

# Underspecification-based grammatical feedback generation tailored to the learner's current acquisition level in an e-learning system for German as second language

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**Abstract.** We present a new feedback strategy implemented in a natural language generation-based e-learning system for German as a second language (L2). Although the system recognizes a large proportion of the grammar errors in learner-produced written sentences, its automatically generated feedback only addresses errors against rules that are relevant at the learner's current L2 acquisition stage. This approach is motivated by the results of two recent studies into German as L2 teaching in classroom situations. Both studies observed that the acquisition stages that L2 learners go through during L2 acquisition are similar to developmental stages for German as first language (L1), with only slight differences depending on the learner's native language (French or Italian). The individual acquisition stages often deviate from the organization of the L2 instruction lessons used in the classroom. They also found that attempts to teach L2 rules which surpass the learner's current acquisition stage are futile. Our system emulates the observed acquisition stages, and the feedback it provides only addresses errors that are 'teachable' at the learner's acquisition stage; the learner is not notified of errors that are beyond this stage. The computational approach to obtain the desired error-diagnostic behavior is based on underspecifications of the system's grammar rules.

**Keywords:** ICALL, e-learning, natural language generation, grammar teaching, German as a second language (L2), personalized feedback.

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## 1. Introduction: developmental stages in L2 acquisition

In research on Intelligent Computer-Assisted Language Learning (ICALL), grammatical/linguistic-awareness teaching figures prominently (cf. Meurers, 2013; Roehr, 2007). Generating appropriate feedback is essential in any e-learning system for second language (L2) learning (cf. a recent empirical study by Kartchava, 2012). Many authors advocate personalized feedback (Vasilyeva, 2007), i.e. different learners receive different information, and learners have the possibility to choose the feedback that suits their needs or preferences best. An indispensable prerequisite in such systems is an appropriate user model enabling the system to take the student’s knowledge and ‘cognitive readiness’ (Varnosfadrani & Ansari, 2011) into account when providing corrective feedback.

In a study of grammar errors in written essays by 220 French-speaking learners of L2 German in primary and secondary schools in Geneva/Switzerland, Diehl, Christen, Leuenberger, Pelvat, & Studer (2000) report that even under classroom conditions, pupils go through acquisition stages similar to those observed in first language (L1) acquisition. Crucially, these acquisition stages do not always reflect the organization of the L2 instruction lessons taught in the classroom.

Diehl et al. (2000) identify three “strands” in L2 grammar acquisition (see Table 1). None of the consecutive steps in any strand can be left out –no deviation is vertically possible. Horizontal alignment within each strand reflects the personal acquisition level of the learner. Diehl et al. (2000) interpret their results as strong support for Pienemann’s (1989) teachability hypothesis, i.e. grammar instruction has only a chance to be effective if it dovetails with natural acquisition orders and strategies. Ballestracci (2005) argues in the same vein, based on error analyses and classifications of German essays written by Italian-speaking students.

Table 1. The three strands of acquisition levels according to Diehl et al. (2000)

(1) Verbal Morphology	(2) Verb Placement	(3) Case Marking in Noun Phrases
I Preconjugative Phase ( <i>Infinitives</i> )	I Main Clauses ( <i>Subject-Verb</i> )	I One-Case-System ( <i>only Nominative forms</i> )
II Conjugation of Regular Verbs in Present Tense	II Coordinated Main Clauses Wh- and Yes/No-Questions	II One-Case-System ( <i>arbitrary distribution of Nominative/Dative/Accusative forms</i> )
III Conjugation of Irregular Verbs in Present Tense; Modal Verb + Infinitive	III Correct Topological Assignment of Verbs ( <i>Left and Right Verb Bracket</i> )	III Two-Case-System Nominative + Object cases ( <i>N-Forms + arbitrarily distributed Dative/Accusative forms</i> )
IV Auxiliaries + Participles	IV Subordinate Clauses	IV Three-Case-System
V Past Tense	V Inversion ( <i>X-Verb-Subject</i> )	
VI Remaining Forms		

## 2. U-COMPASS: generating feedback tailored to the learner's acquisition level

Based on the empirical findings mentioned above, we tailor the feedback delivered by our e-learning system (called U-COMPASS ) to the personal acquisition level of the learner –an input parameter to be set by the teacher.

In a drag-and-drop manner, the learner freely constructs phrases/sentences in German. In order to identify the learner's current problem, the student's and the system's generation process become aligned. For any action by the learner, e.g. adding/inflecting word forms or (re-)arranging word order, a natural language paraphrase generator calculates whether the linguistic construction is correct (for details, see [Harbusch & Kempen, 2011](#)). Linguistic nomenclature and levels of detail depicted by the system can be set by the teacher. [Figure 1](#) is a screenshot taken during the construction of sentence (1) by an advanced learner exercising word order rules in main and subordinate clauses (cf. phase IV/V in strand (2) of [Table 1](#)). The figure illustrates part of the structure underlying sentence (1) in terms of the syntactic formalism of Performance Grammar (PG) ([Kempen & Harbusch, 2002](#)). The teacher has selected a German nomenclature (e.g. Kopf 'Head'). Phrasal node labels are suppressed; instead, colors distinguish phrase types, For instance, a modifier in pink can only bind a leaf node with the same color option.

- (1) Was will der kleine Junge dass ich ihm allenfalls baue  
What wants the little boy that I him at best build  
'What does the little boy want me to build for him at best'

PG distinguishes three aspects of the structure of sentences: dependency relations (grammatical functions), constituent structure, and linear order. The dependency relations and the constituent structure together form the hierarchical (or dominance) structure. The dependency relations include functional relations: SB=Subject, OA=Accusative Object, DA=Dative Object, etc.). The constituent structure comprises word categories (parts of speech) and word groups (the various types of phrases and clauses). PG is lexicalized, i.e. every constituency rule is associated with a lexical anchor consisting of at least one word form (cf. [Harbusch & Kempen, 2011](#)).

Selecting a word form in the lexicon activates a so-called treelet (cf. dependency relations in the second layer of nodes in [Figure 1](#)). Linear order is computed in terms of topology-based declarative rules (not spelled out here; see [Harbusch & Kempen, 2002](#)). Stretchable rectangular grey boxes represent topologies; they are



(2) incorrect structures rescued by malrule application, and (3) remaining errors resulting from a mismatch with the grammar rules (including malrules). U-COMPASS contains malrules for the typical errors outlined in Table 1 and gives feedback only if a malrule is applied. For instance, the malrule dealing with phase I of strand (3) assigns CASE=Nominative to any grammatical function –although the core system’s PG rule only allows CASE=Nominative for the Subject but not the (In-)Direct Object. For learners in phase II, a malrule allows the case options Nominative/Dative/Accusative to be applied to any grammatical function. In phase III, (In-)Direct Objects still allow CASE= Dative/Accusative whereas the Subject is restricted to Nominative. In Phase IV, the full set of rules of the core system is applied without invoking malrules.

Within the PG formalism, the various malrules needed to deal with the three strands of Table 1 can be stated very succinctly by allowing underspecifications for the correct rules. This means modifying the grammar rules in such a way that they overgenerate, i.e. produce certain ill-formed constructions, as desired by the acquisition stages. In the above-mentioned example, the CASE fillers in the treelets have specific underspecification settings (e.g. the Direct Object, which requires CASE=Accusative, has an UNDERSPEC\_CASE= Nominative/Dative/Accusative if phase II in strand (3) is the parameter setting for the learner’s acquisition stage). For linearization, i.e. strand (2), underspecifications tell the system not to apply specific topological rules during certain acquisition stages, e.g. up to phase V, checks of Subject-Verb-Inversion are suppressed.

### 3. Conclusions

In our e-learning system for L2=German, we have implemented a feedback strategy that only notifies the learner of errors that are ‘teachable’ at the current personal acquisition level of the learner, and overlooks any other errors (which will be brought to the learner’s attention only at a later stage of acquisition). This strategy is inspired by the results of recent empirical studies in German as an L2 teaching.

We are preparing a first evaluation of U-COMPASS in a classroom. Moreover, we use the data material collected in the two cited empirical studies to automatically set up language games where the learners are invited to correct authentic errors at their current acquisition level.

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