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Research Article

The Effects of Processing Instruction and Output-Based Activities on Grammar Learning: The Mediating Role of Working Memory

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Processing instruction (PI) is an input-based approach to grammar education based on input processing theory, and output is another element needed for second-language acquisition to be successful. This study sought to examine the impact of PI and output-based activities with the mediating role of working memory (WM) capacity on learning English future tense. To this end, 99 subjects with preintermediate command of English based on an Oxford Placement Test were recruited for the study, and they were divided into three groups: PI, output, and control, with 33 learners in each group. Using a reading-span test, it was revealed that 14 subjects in the PI group, 15 participants in the output group, and 13 learners in the comparison group had low WM, while the rest individuals had high WM capacity. Then, a two-way between-group analysis of variance and a Bonferroni adjustment post hoc test were performed. The results of the analyses showed that both PI and output groups outperformed the control group. Additionally, there was no difference in grammar gain between PI and output groups. Besides, learners with high WM outperformed low WM individuals. The pedagogical implication of this research is that PI and output-based activities can assist teachers in implementing effective strategies to raise L2 learners' knowledge and consciousness.

1. Introduction

It is generally agreed that in second/foreign-language learning, grammar instruction is beneficial, if not essential. Over the last three decades, a shift has been observed in classroom research into the impact of various types of grammar instruction on second-language learning [1–3]. Another challenging question about the role of grammar teaching in these studies' paradigms is whether it would be more effective if it was delivered in one modality vs. another (i.e., comprehension vs. production [4]).

Some scholars, such as Krashen [5], the most prominent figure in zero-grammar instruction, and Prabhu [6], suggested that grammar has a minor impact on second-language acquisition (SLA) and is picked up naturally if students are exposed to significant communication opportunities in the classroom. Others, such as Ellis [7], disagreed, claiming that learners would need to focus on form (FonF) teaching in order to obtain accuracy and fluency in SLA. These opposite views led to the concept of FonF [8] in language learning as a supplemental treatment to meaning-focused treatments. VanPatten [9], based on Schmidt's [10] noticing hypothesis, claims that a type of form-focused teaching, namely "processing instruction" (PI), aids L2 learners in noticing and processing targeted L2 features through comprehension training.

Processing teaching tries to change the way L2 learners perceive and process input [11]. PI [9, 11–16] is an input-based approach to grammar education based on input processing theory. Language learners are exposed to input that contains linguistic forms, which is referred to as input processing [11, 17]. L2 learners, while processing input, have limited resources to ascertain that they make correct form meaning connections [11, 18]. A form-meaning link is created when language learners read a sentence like "They watched a movie" and realize that the verb watched refers to a past event [11, 19–21].

Output, in addition to input, is seen as an important component in acquiring an L2 [22–26]. Swain [23] proposed the output hypothesis, which claims that SLA is more likely to occur and learners can grasp the level of their language proficiency solely through techniques of language production. The most salient feature of the hypothesis, according to Swain [23], is the capability to move from semantic processing to syntactic processing.

Working memory (WM), an important cognitive trait, can influence L2 acquisition rates [27]. WM permits the temporary storage of data as well as the processing of complex data. Input comprehension, as well as the regulation of learners' attention during input processing and the recording of this perceived input in long-term memory, are heavily leaned on WM [28, 29]. There are numerous practical applications for language acquisition in general, and SLA in particular, in the WM theories. Children, young adults, and older adults, for example, have different WM capacities, which can be relevant in comprehending SLA [30–33].

In Iranian schools, extra attention is paid to grammar than it is paid to other language skills. This could be traced back to the fact that summative and/or high-stakes tests in Iranian high schools are mainly grammar based [34, 35]. Despite the high importance of grammar in Iranian high schools, Iranian english as a foreign language (EFL) learners' grammatical knowledge is insufficient as they struggle to learn the linguistic structures to which they are exposed [34, 36, 37]. Therefore, considering the importance of grammar instruction, especially in the context of Iran, this experiment is an endeavor to explore the possible impact of WM capacity and two types of instructional techniques (i.e., PI and output-oriented tasks) on the grammatical improvement of Iranian EFL learners.

As mentioned earlier, although language courses in Iranian public schools are highly grammar focused, a majority of Iranian learners cannot achieve high levels of grammatical accuracy. The reason may be traced back to the fact that insufficient time, only 2 or 3 hr a week, is allocated to English in the curriculum [38–41]. It is for this reason that new research is required to find a practical solution to hone Iranian EFL learners' grammatical knowledge.

Given the importance of grammar and the need for its improvement, especially among Iranian EFL learners, this study seeks to find whether PI and output-based tasks can promote grammatical knowledge in an Iranian context. Furthermore, the potential contribution of WM capacity will be explored in this research to see how high vs. low WM learners differ in their grammar improvement. It is hoped that the findings of this current endeavor find a practical solution for grammar development of the target participants and help teachers, syllabus designers, curriculum developers, learners, and all the stakeholders in general.

2. Literature Review

2.1. Theoretical Background. The Input processing theory, a modern theory of SLA, serves as the foundation for PI [14]. This theory attempts to explain why certain L2 input is processed by learners while other parts are not [12]. VanPatten [14] explains that the theory includes a meaning primacy principle according to which L2 learners first process the input for meaning prior to the linguistic form. For example, when L2 learners are exposed to the sentence *Next week, Robert and his wife will travel to Dubai*, they first process *next week* as pointing to a future event before they process the targeted linguistic form *will*.

In PI, which is based on the theoretical model developed by VanPatten [9], learners are initially given explicit information about a grammatical structure and any associated processing issues. Subsequently, students participate in "structured-input activities," such as referential and emotional activities, where the input is organized so that learners have a higher chance of paying attention to it and are pushed out of their default processing techniques [11, 42]. According to VanPatten [43], it distinguishes PI from other FonF activities. According to VanPatten [9], PI is a psycholinguistically inspired strategy to FonF whose primary goal is to teach grammar without abandoning either communication or learning-centered activities and finally leads students to practice grammar. All in all, PI has been proved to be a fruitful teaching strategy [13, 44, 45].

Output is a further element needed for SLA to be successful [26, 46]. Since it guarantees mental grammatical processing and serves as the best stimulus for the growth of the interlanguage, Swain [22–24], suggested that comprehensible output plays a significant role in L2 acquisition as well. According to the output hypothesis [22], learners can only become aware that they are unable to express themselves in the target language during the production of the second language. The following is a summary of the contributions that output can provide by Skehan [47], building on Swain [23]:

(1) The feedback that students' efforts at production evoke serves to produce better input
(2) Syntactic processing is compelled by production
(3) Learners can test their theories about the grammar of the target language through production
(4) Automating accumulated knowledge is facilitated by production
(5) Learning through production gives students the chance to hone their discourse abilities

(6) By directing dialog to subjects they are interested in contributing to, production is crucial for assisting students in finding their own voices

In addition to what went earlier, some researchers have discovered that WM capability plays a crucial role in language acquisition [48–50]. When performing cognitive tasks like comprehension, reasoning, and learning, the human WM is in charge of simultaneously processing and temporarily storing information [51]. Baddeley and Hitch [52] created the WM model, which was further expanded by Baddeley [53]. This model, according to Alloway et al. [54] consists of a central executive that prioritizes attention and processing as well as three subsystems: the phonological loop, the visual–spatial sketchpad, and the episodic buffer.

Depending on how effectively each person processes each activity, WM capacity differs. There are differences in people's WM capacities, making the task-specific view important in determining how effectively each difficult activity is processed [55]. A significant portion of the research on WM can be attributed to Baddeley's contributions, whose theoretical and experimental work in this area has had a long-lasting and significant impact on the field [56, 57].

2.2. Empirical Studies. The first empirical research on the efficacy of PI on grammar learning is that of VanPatten and Cadierno [58]. These two scholars tried to compare and contrast the efficacy of PI and traditional grammar instruction (i.e., explicit presentation of the form along with opportunities for production). They randomly assigned 80 recruited subjects to comparison group ($N = 27$), PI group ($N = 27$), and traditional group ($N = 26$). In this pretest–posttest study, substantial improvement was observed in productivity and comprehension of individuals who received PI, while the traditional group only gained in production.

In another study, Qin [59] examined the comparative impact of PI and dictogloss tasks on the acquisition of English simple passive. Using two preexisting classes in China, this researcher assigned subjects on a random basis to a PI group and dictogloss group, each with 55 subjects. Employing a pretest–posttest design for the experiment, Qin demonstrated that on the posttest, the PI group dramatically outperformed the dictogloss group in both production and comprehension. There was, however, no difference between the two groups after a month. That is to say, in terms of comprehension and production, both groups greatly improved between the two posttests and the pretest. Qin concluded that both PI and dictogloss tasks are successful educational techniques for assisting beginner EFL students in the acquisition of target linguistic structures.

VanPatten et al. [60], skeptical about the findings of Qin [59] replicated the study with 108 learners of Spanish and compared the efficacy of PI and dictogloss tasks with a comparison group. Unlike Qin who had found both PI and dictogloss tasks to be comparable in efficiency, VanPatten and his associates indicated the paramountcy of the PI group.

Another study which compared the impact of PI and output-oriented instruction of grammar is that of Benati [61]. In this study, explanation of grammatical points and comprehension training were used as PI to change how input is processed and accurate meaning-form links are made by learners of a second language. The goal of the output-based instructional approach was to change the way L2 learners create the target language. It involved explaining grammar rules, followed by production. The findings of this study offered some indication that PI, as opposed to output-based instruction, has higher effects on the developing systems of beginning L2 learners and has beneficial consequences on the acquisition of Italian verbal morphological features.

Birjandi and Rahemi [62] also investigated the relative effects of PI and output-based teaching on the perception and creation of English causatives. In this pretest–posttest study, they recruited 151 learners at university level and subsequently, divided them into PI, output, and explicit instruction groups along with an uninstructed comparison group. The three instructional choices produced some form of gain in knowledge in both the perception and production tasks when compared to the comparison group, according to within-group comparisons, although the gains were not equal. The results of their analyses further revealed that on tasks requiring interpretation, both PI and output group outperformed the explicit group, however on tasks requiring production, the output group beat both PI and explicit groups. Notwithstanding, there was no discernible difference between PI and explicit groups on production tasks.

In a quasi-experimental study, Boostan Saadi and Saeidi [63] looked at how Iranian Intermediate EFL learners learned grammar through input enhancement and output. The study included three input, output, and control groups with 60 male students. Both experimental groups learned the target structures more effectively than the control group, according to the analysis of covariance results, although the input-based group outperformed the output-based group in terms of learning the target grammatical structures. This study's findings point to the paramountcy of input enhancement in grammar learning compared to production training.

Salimi and Shams [64] also looked at the differences between input- and output-based task-induced activities on EFL learners' writing autonomy. In a treatment that lasted six sessions, some writing-related vocabulary was given to the pupils throughout the course of six sessions. In the output-based group, students were encouraged to produce the meaning of the terms or try to use these vocabularies. In the input-based group, the words were simply taught and given to learners without asking them to use these words during the lesson. These researchers came to the conclusion using paired t-test that output-based task-induced activities were more successful in enhancing learners' autonomy in writing.

Another state-of-the-art study by Namaziandost et al. [65] compared the usefulness of input- and output-based activities on preintermediate EFL learners' productive vocabulary knowledge. In order to achieve this goal, they chose 54 intermediate EFL students and separated them into three groups: the input-based group ($n = 18$), the output-based group ($n = 18$), and a control group ($n = 18$). Input-based activities were used to deliver teaching to the input group, while output-based activities were used to deliver instruction

to the output group. These scholars found that both experimental groups outperformed the control group on the posttest and delayed posttest, according to the findings of one-way analysis of variance (ANOVA) and Scheffe post hoc tests. Nevertheless, no significant difference was observed between the experimental groups' performance on the posttest and delayed posttest providing evidence for the efficacy of both types of activities on the acquisition of lexical items.

The immediate and long-term impacts of PI and consciousness-raising on the learning of English articles were also examined by Hassanzadeh and Shahbazi [66]. They selected learners at university level with Persian as their mother tongue and divided them into PI, consciousness-raising, and control groups. The target rules and processing difficulties indicated by the English articles were explicitly taught to the PI group, along with structured input exercises. In the second group, the emphasis was on jointly creating the rules using a consciousness-raising instruction (CRI) subtype known as the PACE model. Three posttests were administered at various intervals after the treatments. The within-group analysis of the data showed that while PI had a late-emerging impact on the learners' receptive performance, CRI had a rather short-term impact on their productive capacity. Notwithstanding, the study of between-group differences showed that neither of the treatment groups had performed better than the comparison group at any point in the posttest.

Perhaps the latest research investigating the comparative effectiveness of input- and output-based activities on grammar learning is that of Kaivanpanah and Rafsanjani Nejad [67]. These L2 researchers compared the ability of Iranian learners to comprehend, create, and reconstruct English inversion structures across three focus-on-form instructional strategies. In order to accomplish this goal, 122 participants were divided into the PI, text editing, textual enhancement, and control groups and received treatment. Repeated measures ANOVA demonstrated PI's supremacy and the potential for training using this input-based approach to transfer to output tasks. The results further showed that implicit instruction is insufficient for producing the required cognitive processes needed for learning. The results also showed that using an output-based text editing method could help students perform better on exams involving the goal structure and maintain the benefits of education.

There is a general agreement among psycholinguists on the decisive role of WM and the acquisition of L2 grammar. For example, Chen and Gao [68] sought to shed light on adult learners' WM capacity hindered the processing of second-language grammar. These researchers came to an understanding that high WM scorers had considerably higher grammar judgment scores than those with low WM capacities. It demonstrates that poor individual WM capacity has a deleterious impact on the processing of L2 grammar.

Even after taking into account learners' prior grammatical knowledge [69], predictive research has shown that phonological short-term memory and executive WM were both connected with grammar learning [70, 71]. Nevertheless, Serafini and Sanz [72] found that, whereas WM was more relevant for beginning grammar acquisition, its impacts waned as learners went to higher levels—a pattern resembling vocabulary learning. In addition, Dai [73] also studied the role of WM and instructional strategies in the learning of English relative clauses. In this study, 11 grammatical aspects were examined on three occasions during and after a semester of instruction on L2 Spanish learners at elementary, intermediate, and advanced levels. It was discovered that the phonological short-term memory and executive WM only accurately predicted the grammar knowledge of beginning and intermediate learners, but not of advanced learners.

To sum up, regarding the effects of PI, output-informed activities examined in the present experiment, the findings are contradictory, with some studies finding PI is more beneficial in increasing and fostering the learning of grammatical features and some studies discovering that output-informed activities are more helpful in fostering grammatical knowledge. Furthermore, a few academics have contended that the effectiveness of PI and output-based activities output is identical. Besides, as opposed to previous research, the researchers aim to uncover the potential contribution of WM capacity in grammar learning based on PI and output-based tasks. Therefore, in the present research attempts are made to find a response to the following question:

Research Question: Is there any significant difference in learning grammar between learners exposed to PI, learners required to produce the target form, and the comparison group with reference to their WM capacity?

3. Methodology

3.1. Design. This study uses an ANOVA design. In this research, the researchers' objective is to uncover the contribution of PI and output-based activities in grammar learning with regard to learners' WM capacity. Therefore, there are two nominal independent variables, namely type of instruction and WM capacity, along with a continuous variable, namely grammar scores in this study. According to suggestions made by Ary et al. [74], it was for this reason that researchers needed to use a two-way between-group ANOVA.

3.2. Participants. The participants who took part in this study were 99 learners of English as a foreign-language studying at a language institute in Khuzestan, Iran. They were recruited for the study using convenient sampling. Out of 150 people, the previously stated sample was chosen. The participants ranged in age from 14 to 18 years old. With Persian as their native tongue and English as their target language, all participants in this study shared the same L1 and L2, respectively. The selected subjects were divided into three groups: PI group ($n = 33$), output group ($n = 33$), and the control group ($n = 33$). It is worth noting that 14 subjects of the PI group were low-span scorers of the reading-span test and the rest were high-span scorers; 15 subjects in the output group had a low-span WM and the rest had a high-span WM; 13 subjects in the control group were low-spanners, and the rest were high spanners. Reading-span test is described later.

3.3. Instruments. A variety of tools that allowed the researcher to gather the necessary data were employed to achieve the goals of the current study. The study's participants were chosen using the Oxford Placement Test (OPT). Based on OPT, the selected subjects scored between 28 and 33, indicating their lower intermediate command of English, and were selected for the research. The reading-span test was also used to examine the participants' WM capacity in order to divide them into two groups, low- and high-span groups. Additionally, to assess subjects' L2 target form knowledge a teacher-made test of grammar was used as a pretest, and a similar version of the test whose items were different from the pretest was administered as the posttest. The tests' items included multiple-choice, fill-in-blanks, and open-ended questions. Additionally, Oxford Living grammar book (pre-intermediate level) by Harrison [75] was used to teach the target L2 form (future tense) to the subjects. To make sure about the construct validity of the instrument, using a known-group technique [74], the data collector asked a group of very advanced learners of English to answer the items of the test. As these subjects outperformed the study's participants, the researchers came to know that the test has construct validity. Additionally, because the items of the test represented the target form under study, it was content valid as well. Using Cronbach's alpha, the reliability of the instrument was also examined ($r = 0.85$), hence, the reliability of the instrument.

3.4. Treatment. In a treatment that lasted five sessions, the recruited subjects were not informed of the purpose behind conducting the study. In the first session, the participants were pretested. The reading-span test was also administered in the second session so that the researchers could understand the WM capacity of the subjects. Inspired by Shahnazari [76], during the reading-span test, the data collector asked the participants to judge each individual sentence grammatically aloud as they read them silently while their answer was recorded. Furthermore, participants had to remember the last word of each sentence in a group in the order that it appeared. The whole exam consisted of three sets of three, four, and six sentences, with the recall time increasing as the number of sentences grew. In the third and fourth sessions, the PI group participated in the structured input activities after receiving explicit information regarding the goal feature. The learners were tasked with determining whether the event was occurring right now, in the future, or had already happened in the past during the structured input tasks. The output group was instructed to read and make notes on any vocabulary or grammatical structures they felt they needed to know before closing the book and creating their own sentences using the structures they had learned. The participants in the control group did not receive any treatment. To gauge the treatment's immediate impact on grammar learning, a posttest was given in the final session. To summarize, in the first session, subjects were pretested so that the researchers can understand their subjects' knowledge of the grammatical form prior to instruction. In the second session, a reading-span test was administered to investigate participants' WM capacity. In the third and fourth sessions, subjects received treatment based on PI and output-based instruction. Finally, in the last session, the participants were posttested so that the researchers can investigate the contribution of treatment with respect to WM capacity in grammar learning among the target subjects.

3.5. Method of Data Analysis. In order to run statistical tests, SPSS software was utilized. First of all, to ensure the normality assumption, a Kolmogorov–Smirnov (K–S) test was used. Then, the effects of PI and output-oriented activities with respect to WM capacity were calculated using a two-way between-group ANOVA. Eventually, post hoc analyses were run to understand which technique is more effective.

4. Results

4.1. The Potential Contribution of PI and Output-Based Activities to Grammar Learning. In this section, attempts are made to statistically answer the abovementioned research question. Because there are two nominal independent variables along with a continuous variable (posttest scores), the use of a two-way ANOVA is warranted [74]. It is worth noting that the pretest scores between groups were nonsignificant, that is the sig. value exceeded 0.05, and the scores were used as the covariate in the two-way ANOVA analysis. Before conducting the ANOVA, let's run a $K{-}S$ test to check the normality assumption.

Table 1 confirms the normality assumption as the p values exceed 0.05. Now, it is time to have a look at the descriptive statistics.

Table 2 reveals the means for PI, output, and control groups with respect to their WM capacities. As the previous table reveals, the mean for the low-spanners of the PI group is 7.07 which is lower than high-spanners' mean ($M = 10.36$). Therefore, we can conclude that as long as PI is concerned, high-spanners outperform low-spanners. In the output group, the mean of low-span subjects is 8.46, while high-span mean is 9.66. Thus, the output group's high-spanners outperformed low-spanners. However, the previous table further reveals that the mean for both high- and low-spanners in the control group is almost the same ($M = 5.20$ for high-spanners, and $M = 5.03$ for low-spanners).

Table 3 indicates the homogeneity of the subjects as the sig. value is above 0.05. Therefore, the subjects are homogenous.

Another important statistic is the interaction between PI, output-based activities, and WM capacity. Table 4 presents such an interaction effect. Looking at the Group $*$ WM part of Table 4, we see that the interaction is significant ($F_{2,92} = 92.43$, $p < 0.05$) with a large effect size (partial eta squared $= 0.176$).

Given the importance of WM capacity in the analysis, Table 5 presents its estimate. It is understood that high-spanners outperformed low-spanners ($M = 6.94$ for low-spanners, while $M = 8.29$ for high-spanners).

Table 6 also presents the sig. value for the pairwise comparison. As the previous table reveals, the difference between low-span WM capacity and high-span WM capacity is significant ($p < 0.05$). The mean difference between high vs.

Table 1: One-sample Kolmogorov–Smirnov test.

	Group	WM	Pretest	Posttest
N	99	99	99	99
Normal parameters				
Mean	2.00	1.57	4.51	7.70
Std. deviation	0.82	0.49	2.09	3.58
Most extreme differences				
Absolute	0.22	0.37	0.13	0.14
Positive	0.22	0.30	0.13	0.14
Negative	−0.22	−0.37	−0.09	−0.08
Kolmogorov–Smirnov *Z*	2.20	3.77	1.32	1.43
Asymp. sig. (two-tailed)	0.09	0.11	0.08	0.07

Table 2: Descriptive statistics.

Group	WM	Mean	Std. deviation	*N*
PI	Low-span	7.07	1.73	14
	High-span	10.36	3.62	19
	Total	8.96	3.36	33
Output	Low-span	8.46	3.90	15
	High-span	9.66	3.51	18
	Total	9.12	3.68	33
Control	Low-span	4.76	1.69	13
	High-span	5.20	1.93	20
	Total	5.03	1.82	33
Total	Low-span	6.85	3.05	42
	High-span	8.33	3.83	57
	Total	7.70	3.58	99

Table 3: Levene's test of equality of error variances.

F	*df1*	*df2*	Sig.
1.554	5	93	0.18

low WM spanners is 1.35 (mean difference = 1.35) and the alpha value is less than 0.01 ($p < 0.05$), hence the significant difference between high vs. low WM spanners.

Considering the importance of PI and output-based activities for the analysis, Table 7 is presented earlier. As the table shows, the mean for PI group ($M = 9.47$) is higher than the mean for the output group ($M = 8.94$), which is in turn higher than the mean for the control group ($M = 4.69$).

Table 8 shows that the PI group performed similarly compared to the output group ($p > 0.05$), while there was a significant difference between the PI group and the control group ($p < 0.05$). That is to say, both PI and output-based activities can enhance grammar learning. The table further reveals that there was a significant difference between the output group and the control group ($p < 0.05$).

To sum up, a two-way ANOVA was run to determine the possible effect of PI and output-oriented activities with reference to WM capacity on learning future tense among Iranian learners of English. Subjects of the study were divided into PI, output, and control groups. The interaction effect between groups and WM turned out to be significant, $F(2, 92) = 9.82$, $p = 0.001$. Besides, there was a large effect size (partial eta squared = 0.176). There was also a significant main effect for treatment with a large effect size, $F(2, 92) = 92.43$, $p = 0.001$, partial eta squared = 0.668. Additionally, the effect of WM capacity turned out to be significant as well, $F(1, 92) = 19.72$, $p = 0.001$, with a large effect size (partial eta squared = 0.177). Post hoc comparisons using Bonferroni adjustment showed that the mean score for the PI group ($M = 9.42$, $SD = 0.267$) was significantly different from the control group ($M = 4.69$, $SD = 0.267$). Notwithstanding, there was a minor mean difference between the PI group ($M = 9.42$, $SD = 0.267$) and the output group ($M = 8.69$, $SD = 0.262$). Furthermore, high-spanners of WM outperformed WM low-spanners (mean difference = 1.35, $p < 0.05$).

5. Discussion

In this section, attempts are made to exhaust the impact of PI and output-based activities on grammar learning, with reference to WM capacity. A two-way ANOVA was performed to find the efficacy of PI and output-oriented activities in learning the future tense of English. The obtained statistics indicated that both PI and output groups outperformed

Table 4: Tests of between-subject effects.

Source	Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial eta squared
Corrected model	1,054.94	6	175.82	78.69	0.00	0.83
Intercept	76.89	1	76.89	34.41	0.00	0.27
Pretest	599.03	1	599.03	268.10	0.18	0.74
Group	413.06	2	206.53	92.43	0.00	0.66
WM	44.06	1	44.06	19.72	0.00	0.17
Group ∗ WM	43.90	2	21.95	9.82	0.00	0.17
Error	205.55	92	2.23			
Total	7,141.00	99				
Corrected total	1,260.50	98				

Table 5: Estimates.

WM	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Low-span	6.94	0.23	6.48	7.40
High-span	8.29	0.19	7.90	8.69

Table 6: Pairwise comparisons.

(*I*) WM	(*J*) WM	Mean difference (*I*–*J*)	Std. error	Sig.	95% confidence interval for difference	
					Lower bound	Upper bound
Low-span	High-span	−1.35	0.30	0.00	−1.96	−0.74
High-span	Low-span	1.35	0.30	0.00	0.74	1.96

Table 7: Estimates.

Group	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
PI	9.47	0.26	8.94	10.00
Output	8.69	0.26	8.17	9.21
Control	4.69	0.26	4.16	5.22

Table 8: Pairwise comparisons.

(*I*) Group	(*J*) Group	Mean difference (*I*–*J*)	Std. error	Sig.	95% confidence interval for difference	
					Lower bound	Upper bound
PI	Output	0.78	0.37	0.12	−0.14	1.70
	Control	4.78	0.38	0.00	3.85	5.70
Output	PI	−0.78	0.37	0.12	−1.70	0.14
	Control	4.00	0.37	0.00	3.09	4.91
Control	PI	−4.78	0.38	0.00	−5.70	−3.85
	Output	−4.00	0.37	0.00	−4.91	−3.09

the control group ($p < 0.05$), but no statistically significant difference was found between PI and output groups ($p > 0.05$), verifying the efficacy of both PI and output-based training on grammar learning. Additionally, there was a significant difference between WM high- and low-spanners (mean difference = 1.35, $p < 0.05$), corroborating the mediating role of WM capacity. That is to say, subjects with higher WM capacity learn more linguistic forms than learners with lower WM capacity, even when they are exposed to effective PI and output activities. Accordingly, the research's null hypothesis can be rejected.

This study found support for the effectiveness of both PI and output-based activities. This finding is in line with some

research reported earlier (e.g., [13, 58, 59, 62, 65, 67]). However, Birjandi and Rahemi [62] reported that on tasks requiring interpretation, both PI and output group outperformed the explicit group, however on tasks requiring production, the output group beat both PI and explicit groups. Although this study also find support for the usefulness of both PI and output activities on grammar learning and that the administered test involved both recognition (multiple-options questions) along with open-ended questions (production items), this study did not take account of differential effects of tasks on grammar learning.

The findings of this study are also in sharp contrast with those of Benati [61], and Salimi and Shams [64]. Comparing the impact of output-oriented activities and PI on the acquisition of Italian verbal morphological features, Benati [61] found out that PI group outperformed the output group. Additionally, Salimi and Shams [64] looked into the effect of input- and output-based task-induced activities on EFL learners' writing autonomy. These scholars showed how output group outperformed the input group. In this study, we argued against these two studies' reports as a beneficial effect for both PI and output-oriented activities was found.

In addition to what went earlier, Hassanzadeh and Shahbazi [66], comparing the impacts of PI and consciousness-raising on the acquisition of English articles, showed that CRI has an immediate impact on the acquisition of articles while the effect of PI is late-emerging. However, the results of the current investigation are in contrast to that of Hassanzadeh and Shahbazi as the immediate impact of PI and the acquisition of targeted L2 form was corroborated.

The findings of this study also showed that although there was not a significant difference between the performances of the two treatment groups on the posttest, the mean scores of PI group were higher than the output group on the posttest indicating the supremacy of PI group to output group. However, the difference was only minor and nonsignificant.

This study's findings showed that learners can gain grammatical knowledge similarly from both PI and output-oriented tasks. In output-oriented tasks, students are encouraged to produce language based on the target form they have been learning, and in this way, SLA can take place, hence the essential role of output-based tasks in grammar learning. In PI-based activities, students are instructed to focus on the essential features of the target form which may be nonsalient in the first instances of occurrence. As students' default processing mechanisms are tuned to focus on the nuance features of the linguistic form being learned, they can grasp the form step by step and move toward controlling the feature. In this way, SLA can take place as well [77].

The results of this research further revealed a significant difference between WM high- vs. low-spanners. That is to say, those learners with high WM capacity indeed grasped more of the target feature on the posttest as opposed to low WM spanners who could not catch up with high WM participants. Taking this into account, one can understand the mediating role WM capacity plays in learning grammatical features. In another words, learners with higher WM capacities can indeed learn more of the linguistic features they are exposed to than their low WM capacity peers.

The novelty of this study is that the mediating role of WM capacity was also considered in this experiment. This study confirmed the mediating role of WM on grammar learning as reported by Chen and Gao [68]. These researchers reported that WM high-spanners scored more on a grammar judgment test than WM low-spanners. Nevertheless, as opposed to Chen and Gao who reported that low WM capacity is related to weak L2 grammar processing, the findings of the present study showed that although there is a significant difference between WM high scorers and low scorers ($p < 0.05$), these subjects, irrespective of their WM capacity can indeed learn the target L2 feature. The point is that, if subjects are exposed to either PI or output-based activities, they can learn grammar, but WM high-spanners learn more and it does not mean that WM low-spanners do not learn the linguistic structure, at least as long as English future tense is concerned. The conclusion from earlier studies (e.g., [69–71]) that greater WM is associated with more grammatical acquisition is also consistent with the findings of the current investigation.

6. Conclusion

This study looked into how learning L2 grammar was affected by PI and output-based exercises and WM. Additionally, the findings revealed the important effects of PI, output-based, and WM capacity on grammar acquisition. The results of this study are mostly favorable for those students who specifically seek to improve their knowledge of L2 grammar. This study's pedagogical consequence is that PI and output-based activities can assist teachers in implementing effective strategies to raise L2 learners' knowledge and consciousness. This study shows that, when it comes to grammar learning, PI may be used successfully in EFL classrooms for students and are at least as effective as output-based activities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Additional Points

Implications, Limitations, and Suggestions for Further Research. As stated earlier, strong evidence was found for the effectiveness of both PI and output-based activities in grammar learning in this research. Additionally, learners with high WM capacity learned more of the target linguistic form than learners with low WM capacity. Therefore, the pedagogical implication of this study is that teachers of EFL classes can resort to both PI and output-based tasks and employ them in their classes to enhance grammar learning among their students. Another implication that is relevant to learners themselves is that they can make use of suggestions made on the application of PI and output-informed activities so that they can hone their grammar

knowledge. Syllabus designers, curriculum developers, policymakers, and all the stakeholders can also benefit from the findings of this study in that they can produce more compelling materials that can enhance grammar learning among EFL learners. Teacher trainers are also advised to encourage prospective teachers to employ these techniques in their classes because such tactics proved to be useful in improving grammar learning.

This study, however, is not without limitations. One of the limitations of this study is the number of subjects in each group. Future studies can be implemented with more subjects in each group to determine more closely and meticulously the effect of PI and output-based activities with the mediating role of WM. Another limitation of this study is that the researchers utilized convenient sampling selection which is a weak form of sampling [74]. As a result, the results may not easily be generalized to other contexts [74]. Thus, further research using random sampling is needed. Additionally, only the mediating role of WM was explored in this study. Future studies can also look into different leaner features (e.g., field dependence/independence, anxiety, L2 aptitude, intelligence, etc.). Besides, this study only explored the effects of PI and output-based activities on a single proficiency level. Future experiments can look into the effect of this treatment across different proficiency levels. Finally, not the least among the limitations of this study is that the role of gender was not investigated. Accordingly, future researchers can also look into the role of gender and see whether there will be a difference between male learners vs. female learners when exposed to such a treatment.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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