw two tree diagrams** for each sentence indicating its two different possible structures, and then **explain the two meanings and how they differ**. Do not use triangles. (10 points)

1. Farida watched the birds in the garden.
2. The man killed the king with the knife.

IV. Identify the errors in the following ungrammatical sentences, and then **correct them.** (30 points)

1. *She can swims very fast.
2. *Manal will to come tomorrow.
3. *The man been to Chicago twice.
4. *The ink black stained his shirt.
5. *Those woman are striking for peace.
6. *He took his brother yesterday to the store.
7. *Mona ran for shelter because was raining.
8. *Sarah gave the books.
9. *Mohammad plays beautifully the flute.
10. *Mostafa is jump rope.

11. *she running now.
12. *Not anyone was planning to come
13. *These boys no like me.
14. *I didn't do nothing. (nonstandard)
15. *Seth is very unpatient.

PART TWO:

I. Write a short descriptive paragraph that is syntactically accurate and meaningful (of at least 150 words) on only ONE of the following topics. (25 points)

1. A person that you admire (outside of your family)
2. A way of travel that interests you (by train, bicycle, hot air ballon)
3. Your favorite place to visit

II. Look at the following picture and then give an oral description that is syntactically accurate and meaningful about it (of at least 10 sentences). You have one minute to familiarize yourself with the picture and to plan your description before speaking which will be given another one minute. (25 points)

Appendix C
The Scoring Rubrics for the EFL Syntactic Competence Test

(PART ONE: Questions II and III)

Level / Skill	1 Poor	2 Below Average	3 Average	4 Above Average	5 Excellent
- Drawing tree diagrams using the phrase structure rules, applying the affix transformation, subject-verb agreement, and morphological rules	The tree diagram is incomplete and unreadable with no or incorrect labels and poorly drawn branches. Relationships are impossible to interpret. It is severely disorganized and does not display the hierarchical structure of the given sentence. It does not analyze the sentence demonstrating a lack of understanding of the phrase structure rules learnt. Affix transformation, subject-verb agreement, and morphological rules are not applied.	The tree diagram is not accurately drawn and difficult to read with unclear labels. Relationships are difficult to interpret. It is disorganized and does not clearly display the hierarchical structure of the given sentence. It minimally analyzes the sentence demonstrating a limited understanding of the phrase structure rules learnt. Affix transformation, subject-verb agreement, and morphological rules are not accurately applied, resulting in significant omissions or errors.	The tree diagram is somewhat accurate and readable using somewhat properly labeled nodes and branches with noticeable errors. Relationships may be difficult to understand in some areas. It is somewhat organized and partly displays the hierarchical structure of the given sentence with noticeable inconsistencies. It partly analyzes the sentence demonstrating a basic understanding of the phrase structure rules learnt. Affix transformation, subject-verb agreement, and morphological rules are applied with noticeable omissions or errors.	The tree diagram is adequately drawn and mostly readable using properly labeled nodes and branches with minor errors. Relationships are understandable. It is organized and mostly displays the hierarchical structure of the given sentence with minor inconsistencies. It sufficiently analyzes the sentence demonstrating a good understanding of the phrase structure rules learnt. Affix transformation, subject-verb agreement, and morphological rules are applied with minor omissions or errors.	The tree diagram is accurately drawn and readable using appropriately labeled nodes and branches with no errors. Relationships are easily understood. It is well-organized and clearly displays the hierarchical structure of the given sentence. It effectively analyzes the sentence demonstrating a thorough understanding of the phrase structure rules learnt. Affix transformation, subject-verb agreement, and morphological rules are accurately applied.
- Drawing tree diagrams of syntactically ambiguous sentences, giving explanation	The two tree diagrams do not accurately represent the syntactic ambiguity of the given sentence, failing to indicate the two possible structures/ interpretations. The explanation provided is unclear and does not demonstrate understanding of the sentence ambiguity with its two interpretations.	The two tree diagrams inaccurately represent the syntactic ambiguity of the given sentence, lacking clarity in indicating the two possible structures/ interpretations. The explanation provided lacks clarity and demonstrates a limited understanding of the sentence ambiguity with its two interpretations.	The two tree diagrams partly represent the syntactic ambiguity of the given sentence, showing some understanding of the two possible structures/ interpretations. The explanation provided is somewhat clear and provides a basic understanding of the sentence ambiguity with its two interpretations.	The two tree diagrams mostly represent the syntactic ambiguity of the given sentence and indicate the two possible structures/ interpretations. The explanation provided is clear and provides a sufficient understanding of the sentence ambiguity with its two interpretations.	The two tree diagrams accurately represent the syntactic ambiguity of the given sentence and clearly indicate the two possible structures/ interpretations. The explanation provided is clear, concise and provides a thorough understanding of the sentence ambiguity with its two interpretations.

(PART TWO)

Level / Skill	1 Poor	2 Below Average	3 Average	4 Above Average	5 Excellent
1. Communicative Meaningfulness	Students demonstrate little or no ability to get message across meaningfully; the syntactic meaning of the sentences is barely conveyed, and the message lacks relevance and validity.	Students demonstrate limited ability to get message across meaningfully; the syntactic meaning of the sentences is slightly conveyed, and the message lacks relevance and validity.	Students demonstrate basic ability to get message across meaningfully; the syntactic meaning of the sentences is partially conveyed, and the message lacks some relevance and validity.	Students demonstrate good ability to get message across meaningfully; the syntactic meaning of the sentences is adequately conveyed, and the message is mostly relevant and valid.	Students demonstrate full ability to get message across meaningfully; the syntactic meaning of the sentences is completely conveyed, and the message is entirely relevant and valid.
2. Sentence Structure	Students lack command in sentence structure with little or no variety. Sentences are incomplete or in-comprehensible.	Students demonstrate minimal command of sentence structure, with limited variety. Sentences are simplistic or unclear.	Students demonstrate basic command of sentence structure, displaying some variety. Sentences may be repetitive or look awkward at times.	Students demonstrate good command of sentence structure, using mostly varied and well-constructed sentences that contribute to understanding.	Students demonstrate excellent command of sentence structure, using varied and well-constructed sentences that enhance understanding.
3. Word Order	Words are constantly out of order making the paragraph/ description difficult to read/ follow.	Various words are out of order, affecting understanding.	Some words are out of order, but not impeding understanding.	Most words are in the correct order.	All words are in the correct order.
4. Subject-verb Agreement and Morphological Rules	Lack of appropriate use of subject-verb agreement and morphological rules.	Major errors in subject-verb agreement and morphological rules impacting understanding.	Frequent errors in subject-verb agreement and morphological rules.	Correct use of subject-verb agreement and morphological rules with minor errors.	Skillful use of subject-verb agreement and morphological rules.
5. Parts of Speech	Lack of appropriate use of various parts of speech.	Various errors in using parts of speech affecting understanding.	Noticeable errors in using some parts of speech impacting the clarity of meaning.	Appropriate use of most parts of speech with minor errors.	Skillful use of various parts of speech (nouns, verbs, adjectives, adverbs, and prepositions) to convey meaning accurately.

Appendix D
The Semi-structured Interview Questions

1. Can you describe your experience with using the syntax tree drawing program TreeForm? What did you find most useful and what were some difficulties you encountered?
2. Do you think that using the TreeForm-based intervention enhanced your overall EFL syntactic competence, especially in your speaking and writing? If so, how? Please, provide specific examples to justify your answer.
3. Did you enjoy using TreeFom? How satisfied were you with using it in improving your EFL syntactic competence? Please, give reasons.
4. In what ways did computer-based tree diagramming using TreeForm differ from traditional paper-based tree diagramming? Which method do you find more effective, and why?

Appendix E
The Student's TreeForm Rubric

Student: …… Sentence: ……..

Level / Components	1 Poor	2 Fair	3 Good
1. Accuracy and Readability	The tree diagram is poorly drawn and unreadable with no or incorrect labels and branches.	The tree diagram is somewhat accurate and readable using somewhat properly labeled nodes and branches with noticeable errors.	The tree diagram is accurately drawn and readable using appropriately labeled nodes and branches with no errors.
2. Completeness	The tree diagram is missing most elements and does not adequately illustrate the phrase structure rules learnt.	The tree diagram includes some necessary elements that adequately illustrate the phrase structure rules learnt.	The tree diagram includes all the necessary elements that clearly illustrate the phrase structure rules learnt.
3. Organization and Hierarchy	The tree diagram is disorganized and does not display the hierarchical structure of the given sentence.	The tree diagram is somewhat organized and partly displays the hierarchical structure of the given sentence.	The tree diagram is well-organized and clearly displays the hierarchical structure of the given sentence.
4. Font and Highlight Features	Students do not use font and highlight features.	Students use some font features and highlighting in their tree diagrams.	Students use font and highlight features effectively in their tree diagrams. They are visually interesting.
5. Integration of Affix Attachment	Affix attachment is not shown in the tree diagram.	Affix attachment is partially shown in the tree diagram, and it is not clear where the movement started and where it ended.	Affix attachment is successfully integrated into the tree diagram, where the movement is clearly indicated with an arrow.