Corpus for Children's Writing with Enhanced Output for Specific Spelling Patterns (2nd and 3rd Grade)

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Abstract

This paper describes the collection of the H1 Corpus of children's weekly writing over the course of 3 months in 2nd and 3rd grades, aged 7-11. The texts were collected within the normal classroom setting by the teacher. Texts of children whose parents signed the permission to donate the texts to science were collected and transcribed. The corpus consists of the elicitation techniques, an overview of the data collected and the transcriptions of the texts both with and without spelling errors, aligned on a word by word basis, as well as the scanned in texts. The corpus is available for research via Linguistic Data Consortium (LDC). Researchers are strongly encouraged to make additional annotations and improvements and return it to the public domain via LDC.

Keywords: Orthography, Corpora, Children's Texts, Digitization, Anonymization

1. Introduction

Reading and Spelling are key skills acquired by children during their first four years of school. According to PISA and IGLU (OECD, 2014), a significant number of school children are still left behind in Germany. PISA (2000-2012) has documented a significant discrepancy between students' scores. It is generally known that underachievement in reading and spelling acquisition can stem from a lack of a variety of skills, including phonemic awareness, knowledge of grapheme-phoneme correspondences and reading (Read, 1975; Bissex, 1985; Wagner et al., 1994; Treiman, 1993). In addition to that, Germany has a number of children with migrant backgrounds, only those with foreign nationality entering the official statistics. Despite almost two decades of effort to increase the number of foreign children participating at the level of Gymnasium, the statistics since 1995 have not changed much.

These children grow up in multilingual environments. Their lack of German language skills compounds the process of writing skill acquisition in several areas. The degree to which these skills are acquired furthermore has a direct impact on students' scholastic performance across subjects and can prevent academic performance that would lead to the ability to obtain an education degree or continue to higher education. PISA categorizes around 29% of children with 2nd generation migration background below level 2 in Mathematics. (OECD, 2014, Table II.3.7).

In order to prevent problematic developments, early reading, spelling and language skills have to be targeted in specific interventions (National Reading Panel, 2000). Especially reading and spelling interventions administered from Grade 1 to Grade 2 show positive effects (Suggate, 2014). In order for instructional material, diagnostics and intervention to be effective, more research is needed to understand how writing skill acquisition develops. Due to technology for automated spelling analysis (Berkling et al., 2011) a detailed study of typical orthographic skills in a large corpus (Lavalley et al., 2015) has revealed that several categories of spelling errors persist to a significant degree up to eighth grade. To study these phenomena in more detail, relevant state-of-the-art work must collect corpora, make these public for comparative research and automate the processing of large scale data.

The study of orthographic skills acquisition is mostly limited either by the data set that is to be analyzed or by the detail with which the data is analyzed. Due to the limited number of data sets in this area, analysis is not done with large data sets and high degree of detail. A number of early acquisition models exist (Frith, 1985; Wimmer, 1993; Coltheart et al., 2001). Beyond the first years of acquisition it is difficult to find a unified model of acquisition encompassing the integrated development of spelling and sentence grammar throughout school. In psychology some research has been done on word acquisition of the brain. Levelt (Levelt, 1992; Levelt and Wheeldon, 1994) explains the connection between phonemic representation, syllables and semantics in relation with word access for speech processing and this model has relevance for spelling acquisition and access. Vitevitch (Vitevitch and Luce, 1999) showed that phonotactics is one important component in word access. Fiez et al. (Fiez et al., 1999) are an example of the study of spelling-to-sound conversion. While this type of research provides an insight into brain processing regarding word access that can influence the way we model reading and writing acquisition, they do not provide a direct prescription for optimal instruction of orthography nor the possibility to set expectations of skill sequence and mastery for "normal" acquisition up to advanced levels.

Analyzing orthographic abilities of children in Germany are usually either performed on smaller datasets (Berkling et al., 2011), or the spelling errors are evaluated at a high level (Thomé, 1999) and are marked by hand (Hanke and Schwippert, 2005), or orthographic progress is marked in broad steps of acquisition (Sassenroth, 1991; Bredel, 2011). Studies often focus on children with dyslexia or multilingualism (Günther et al., 1989; Landerl, 1996; Röber-Siekmeyer, 2003). A large body of research has mostly focused on phonological awareness and its effect on spelling

capability (Roth and Schneider, 2002; Küspert, 1998). Using handlabels, error categories tend to be at a broader level. A number of pencil and paper tests have been developed as standardized tests with large data collections to form statistically accurate diagnoses, normed for specific grade levels. Among these are the "Diagnostische Rechtschreibtest" (DRT), "Deutsche Rechtschreibtest" (DERET), and "Hamburger Schreibprobe" (HSP). They are expensive to administer and cover word level and sentence level spelling errors where both words and sentences are manually tagged for predicted errors in predetermined words and texts that are either dictated to the child or elicited via pictures. Administration of these tests have been facilitated by providing online forms for tests (e.g. HSP-plus). 'Gutschrift' by Löffler and Meyer-Schepers offers an online analysis tool based on a linguistic approach. 'Lernserver' by Schönweiss at Universität Münster results in a diagnosis with personalised exercises. Additionally, an increasing number of schoolbook publishers are offering diagnosis online coupled with targeted learning material. A serious shortcoming with any of these types of tests, whether on paper or online, is the predetermined word and sentence material on which the child is tested. Manual tagging of spelling variations is possible with known intended (target) words/text. Another key limitation for predefined items is further the limit on test-taking frequency. This problem may have been addressed in part by OLFA (Thomé and Thomé, 2010). While being somewhat text independent, manual annotation demands expertise by the teacher that makes its use somewhat difficult, not only for the teacher but particularly for large scale data processing. The tool developed by Berkling (Berkling et al., 2011) is able to automatically tag a number of the detailed error categories and has been developed further on the basis of spontaneously written text samples written by children from grades 2-8 (Lavalley et al., 2015). A compromise between completely spontaneous text and predefined items is a method for text elicitation that has been used in some preliminary studies (Berkling et al., 2015). During the writing phase the kids are presented with pictures that elicit enhanced output with respect to the error categories under observation. Additionally, the topics are selected in such a way that personal information is virtually non-existent, thereby eliminating the large time span needed to clean up data collections in the past. The elicitation technique for the current database is based on this design.

There are currently only few corpora of this kind available for the German language. The two largest ones are the KoKo Corpus (Abel et al., 2014), where 1400 children have written an essay, not publicly available, and the KT Corpus (Lavalley et al., 2015) with 1700 texts, available through LDC as of Fall, 2015. These corpora have been collected in an L1 context. There are some other corpora that are of smaller size and not available openly. Because the children texts that we are interested in are also written by migrant children, L2 corpora are relevant. The most commonly used L2 German corpora are the Merlin corpus (Wisniewski et al., 2013) which consists of 1000 writing samples extracted from language tests (TELC) and exams performed at the University of Prague and the Kobalt Corpus (Zinsmeister et al., 2012). However, both are composed of texts written by young adults. Thus, it is impossible to achieve significant and realistic studies regarding German L2 learning by children of elementary school age on a small or a large scale. There are currently no other corpora as described above for German in L2 context for elementary school age. Our project will contribute to research in elementary school aged acquisition of German orthography and text writing by providing another publicly available learner corpus of writing samples. Like our first corpus, this one will be released for researchers with all information needed to study related questions: A picture of the handwritten original child text, a typed version of the original text, the corrected text, as well as relevant meta-information.

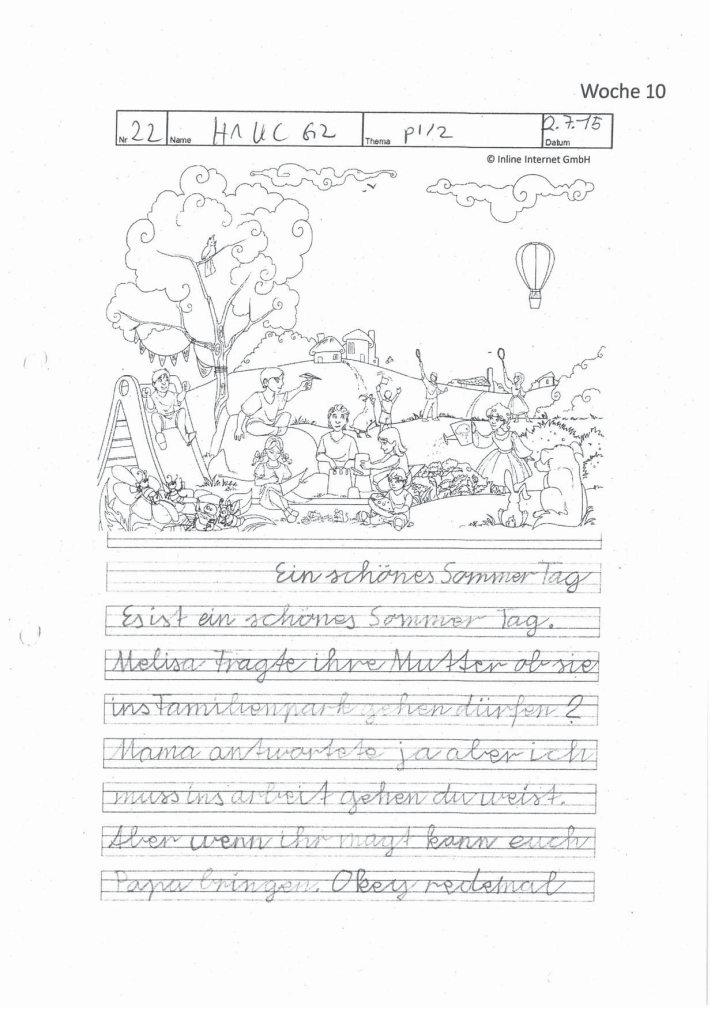

Figure 1: Picture for text elicitation in Week 10.

2. Data Collection

This new database overcomes many of the problems that were discovered in the previous data collection (Lavalley et al., 2015)(Linguistic Data Consortium, 2015). The previous corpus required an enormous amount of manual labor to anonymize because the text included too much personal information. This new corpus has several advantages over the former: It includes longitudinal data, through constraining the vocabulary to some degree it includes highly

comparative freely written texts collected in two different grades. There are formal pre- and post-tests that are the same for all participants, the children were given lined papers and as a result the text is much more readable.

This section describes the collected data and the data transcription and annotation methods. The data that was used for this paper was collected by an elementary school in Baden Würtemberg, Germany and digitized at the Cooperative State University of Karlsruhe during the second half of the 2014/2015 schoolyear.

Three classrooms participated, each of grades 2 and 3 resulting in a total of 88 children whose parents donated these texts to science. Out of these, meta data is available for 85 children, 57 of these are multilingual and only 28 are monolingual in German. Every week of 12 one text was written, resulting in a total of 996 texts, 8119 types and 62764 tokens. The most frequent 100 words cover 50% of the text.

2.1. Text Elicitation

Texts were written within regular class settings. The pictures that are used for text elicitation are designed to enhance the output with respect to important spelling error categories, namely the marking of short vowels with a silent consonant letter and the correct spelling of the long vowel <ie>. This is motivated by previous work in this area that shows that these are the key persisting error categories until the upper grades of high school (Berkling and Lavalley, 2015). Children had at least 15 minutes time to write the texts. They were asked to write a story or else describe the picture. If unable to write a text, they were asked to list the things they see on the pictures. An example of such an output is depicted in Figure 1.

2.2. Pre- and Posttests

Pre- and post tests contain the same writing material across all writers and were administered as an anchor with respect to the orthographic skills measured through the spontaneous texts based on picture elicitation. The pre- and post tests were given at the beginning and end of the data collection. The words were split between dictation and picture naming to account for dictation bias. The words are chosen to have a high frequency in 2-syllable and 1-syllable words containing <ie> and short vowel marking with silent following consonant letter. The list is shown in Table 1.

2.3. Meta Data

Meta data was collected for every text in the database.

- school week of collection
- school type is always elementary school
- age
- gender
- grade / classroom
- language spoken at home
- school materials used for German (Jojo)

Category	Wordlist
Pretest (23 items)	
Long Vowel (LV)	Lupe, Hose, Besen, Nadel
LV Challenges	Schuhe*, Sahne*, Beule*
Silent Consonant (SC)	Koffer, Tunnel, Sonne
	Teller, Wippe, Butter
SC Challenges	Schnecke*, Katze*
	Zunge*, Töpfe*
Short Vowel	rund*, Murmel*
Short <i>	Kiste, Spinne*
Long <ie>	Biene, sieben*
Post-test (45 items)	
Long Vowel (LV)	Lupe, Hose, Besen, Nadel, *Rose, Feder*
LV Challenges	Schuhe*, Sahne*, Beule*
Silent Consonant (SC)	Koffer, Tunnel, Sonne, Teller
	Wippe, Butter, *Hammer, Roller*
	Tanne, Tonne, Wasser, Kanne
	Sessel, Ritter
	Bett, Fett*, lassen*, hoppeln**
	er rennt, sie lässt**
SC Challenges	Schnecke*, Katze*
	Zunge*, Töpfe*
Short Vowel	rund*, Murmel*, *Wolke, Pinsel*
Short <i>	Kiste, Spinne*
Long <ie>	Biene, sieben*
	*Dieb, Brief, lieben**

Table 1: Wordlist for Pre- and Post-test. Words are elicited via pictures or dictation*.

3C	pre	w3	w4	w5	w6	w7	w8	w9	w10	w11	post	w13
1	x	x	x	x	x	x	x	x	x	x	x	x
2	x	x	x	x	x	x	x	x	x	x	x	x
3	x	x	x	x	x	x	x	x	x	x	x	x
4	x	x	x	x	x	x	x	x	x	x	x	x
5	x	x	x	x	x	x	x	x	x	x	x	x
6		x	x		x	x	x	x	x	x	x	x
7	x	x			x	x	x	x	x	x	x	x
8												
9	x	x	x	x	x	x	x	x	x	x	x	x
10	x	x	x	x	x	x	x	x	x	x	x	x
11	x	x	x	x	x	x	x	x	x	x	x	x
12												
13		x	x	x	x	x	x	x	x	x	x	x
14								x		x	x	x
15												
16	x	x	x	x	x	x	x	x	x	x	x	x
17	x	x	x	x	x	x	x	x	x	x	x	x
18	x	x	x		x		x	x	x	x	x	x
19	x	x	x	x	x	x	x	x	x	x	x	x
20												
21	x	x			x	x	x	x		x	x	x

Table 2: Texts collected by class, ID, and week

Statistics about the data are released with the data itself. There are files containing the school week for which children wrote texts, the list of texts submitted by class, week and child (including absences) as shown in Table 2.3., and the meta data (see excerpt in Table 2.3.). In addition, the packages (including templates and pictures) as well as instructions given to the teachers are available.

ID	Class	f/m	B-day	Age	Languages		
H1.KA.G2.2	2a	m	06.07	8	g		
H1.KA.G2.4	2a	m	09.07	8	e	ar	g
H1.KA.G2.5	2a	m	09.06	9	g		
H1.KA.G2.6	2a	m	12.06	9	g		
H1.KA.G2.8	2a	m	08.06	9	g		
H1.KA.G2.11	2a	m	03.07	8	k	g	
H1.KA.G2.12	2a	w	05.07	8	g		
H1.KA.G2.13	2a	w	03.07	8	g		
H1.KA.G2.14	2a	w	10.06	9	g		
H1.KA.G2.18	2a	w	09.07	8	al	g	
H1.KA.G2.19	2a	w	07.07	8	g		
H1.KA.G2.21	2a	w	11.06	9	i	g	
H1.KA.G2.22	2a	w	03.07	8	g		
H1.KA.G2.23	2a	w	09.07	8	g		
H1.KA.G2.24	2a	w	10.06	9	t	g	

Table 3: Meta-data for Corpus. Author ID, classroom, gender, birth month, age at time of writing, and language biography (ar=aramaic, al=albanian, k=kurdish, g=german, e=english, i=italian, t=turkish).

2.4. Anonymization

Texts were submitted in anonymized fashion. There was almost no extra work required. In four cases students wrote their name by accident. These were removed.

3. Transcription

The obtained texts were digitized in two forms: the original text, including all errors (achieved) and the intended (target) text, where all spelling errors have been removed. Annotations are needed at this level to distinguish the words that should not be analyzed for spelling errors such as names or foreign words. All annotations, as listed in Table 4 are added to both the target and achieved text to maintain a word by word match between the two texts, see also (Berkling and Lavalley, 2015; Lavalley et al., 2015). In order to prepare for sentence-level analysis, syntax errors have been annotated by marking substitutions, deletions and insertions at word level. In such cases, the used word is analyzed for spelling and the correct word is used for sentence structure analysis. The annotation conventions used in the transcription are listed in Table 4 at both word and sentence level. Note, that primarily sentence boundaries are marked but other punctuation marks, like commas and quotes have not been annotated in the first version. The following text example shows some of the examples of how annotation is used.

Achieved:
Ein schönes Sommer§Tag . Es ist ein schönes Sommer§Tag . Melisa Fragte ihre Mutter ob sie ins [§ den] Familienpark gehen dürfen . Mama antwortete ja aber ich muss ins [§ die] arbeit gehen du weist . Aber wenn ihr magt kann euch Papa bringen . Okay{F} rede_mal mit Papa wenn Papa will dann sag bescheit Mama . Weill meine Geschwister wollen auch ins [§ den] Familienpark [§ .] Mama hate schnel mit Papa geredet . Papa hate Okey{F} gesagt . Mama ging ins [§ die] arbeit und nachÂ§dem Mama gegangen ist [haben sind] sie los gefahren [§ .] in 15 min waren sie schohn da . sie haben gerutst und mit Sand ge§spielt und so weiter [§ .] nach 2 Stunde waren sie sehr schlap und [haben sind] nach_hause gefahren . Ende .

Target:
Ein schöner Sommer§tag . Es ist ein schöner Sommer§tag . Melissa fragte ihre Mutter ob sie in [§ den] Familienpark gehen dürfen . Mama antwortete ja aber ich muss in [§ die] Arbeit gehen du weißt . Aber wenn ihr mögt kann euch Papa bringen . Okay{F} rede_mal mit Papa wenn Papa will dann sag bescheid Mama . Weil meine Geschwister wollen auch in [§ den] Familienpark [§ .] Mama hatte schnell mit Papa geredet . Papa hatte Okay{F} gesagt . Mama ging in [§ die] Arbeit und nachÂ§dem Mama gegangen ist [haben sind] sie los gefahren [§ .] In 15 Min waren sie schon da . Sie haben gerutscht und mit Sand ge§spielt und so weiter [§ .] Nach 2 Stunden waren sie sehr schlapp und [haben sind] nach_Hause gefahren . Ende .

Letter- and Word-Level Annotations:	
*	unreadable letter
a_b	a and b should have been written separately
a§b	a and b should have been joined
a=b	missing hyphen
a∼b	wrongly placed hyphen
a−−b	denotes split of word at end of line (not hyphen)
a{n}	n repetitions of word a
a{F}	Foreign word defined by non-German graphemes foreign grapheme-phoneme correspondence
a{G}	grammatical errors not to be analyzed for spelling
a{N}	Names, not analysed with the spell tagger
Sentence Level Annotations	
[§ fW]	an unknown deletion
[§ b]	a known deletion b
[a §]	an insertion a
[a b]	substitution of a for b a is corrected on target side Achieved: [seinne ihre] Target: [seine ihre]
[a b_c]	best guess of word boundary
[a_b c]	kanicht = ka[n nn_n]icht
[a *]	some combinations of letters make up word a the real word can not be identified.
a can include conventions from word-level annotations For example: [rtchen**gdsdfg *] [rtchen**gdsdfg *] or [a{G} b] Numbers (1,2,..): kept as numbers. Words with exaggerated spelling: [Leeeeooooooon Leon].	

Table 4: Conventions for annotation of transcriptions as relevant to automatic spelling annotation.

4. Data Exploration

The following results exemplify the kind of work that can be accomplished on the children's text corpus. Since our work concentrates on orthographic development, we were able to use the automatic error tagger on all the texts in order to explore the possibility of classroom diagnostics or long term development of particular orthographic skills. The automatic error tagger was published (Lavalley et al., 2015) and is available via web interface (Berkling, Kay, 2015) for public use.

Figure 2 shows a spelling profile for the post test in one of the classrooms. Depicted are the counts of correctly and incorrectly spelled orthographic categories relating to vowel length marking (see also (Lavalley et al., 2015) for more details on spelling error categories). Most prominent are categories for correct use of <ie> (blue) and short vowel marking (as in *kö***nn***en* (red)). Correct occurrences of each category are shown in pastel, incorrect writings are shown in full color. In the graph we can see that there were a number of occurrences of pastel red (correctly written short vowel markation) so it seems most children have mastered this skill in the post test. However, we can also see that about three kids deserver further study. In particular, child 9, 10, and 20 in this graph deserve a closer look because the dark red component of the bar is significantly taller than for the other children in that same classroom.

Taking a look at the development of child number 20 in that classroom, Figure 3 shows the results across all the texts that were collected each week for the duration of the study. The graph shows differences in number of total occurrences but no visible progress in terms of number of spelling errors committed for the category we are looking at (in red).

While this work was done regarding the orthographic development, similar studies can be performed at the sentence and text level.

5. Conclusions

We have provided a digitized transcription for a publicly available data set of student writings from grades 2 and 3. The data are available via the Linguistic Data Consortium (H1 Children's Text; LDC (Linguistic Data Consortium, 2016)). There is no report on inter-annotator agreements because the goal of this work was to publish the resource and it's transcription (see acknowledgements on funding). Improvements to the transcription are highly welcome.

There are many annotation methods in existence that have been validated and standardized through large projects. The annotation provided here is very minimal and invites contributions of further annotations to the public domain (via LDC).

The transcription of original and targeted text along with the annotation and meta-data indexing allows the researcher to select subsets of the data in order to analyse these with respect to various dimensions, some of which have been reported here.

With the advent of large public databases, language acquisition can be studied in more detail. Understanding language acquisition is a prerequisite to diagnosis and supporting tools. Very little work exists joining those three areas of study and using speech and text processing technology for automatic analysis of large amounts of data. With more know-how in this area, the field of personalized training for children can grow.

6. Acknowledgements

The existence of this data is due to a number of dedicated teachers, a director of a very special school, a large number of children who write for us, and the parents who donate these texts to help understand the process of learning so that we can improve our knowledge of orthographic acquisition. Thanks go to all the people who put the work into making this happen but mostly to the children. This work is a grass-roots effort. Government funding for this kind of research is rejected because "the pedagogic goal of this work is not clear" and "the contribution of computer science is not relevant" to quote the reviewers.

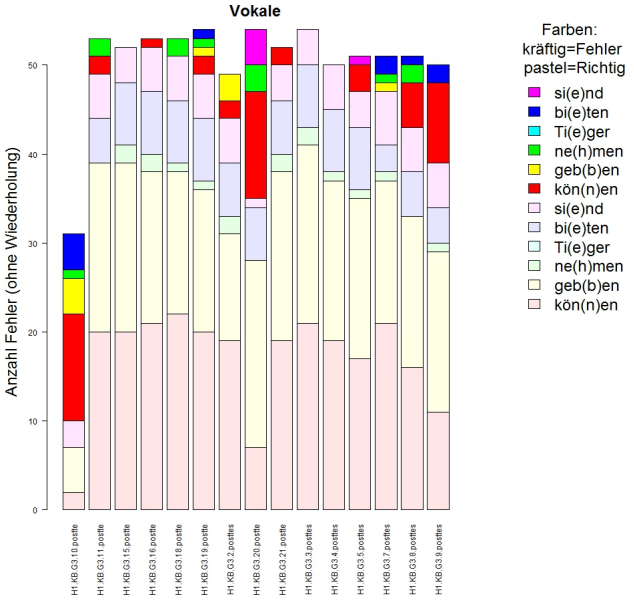

Figure 2: Spelling error profile for one classroom across all children as shown to a teacher. Showing "Vokale" (vowel spellings) with dark colors showing mistakes and pastel colors correctly written words vs. number of times this type of pattern occurs. Children 9,10,20 show distinctive error profiles worth investigating.

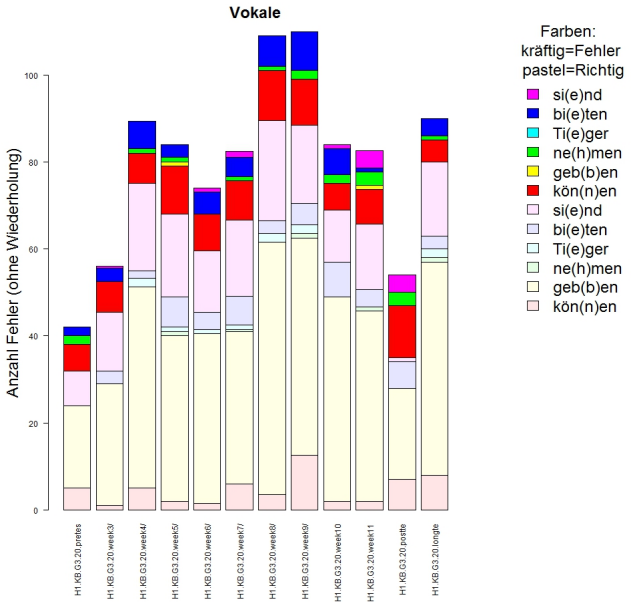

Figure 3: Spelling error profile for one child (20) across duration of study as shown to a teacher. Showing "Vokale" (vowels) with dark colors showing mistakes and pastel colors correctly written words vs. number of times this type of pattern occurs.

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