

ARTICLE



Learning grammar the explorative way: Integrating interactive grammar animations into CALL

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Abstract

Interactive grammar animations (InGA) represent a further development of conventional grammar animations by building on their theoretical foundations in cognitive linguistics and multimedia pedagogy while extending their didactic potential. Unlike their predecessors, InGAs feature an input interface that enables learners to interact with the animated content, and thus, explore the meaningfulness and conceptual motivation of grammar, potentially leading to deeper engagement and a more comprehensive understanding. To develop an instructional concept that integrates this innovative learning medium, which to some extent defies conventional methods of tutorial computer-assisted language learning (CALL), a design-based approach was adopted, allowing for iterative testing and refinement across multiple cycles for didactic alignment. This paper reports on the sixth and final cycle, in which InGAs were put to the test for the first time in a fully ecological learning environment. The empirical findings indicate that task-based language teaching is an effective framework for integrating InGAs and suggest a possible expansion of the didactic repertoire of tutorial CALL. By discussing the performance and evaluation of the instructional concept and learning medium in the context of previous cycles, two key principles were derived to guide the development of analogous didactic scenarios in CALL: transparency and adaptability.

Keywords: tutorial CALL, grammar animation, TBLT, DBR

Language(s) Learned in This Study: German

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Introduction

Interactive grammar animations (InGA) constitute an innovative language learning medium that aims to engage learners in exploring abstract grammatical concepts in an easily understandable way. InGAs manage this balancing act by inheriting visual metaphors from conventional grammar animations (Roche & Scheller, 2008; Roche & Suñer, 2016) and integrating them into an interactive learning environment. Complementing the existing toolset of technologies for grammar learning, it has the potential to enrich the didactic repertoire of computer-assisted language learning (CALL). While tutorial CALL typically “follows a deductive teaching approach to grammar by presenting explicit explanations of grammatical concepts and by focusing language practice on graded and discrete grammatical points” (Heift & Vyatkina, 2017, p. 27), InGAs are designed for an inductive approach, in which learners are actively involved in the discovery of grammar. Rather than being presented with fixed rules for formal aspects of a grammatical phenomenon, InGAs encourage learners to identify patterns and infer rules themselves by allowing them to manipulate the interactive elements of the animations and to observe how changes in the conceptualisation of a scene affect its verbalisation.

“*Benefits of CALL*”, as highlighted by Li (2016, p. 463), provide a rationale for the implementation of such a learner-centred and exploratory approach to grammar, promoting deeper engagement and

comprehensive understanding. Interactive animations have long been researched, including language learning (Halenko, 2018; Schnotz et al., 1999; Schwartz et al., 2008). In this respect, the innovative character of the InGAs lies not in the combination of different technologies, but in the didactic possibilities that arise for computer-assisted grammar learning. However, to unfold this potential and harness the defining features of InGAs, the selection of a suitable learning object and its didactic-methodological integration with respect to the learners remains crucial (Beatty, 2013; Betrancourt, 2005).

To solve the research puzzle of didactic alignment and to answer the question of how a digital medium for grammar learning that engages the learner already in the phase of exploring the phenomenon, and not only in the practice phase, can be integrated into foreign language teaching, this study adopted task-based language teaching (TBLT) as a didactic framework. A design-based research (DBR) approach was applied to evaluate its fit. Through six cycles of design, testing, evaluation, and redesign, the InGAs and the instructional concept integrating them were continuously improved using the case of the passive voice in German. This paper reports on the results of the final iteration and concludes the project by deriving general principles that may be useful for the development of similar didactic scenarios.

Theoretical Foundations

InGAs & Tutorial CALL

InGAs are based on conventional grammar animations. However, their transformation into an interactive medium that enables the manipulation of the animated content aligns them more closely with applications of tutorial CALL. With their non-interactive precursors, they share a common linguistic and learning-theoretical basis. In terms of linguistic theory, both refer to the same assumptions and descriptive models of cognitive linguistics to explain the meaningfulness and conceptual motivation of grammar (Langacker, 2008a, 2008b). By drawing on general principles and procedures of human cognition that influence the properties of grammatical symbols (Evans, 2012; Panther & Radden, 2011), the language descriptive models of Cognitive Grammar emphasise semantic and functional aspects of grammar (Langacker, 2009).

From a learning-theoretical perspective, InGAs inherit the graphic design from their predecessors, including grammatical metaphors and the principles of multimedia learning governing it, to facilitate a deeper understanding beyond formal aspects. Grammar animations use visual metaphors that illustrate the conceptual basis of grammatical symbols to make their meaning transparent and easy for learners to grasp. Moreover, both new and old grammar animations adhere to the cognitive principles of multimedia learning (Mayer, 2014) that aim for an optimal use of mental resources, based on assumptions regarding text-image processing as well as the creation and modification of mental models (Schnotz, 2014; Sweller et al., 1998).

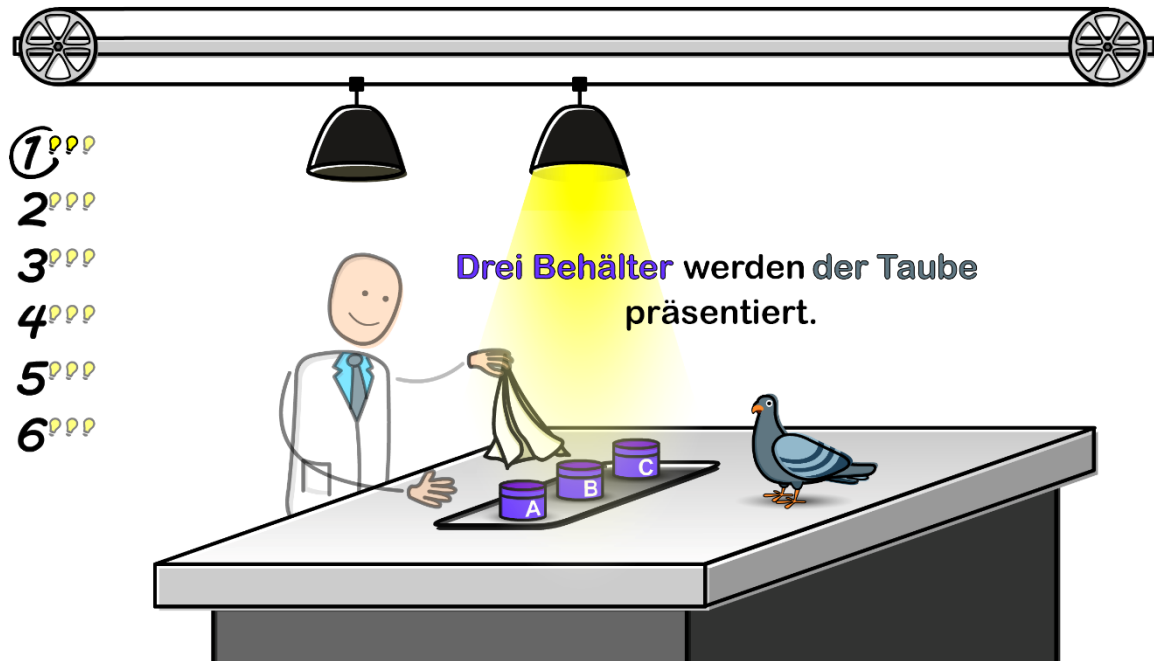
What distinguishes InGAs from conventional grammar animations and makes them more akin to a CALL tool is their input interface that enables users to interact with the animations in two ways: first, learners control the playback of a scene and navigate between scenes; second, and more importantly, they manipulate objects within a scene, and thus, change its conceptualisation.

In this case study, the InGAs are based on the grammar animations developed by Arnett and Suñer (2019; see also Arnett et al., 2019), following Langacker (2004, 2008a), for the grammatical category of voice in German. Both the original and the new grammar animations present active and passive as two different arrangements of the same conceptual content and visualise the image schema of the action chain, which acts as a structural framework for the notion of transitivity, through a concrete physical action. To arrange the content within this conceptual structure according to the prominence of its elements, the InGAs allow the setting of the visual metaphors that illustrate two core dimensions of the construal: the organisation of agent and patient in a sequential order as *trajector* and *landmark*, and the *profiling* (Langacker, 2008b). At first instance, the user adjusts the grammatical metaphor of the spotlight that selects the *trajector* by switching the lamps above the respective participant on/off (Figure 1). The *trajector* acts as the primary access point for the construal. In this focal position, the selected element appears salient, while the other

elements, including the *landmark*, are set back and are, thus, less prominent. On a syntactic level, *trajector* and *landmark* can be linked to subject and object, respectively. In a second instance, the user may also fade in/out the participants to delineate a profile of the scene that focuses on a specific aspect of the action chain¹.

Figure 1

Scene 1 of InGAs on German Passive: Trajector Selection and Conceptual Base Profiling (Own Illustration)



As the grammar animations were extended with an input interface that controls the visual output, their theoretical foundation for multimedia learning likewise required extension. By allowing the manipulation of animation parameters, the user influences what is shown in the image series, which in turn affects them in their perception. As the learner actively shapes the animation content, this results in a dynamic process of mutual influence between learner and learning medium (Domagk et al., 2010). On the one hand, interactivity encourages the learner to generate and test hypotheses by manipulating the parameters when given an appropriate learning task (Betrancourt, 2005). On the other hand, this interaction draws the learner's attention to the linguistic realisation of the conceptualisation shown in the animation. From a language learning theory perspective, this direction of attention is supported by Schmidt's (2001) noticing hypothesis, which recognises the role of awareness in L2 learning.

From a technical standpoint, interactivity constitutes only one feature that qualifies InGAs as a CALL application. Additionally, they incorporate simple feedback and guidance systems: automated feedback is delivered in the form of small light bulbs which inform the learner about the formal accuracy and functional appropriateness of their verbalised conceptualisation, while the system provides adaptive hints to assist learners in overcoming impediments to their progress. Notwithstanding these similarities, InGAs also differ from prototypical CALL tools in five key aspects: linguistic unit, linguistic structure, learning theory, interactivity, and epistemology.

In tutorial CALL, the computer is predominantly used for sentence-based practice activities, especially for written practice targeting vocabulary and grammar (Heift & Schulze, 2015), and if grammar is

practiced, it is predominantly focussed on form, rather than meaning (Schulze, 2024). Despite the efforts of Hubbard and Siskin (2004) to discredit several preconceptions surrounding tutorial CALL, it remains strongly associated with behaviourism, and thus, with drill practice, offering learners a low level of interactivity and resulting in exercises with a mechanical feel to them (Blake, 2011). In relation to this function of tutorial CALL, Heift and Vyatkina (2017) describe a propensity towards a deductive approach, whereby explicit grammar rules are elucidated prior to their application in a practice activity.

To overcome these limitations of tutorial CALL, various approaches have been developed. One attempt has been to position the computer as a grammar tutor instead of using it to provide exercises (Merlo & Gruba, 2015). Another extends to intelligent CALL (ICALL), where natural language processing, student modelling, and expert systems have been employed to connect form and meaning (Schmalz & Cornillie, 2022), while also enhancing interactivity via individualised feedback (Elahi Shirvan & Taherian, 2025). A complementary route of development is the incorporation of gamification to engage learners and to motivate them intrinsically, rather than drilling them through repetitive practice (Rueckert et al., 2020). Further approaches to grammar in CALL include data-driven learning (DDL), which not only focuses on lexicogrammar, integrating form and meaning, but also favours an inductive method (Gilquin, 2025). Due to their characteristics, InGAs join the ranks of innovative approaches in advancing the tutorial CALL paradigm.

InGAs are designed for an inductive approach to grammar, as they provide the learner with a highly interactive digital learning environment, which enables them to explore the interconnection between conceptualisation and verbalisation and to infer grammar rules from (meta-)linguistic input. In this way, InGAs not only provide cognitively stimulating content for learning grammar, but they also promote constructivist learning as they encourage learners to actively discover language and its systematics. The formation of rules is not limited to formal aspects based on an isolated prototypical linguistic sample; rather, InGAs emphasise both the meaning of grammar through visual metaphors illustrating the conceptual basis of grammatical phenomena and its function through a communicative instance that extends beyond the sentence level. Nonetheless, to harness this learning potential, InGAs need to be integrated into a compatible didactic framework that leverages their defining features.

InGAs & TBLT

For integrating InGAs into an instructional concept that aligns with their characteristics, i.e. a high degree of interactivity as well as emphases on meaning and function, a task-based approach was adopted as is also recommended for the conventional grammar animations (Roche & Suñer, 2016). Although there are various programmatic forms of TBLT, at its core, it prioritises authentic communication, functional language use, and the negotiation of meaning (Ellis et al., 2020). According to van den Branden (2006), a “task is an activity in which a person engages in order to attain an objective, and which necessitates the use of language” (p. 4). Tasks should therefore be as authentic as possible and have a real-life relevance for learners, so that the use of language within the activity appears meaningful to them.

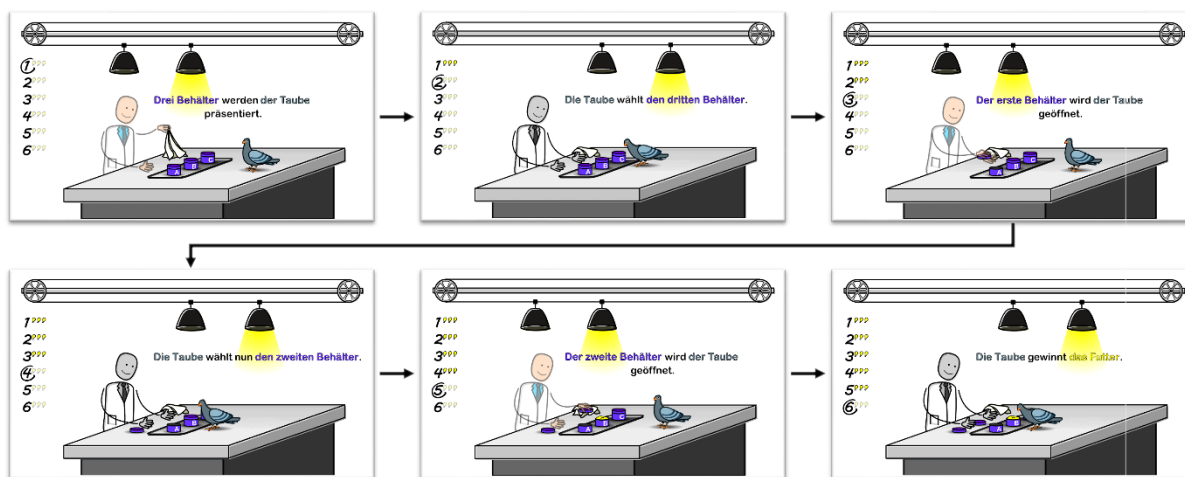
While TBLT has already found its way into the CALL domain, its use is largely limited to computer-mediated communication (CMC) and other technology-supported collaborative or partitive learning activities (González-Lloret, 2020; Thomas & Reinders, 2010). Since exercises in tutorial CALL are primarily form-focussed and do not serve a communicative function, a TBLT-approach is not a necessary consideration. For InGAs, however, linguistic situatedness is crucial for enabling learners to experience the function of grammatical symbols.

To provide learners with a linguistic activity that is purposeful and, thus, enables them to understand its intentionality, they were tasked in an 80-minute lesson (see full lesson plan in [Appendix A](#)) with writing an experimental protocol for a harmless animal experiment depicted in the animations ([Figure 2](#)). The experiment unfolds in a sequence of six scenes² in which a scientist challenges a pigeon with the Monty Hall dilemma. The text production of the protocol takes place in three steps: (1) the learners are first required to produce a text outline in which they describe the events of each of the six scenes in their own

words; (2) they then revise their scene descriptions by incorporating passive constructions where appropriate, according to the conventions of the text type. The animations provide linguistic templates for this based on the conceptualisations developed. (3) Finally, they refine their revised draft by experimenting with different conceptualisations within the InGAs and erasing redundant information.

Figure 2

Learning Path of Animal Experiment Revising Experimental Protocol (Own Illustration)



Another general aspect of tasks in TBLT is that, although the primary focus is on using language for communicative purposes, rather than on language itself, phases of reflective language observation are also considered important for learning (van den Branden et al., 2009). The objective of the text development with the help of the InGAs is to facilitate moments of awareness regarding linguistic patterns, which in turn inform the joint discussions about the formal, semantic, and functional dimensions of voice after each phase of text revision. Combining language use and language reflection within the task cycle aligns with the goal of TBLT, which aims to develop communicative competence, taking into account the promotion of accuracy, fluency, and complexity as well as the ability to act in a linguistically appropriate way (Kumaravadivelu, 2006; Samuda & Bygate, 2008).

In summary, InGAs are characterised by inheriting visual metaphors from conventional grammar animations which illustrate the meaning and conceptual motivation of grammatical structures. In contrast to their predecessors which are primarily designed for presentation by an instructor, with learners assuming a passive role, InGAs are designed to engage the learner from the outset by interactively exploring the linguistic manifestations of different conceptualisations in a communicative context. Due to their interactive features of navigation and content manipulation, InGAs—complemented by systems of automated feedback and adaptive assistance—are closely aligned with applications of tutorial CALL, albeit in a non-prototypical way. Nevertheless, when integrated into a compatible didactic framework that leverages their characteristics such as TBLT, InGAs have the potential to expand the didactic repertoire of tutorial CALL.

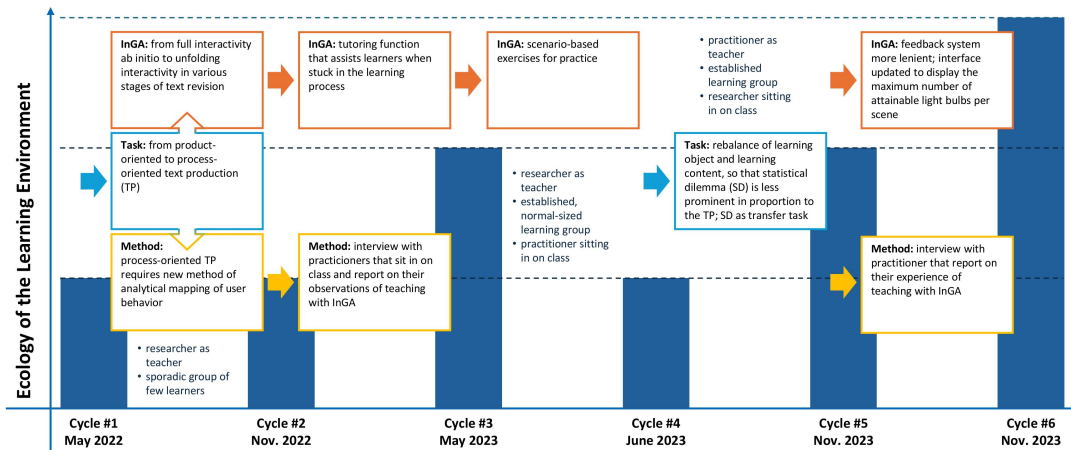
Methods

To develop an instructional concept that integrates the InGAs, a DBR approach was adopted as an established practice for systematically exploring “how to design educational environments so that new technologies can be successfully introduced” (Collins, 1992, p. 4). In a cyclical procedure of design, testing, evaluation, and redesign, the approach aims to optimise learning materials, media, and settings,

but also to derive general principles that can be applied to the development of similar teaching-learning scenarios (Reeves & McKenney, 2013). Given the intertwining of theory and practice, DBR appears particularly well-suited to CALL research. However, it is important to also consider its limitations, such as the absence of standardised methodological guidelines, the researchers' involvement, and challenges with generalising the findings. Simultaneously, the methodological flexibility of DBR allows it to address the often complex problems within CALL (Egbert & Petrie, 2006).

Figure 3

Evolution of the Didactic Concept for InGAs within Six Cycles of (Re-)Designing, Testing, and Evaluating



Integrating the InGAs proved challenging because their defining features required a bespoke solution in the absence of an established model. Over the course of five cycles, the InGAs and the instructional concept integrating them have been incrementally refined and harmonised (Figure 3). To speed up the development process, summarised in Pust (2023), different testbeds were used, varying in terms of the learning environment's ecology, while other factors such as the target group, the learning products, and the learning goal were kept constant. In previous cycles, learning groups were sometimes formed sporadically to test adaptations quickly; however, the primary objective was to examine the instructional concept in a fully ecological learning environment, i.e. an established TP learning group in a set language course, with the regular teacher delivering the lesson plan rather than the researcher. This is the case for the 6th cycle, which is the subject of this study.

Data Collection and Analysis

To gain a comprehensive understanding of how to integrate InGAs into the factor complex of foreign language teaching, a mixed-method approach was employed, which taps complementary data sources to provide a holistic picture. A readily available source was the digital traces users left as an inevitable byproduct of interacting with the animations. These inputs were recorded in a database, with each entry containing the following information: user id, type of task, type of action (selecting/editing/playing a scene, requesting assistance), and timestamp. This type of online monitoring allowed the reconstruction of individual learning paths during task completion. By combining process-oriented learning analytics based on descriptive statistics with a product-oriented evaluation of learners' texts against predefined criteria, this study aims to provide insight into their engagement with the InGAs and the effectiveness of their interaction strategies.

Another data source that complements this quantitative approach to exploring the didactic fit of the InGAs in relation to the instructional concept was the study participants themselves, including both the learners and the teacher. To comprehend their perspective on the learning medium and its integration, two

separate, semi-structured interviews were conducted immediately after the lesson: first with a subsample of four of the learning group who volunteered to participate, and then with the teacher. The questions loosely structured the interview, providing prompts without restricting interviewees from addressing topics they felt were relevant. The two interviews were then transcribed using a simple format as the propositional content of the interviewees' contributions sufficed for the subsequent qualitative content analysis (Mayring, 2021).

On the one hand, the analysis consisted of structuring the content of the textual material. In a deductive procedure, the coding of the interview data was based on categories already created in previous cycles (cf. Pust, 2025), with minor modifications, to interpret the participants' experiences with the InGAs in the classroom context (see [Appendix B](#) for coding book). On the other hand, a scaling structure using a three-point bipolar scale (positive, neutral, negative) was applied to categorise the evaluative positioning of the experiences. A residual category consisted of ambivalent contributions mentioning both positive and negative aspects. To ensure the quality of the coding in both structural analyses, inter- and intra-rater reliability tests were carried out: while two different raters achieved substantial agreement for both interviews (Landis & Koch, 1977), one of the two achieved almost perfect agreement scores when repeating the coding process several weeks apart, again for both interviews.

Sample

The sample in this cycle can be described as an established learning group attending a German as foreign language course at B1-level (CEFR) that took place twice a week à 90 minutes for almost half a term (semester week 6 of 14) at the time of the survey. It consisted of 13 students studying at the Otto von Guericke University of Magdeburg and was balanced regarding gender (m/f/d/ns = 7/5/0/1) as well as fields of study (sciences/humanities/ns = 5/7/1). The variety of first languages among participants was broad with a total of 13, two of whom were bilingual. Due to characteristics such as proficiency in other languages, use of media for language learning, and motivation to learn German, which were assessed in a questionnaire, the sample can be considered a typically heterogeneous learning group for the given learning context and therefore representative. This assessment is confirmed by the teacher in charge of the course, who had over 20 years of professional experience, describing the learning group overall as typical for this educational context in terms of learning commitment, classroom behaviour, and group dynamics. The teacher described herself as tech-savvy and her use of media in her regular teaching as technology-enhanced, habitually using various digital media for her courses as well as a course management platform for the distribution of learning materials and organisational purposes. All study participants provided informed consent prior to participation.

Results

User Data

To gain insight into how the learners engaged with the InGAs in solving the writing task, their user behaviour was analysed and aligned with the text products. Parameters describing individual learning processes and products varied notably in usage time, number of interactions, amount of automated support, and result quality. On the basis of these characteristic values, patterns emerged that lead to the formation of three discernible groups.

Group A, comprising a simple majority of six learners, can be described as productive in meeting the task objective and efficient in using the InGAs for reaching it. They spent only 17.6 minutes interacting with the InGAs, making them the fastest in attending to the task ([Table 1](#)). In this time, they executed on average 83 actions related to setting scenes and navigating through them with the least amount of support among the three groups. As help is only provided after pressing play to enter a particular conceptualisation of a scene, the level of support is highly dependent on the number of playbacks; i.e. a learner who plays few scenes or none receives little to no help, even if needed. To mitigate distortions,

help is therefore represented as the ratio of support events to scene playbacks. Participants in this group received less than one hint for every fourth input. Because subjects in Group A scored 18.5 out of a maximum of 20 points—based equally on system feedback and the evaluation of the text products—with relatively few actions, little assistance, and in a subpar time, their user behaviour can be considered efficient.

Table 1

User Data: Grouping of the Participants According to Learning Processes and Products

Group	Characteristics	n'	Time (m:s)	Actions	Help	Score
A	productive/ efficient	6	17:36	83.00	0.24	18.50
B	productive/ exploratory	3	19:32	134.67	0.35	18.33
C	unproductive	4	18:06	81.00	0.47	9.00

Note. n' = size of subsample; m:s = minutes:seconds

Group B, consisting of three subjects, demonstrated a comparable level of productivity to that observed in the first group, as evidenced by a similarly high score. But in every other aspect, the user behaviours between these groups differ. The learners in Group B required more time and also a greater level of assistance, with an average of slightly more than every third press of the play button. These increased values appear to be (partly) due to the roughly 60% higher number of total actions, which may indicate an inefficient approach or problems in completing the writing task.

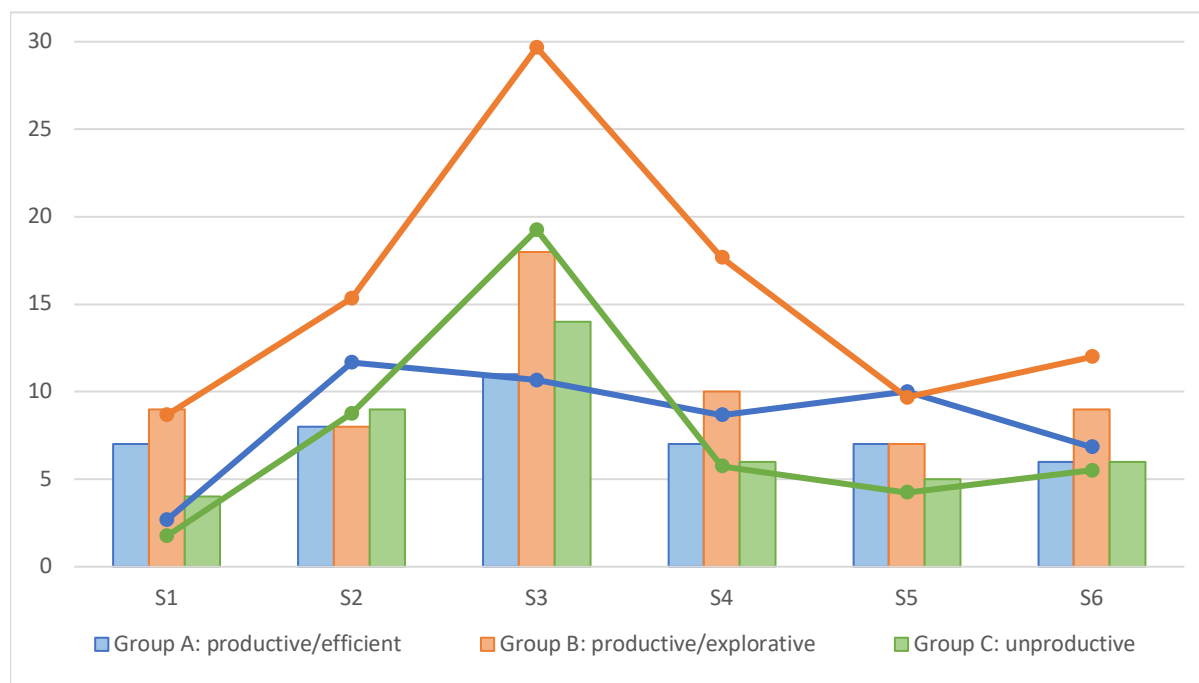
Figure 4 demonstrates that neither of these presumptions is likely to be accurate. The line graph representing the average frequency of actions per scene and group—excluding navigational actions—shows that subjects in Group B made considerable use of the InGAs' feature of conceptualising scenes. With the exception of Scene 5, they carried out a greater number of actions in every scene, suggesting that the surplus of actions mainly stems from manipulating and testing scenes. The bar graph in Figure 4 displays the number of different conceptualisations, with Group B also on top in 5 out of 6 scenes, indicating that they did not randomly tap around, but rather purposefully sought out different options for setting a scene. Given the likelihood that they deliberately discovered different conceptualisations, the user behaviour of the subjects in Group B can be characterised as exploratory.

Finally, the analysis revealed a third group of four subjects (Group C) who were significantly less productive than the ones in the other two groups. They only achieved less than half the score. In this context, the automatic support provided to them, which is the highest in the sample with almost every second execution of a scene, appears to be rather ineffective. Other parameters, such as interaction time and overall actions, are average and indicate normal rather than failed usage of the InGAs, which would otherwise explain the suboptimal results.

A closer examination of Group C in Figure 4 reveals that their performance is characterised by the fewest number of settings and plays of scenes, with the exception of Scene 3. One possible explanation for this behaviour is that the first two scenes were covered in class as preparation—Scene 1 in greater depth than Scene 2, which explains the increase in interactivity in all groups at this instance. The third scene, however, was always the first one that learners had to deal with on their own. At this juncture, Group C displays a similar exploratory interest to Group B, though to a lesser extent and of less permanence. For the remaining scenes, their engagement in finding out different conceptualisations drops below average. This decline may be due to initial efforts without success, which in turn could have led to demotivation and, consequently, to suboptimal results.

Figure 4

Interactions with InGAs in Groups: Actions as Line Chart and Different Conceptualisations as Bar Chart



As the process-product analysis of the user data shows, learners employed disparate strategies in their engagement with the InGAs to fulfil the writing task, resulting in different outcomes. Some learners chose a direct learning path to reach the learning goal, solving the task efficiently; others preferred an exploratory route, discovering various options for conceptualising the scenes of the experiment; still others seemed to have issues interacting with the InGAs purposefully and achieved the envisaged outcome only in parts despite the guidance of the automated assistance. Similar observations have already been made in other field trials with the InGAs (Becker & Pust 2024). But even though these observed patterns have some plausible explanatory potential, it must be noted that learners did not behave uniformly within groups, but there was also considerable variation. For this reason, it may be insightful to understand the learning experience from both the learners' and the teacher's perspective.

Group Interview with Learners

The group interview took place right after the lesson with four volunteering participants. Two participants came from Group A and two from Group C (Table 2). Learners from Group B were not represented in the interview. As the interviews were conducted on a voluntary basis, the data may be subject to bias. The interview lasted 15.1 minutes and resulted in a total of 32 contributions.

The communicative context was such that each participant received sufficient and equal opportunity to speak. Nevertheless, the participants' contributions differed quantitatively in terms of their total speaking time; and the analysis of the scaling structure also revealed qualitative differences in their evaluation of the lesson (Table 2). While participants were communicative to varying degrees and expressed approval and disapproval by reporting positive and negative experiences, EE#4 was particularly active and more critical than the others. While the balance of criticism expressed by all participants tipped slightly in favour of the InGAs and their integration into the instructional concept, EE#4 acts as a counterbalance.

Table 2*Characteristic Parameters of Group Interview*

Interviewee	User Group	Contributions	Length (m:s)	Evaluation (pos./neg.)
EE#1	C	9	1:08	5/3
EE#2	C	7	2:27	7/2
EE#3	A	6	2:46	3/1
EE#4	A	10	4:31	3/8

Note. m:s = minutes:seconds, pos./neg. = positive/negative

For the content analysis, the participants' contributions were coded according to five categories, which are grouped into two overarching themes. One major theme was the InGAs, discussed either in relation to how they worked or to how they supported language learning. The other central theme of the interview was the teaching-learning process, which included contributions on its structure and the resources used in it—apart from the InGAs—as well as contributions on a meta-level beyond the specific lesson. In the analysis, particular attention was paid to contributions that pertained to both themes, as these provided valuable insight into the interconnections between the InGAs and the teaching-learning process.

All participants reported that they found the first task of drafting an experimental protocol and, in part, also the second one of revising the draft text with the help of the InGAs confusing. EE#2 mentioned in reference to the second task: “I was a little bit confused, because some sentences [that] were coming [up were; A/N] similar [...]. So, yeah, I wasn't ready. I couldn't understand the purpose of doing it” (01:46). The learning objective only became evident to the participants when they realised that the InGAs not only prompted the production of a specific text, but also assisted them in composing a stylistically appropriate experimental protocol as this comment also from EE#2 illustrates:

Even for me, like the task 2 and 3, it kind of gave us more clarity of [...] using particular verbs or how to improve your own sentences. And because you already have a set of sentences [...], it was much easier, [...]. And it was with the help of the application, it was better to understand like how to improve [the text] or how to use [a certain; A/N] style of language (8:31).

The initial confusion about the learning task was probably caused by suboptimal descriptions, as participants unanimously noted that they contained unfamiliar expressions. Although the teacher asked the learners to confirm their understanding of the task and gave additional explanations where necessary, EE#4 pointed out that “when you face a new application or this kind of [task, A/N], it is important that you find it kind of familiar, you know, even the words. There were few that you needed to know, but in the whole process, it might be a big thing for a language learner” (10:16). It stands to reason that the other participants were similarly unclear about the learning objective, which prevented them from immediately comprehending the InGAs' suggestions for revising their drafts.

Another issue spanning both themes, the InGAs and the teaching-learning process, was the lesson's pacing and the time allocated for drafting and revising the protocol. EE#4 argued that the timeframe available to incorporate the InGAs' suggestions was insufficient and impeded achieving the learning objective: “[I]t was quick and I think you have to digest them [the suggestions, A/N] and compare them to the things that you have written in the previous texts, and that was a little bit hard for me” (03:03).

This concern about the pacing is related to another point of criticism regarding the feedback process. The unanimous opinion was that the feedback should be faster, without requiring an average wait of 12 seconds each time for the scene to finish playing. As a solution, EE#3 suggested giving the learner the option to watch the scene (again) or to reveal the result along with feedback immediately. This optional acceleration of the feedback would give learners more time for the actual task, and thus, if not solve, at least alleviate the time constraints.

Moreover, EE#3 argued that a thorough processing of the input takes time but leads eventually to a more sustainable understanding: “I think the interaction with the app [...] helped me to establish a long-term memory [...]. If you want to study deeply, it takes more time to digest a certain amount of knowledge. [...], when I practice with the app, it takes more time, but on the other hand, I can remember it longer” (13:27). This highlights the importance of allowing sufficient time to work with the InGAs for effective results.

In summary, the group interview with a sub-sample of four learners provided valuable feedback for improvement and revealed two key issues regarding the integration of the InGAs. On the one hand, the task description has to be fully intelligible to make the learning objective transparent, especially as the InGAs are a new learning medium; on the other hand, the InGAs have to be adaptable to the learners’ needs to support efficient learning. Both points of criticism had already been raised by learners in previous iterations and addressed by adapting the task and the InGAs. Despite justified criticism, the learners approved of the InGAs for language learning purposes, as this last comment from EE#4 shows once more: “The idea was brilliant, how to use an example and keep going and kind of improve yourself, optimise your text” (12:23).

Interview with the Teacher

The interview with the teacher resulted in a recording of her speaking for a total of 10.1 minutes spread over 17 contributions. As in the interview with the learners, contributions glancing on both overarching themes were of special interest. In contrast to the learners, the teacher was more critical and held a rather ambivalent view of the instructional concept integrating the InGAs, with a ratio of 6 to 7 positive to negative comments.

In favour of the instructional concept integrating the InGAs, the teacher commented that the time management was successful, as the vast majority of learners had enough time to complete the task and there was never a sense of time pressure or rush from her perspective. Moreover, the teacher identified the rapport of the learning environment as an important factor for the successful use of the new learning medium. Comparing her own lesson with a less ecological one she had observed in preparation (Cycle #5), she noticed that the learners in her class were more responsive to instruction and more open in their collaboration, which she attributed to the trust that had been built up and established classroom routines.

When asked about the challenges she faced, the teacher replied that the use of the InGAs, especially in coordination with the other didactic resources, caused her problems on several occasions. When giving instructions for the second phase of the text development, she forgot to write on the whiteboard an example sentence that had been worked out using the animations. This led to uncertainty and questions among the participants, but it was easily rectified later. A similar problem arose in the preparation of the third phase, in which all the functions of the InGAs are activated and the teacher admittedly struggled with presenting them. The teacher conceded that she had underestimated the preparation needed to familiarise herself with the InGAs beforehand. In her opinion, it is necessary to get a feel for using the application, both to present it confidently and to anticipate how the learning group will engage with it. Finally, she found it challenging to reflect on the linguistic observations at a meta-level with the learners when discussing the results, as she prefers to explain grammar directly, i.e. a deductive approach, rather than involving the learners in rule-making.

In response to the question of how she would employ the InGAs without the restriction of the given lesson plan, she replied that she would not utilise them in the classroom to the extent prescribed by the current instructional concept. Instead, she proposed doing only the first phase, the drafting of the experimental protocol, in class, and assigning the revision as homework after explaining how to use the InGAs for it. The results would then be discussed in the following lesson.

The interview with the teacher reveals that the novelty of the medium is challenging for learners and teachers alike, as its functionality disrupts established usage habits from tutorial CALL and resets common teaching routines. The inductive approach to grammar adopted by the InGAs may present additional difficulties, if it conflicts with personal preferences. Therefore, effective adoption in the language classroom requires that the learning medium, grammatical structure, and instructional method be accessible to teachers.

Discussion

Overall, the data analysis yields a largely consistent picture, even though the three levels of analysis are not perfectly aligned, resulting in two notable inconsistencies regarding transparency and adaptability that require further explanation. In general, the instructional concept of applying TBLT as a framework for integrating the InGAs was found to be both functional and effective: functional in that it enabled learners to explore the grammatical phenomenon comprehensively by employing it purposefully in an authentic linguistic use case; and effective insofar as most participants were able to utilise the InGAs expediently throughout the lesson to produce a linguistically appropriate experimental protocol using different strategies. These findings are corroborated by the productive utilisation of the InGAs by two-thirds of the participants and by the predominantly positive evaluations from the learners. Nonetheless, the overall positive outcome warrants a nuanced perspective, as it is accompanied by clear criticism from participants who used the InGAs effectively for the writing task on the one hand; on the other hand, this final iteration of the DBR approach to integrating the InGAs was trialled in a fully ecological environment—i.e. in an established learning group with their teacher—demonstrating that the instructional concept also works under real-life conditions.

At this stage, the instructional concept integrating the InGAs and the learning medium itself appear to have reached a high level of maturity. Concurrently, the theoretical framework informing the design choices has evolved at a meta-level (Rodríguez, 2017), also to address the recurrent issues related to transparency and adaptability, which were also highlighted by the interviewees in this cycle. Indeed, these issues have persisted since the initial cycle and have only been partially alleviated with each iteration by adhering more closely to the principles of multimedia learning: i.e. the segmentation principle (Mayer & Fiorella, 2014), by gradually introducing the functionality of the animations (Cycle #2), as well as the principle of guided discovery (de Jong & Lazonder, 2014), by implementing a support system that intervenes when the learner encounters obstacles and gives hints on how to proceed (Cycle #3).

One potential explanation for the persistence of these problems may lie in the innovative nature of the learning arrangement, which requires learners to engage with a new linguistic phenomenon while following an unfamiliar approach to grammar (inductive and usage-based) and using an atypical CALL application—all under time pressure. This excessive influx of new information may lead to cognitive overload due to the limited capacity of the working memory (Sweller, 2020). Given that adherence to principles of multimedia learning provides only partial remediation of the aforementioned issues, it seems prudent to consider broader didactic principles crucial for harmonising tutorial CALL and TBLT.

From the two interviews, two contrasting perspectives on transparency emerged. While the learners' initial confusion subsided as the lesson progressed and they became increasingly familiar with the task and its learning objective, the teacher exhibited a growing sense of insecurity in her role as instructor. One plausible interpretation for these disparate experiences is the difference in the length of exposure to the medium. While the teacher admitted insufficient preparation for the demonstration of the InGAs, the longer the learners used the InGAs for the text production, the more familiar they became with the learning tool and how to use it to achieve the learning objective. While exposure mitigates the cognitive load over time, it is evident that providing transparency to learners and teachers alike through clear task descriptions and guidance on operating the application appears to be an important principle for using TBLT in tutorial CALL.

A further point of contention is the pacing of the lesson. While the teacher was satisfied with the time management, the learners themselves expressed discontent with the time pressure and advocated for an extension of the text revision phases to fully process the input. As a remedy, the learners proposed the technical feature of fast-forwarding—implemented in the redesign following this cycle—to enhance the flexible use of the InGAs, thereby alleviating some of the time constraints. The teacher’s proposal of moving the text revision to a self-learning phase outside the lesson, although not directly related to the pacing of the lesson, would also afford learners greater autonomy in terms of time management and more space for reflection in class. With less time constraints, it is likely that learners and teachers alike could work more effectively with the InGAs. It can thus be concluded that the adaptability of the learning medium and the teaching design represents a further pivotal principle for combining tutorial CALL and TBLT.

Although this study offers valuable insights into the use of InGAs in an ecological teaching environment and provides general guidelines for the development of instructional concepts for the application of analogous learning media, it should be noted that the knowledge gained is also limited in several respects. A limitation of this study is that the results are conditional on the specific learning setting in terms of the learners, the teacher, the institutional context, and the object of learning. Further studies are needed to test the instructional concept integrating InGAs for different grammar topics and in alternative settings to increase the external validity of the results. Since all participants in the project were young adults with advanced language skills other than German, they were already to some extent entrenched in certain language learning routines. Younger learners, on the other hand, may be more receptive to an unorthodox method of learning. Another limitation is that, while the TBLT approach to integrating the InGAs proved to promote language learning, it cannot be ruled out that other methods might be just as good or even better. In light of the recommendations by participants in this cycle, a didactic concept that employs InGAs for autonomous learning appears to be a promising avenue for further investigation. Concerning methodology, future research could vary interview formats, as individual interviews may elicit more nuanced or divergent perspectives that group settings risk suppressing due to conformity effects.

Conclusion

In conclusion, InGAs offer an alternative access to grammar learning by engaging learners in the exploration of morphosyntactic structures with a focus on semantic and pragmatic aspects to provide a holistic understanding. The transformation of grammar animations from a teaching to a learning medium also expands the didactic repertoire of tutorial CALL by defying the paradigm of a deductive approach to grammar and related assumptions. Adopting TBLT as a didactic framework for integrating InGAs into language instruction complements their overall functional orientation. Nevertheless, the presented instructional concept is not a *passé-partout* and requires further refinement and adaptation, as the research method could reveal. The DBR approach has proven to be an efficacious testing instrument, offering both rigour in identifying what works and what does not, and flexibility in adapting to changing research conditions. The project yielded not only a functional learning medium and an instructional concept integrating it but also highlighted crucial principles of multimedia learning and more general didactic principles associated with them. The design recommendations concerning transparency and adaptability lie at the interface between the CALL tool and the instructional concept: For CALL to succeed, the tool must be transparent in both its operation and its role in completing tasks and achieving learning objectives. Similarly, adaptability should extend beyond user interaction to encompass flexible integration into the teaching-learning process, accommodating the needs and preferences of both learners and teachers. These findings could help educators, designers, and researchers make informed design decisions and encourage innovation in this field—particularly regarding the incorporation of Cognitive Grammar in CALL and the consideration of gamification aspects.

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Notes

1. In Scene 1 of the InGAs on the German passive (Figure 1), *trajector* selection and *profiling* of the conceptual base are visualised through grammatical metaphors—spotlighting the patient and fading out the agent—corresponding to verbalisation: “Three containers are presented to the pigeon.”
2. Scene 1-6 translate as follows: (1) “Three containers are presented to the pigeon”; (2) “The pigeon chooses the third container.”; (3) “The first container is opened for the pigeon.”; (4) “The pigeon now chooses the second container.”; (5) “The second container is opened for the pigeon.”; (6) “The pigeon wins the feed.”

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Appendix A. Lesson Plan

Central Objective		Learners can:			
Prerequisites		Learners should:			
		<ul style="list-style-type: none"> · understand passive constructions in their form, meaning and application; · use them correctly for the development of an experimental protocol with support. 			
		<ul style="list-style-type: none"> · be familiar with the auxiliary verb <i>werden</i> and be able to form the future tense; · be familiar the past participle and be able to form the perfect tense; · understand the concept of the verb bracket (Satzklammer) in main clauses. 			
Time	Phase	Objective(s)	Actions of teacher (T) and Learners (L), incl. Task Instructions (TI) and Expected Outcome (EO)	Instructional Formats	Media & Materials
	Preparation		T prepares learning environment: sets up presentation; distributes tablets and worksheets (WS) to each desk.		tablets, WS
5	Introduction		a) L are confronted with passive constructions, b) familiarise themselves with Monty Hall dilemma (MHD), c) engage with scenario of animal experiment, d) experience control elements of InGAs. T presents MHD in experimental scenario with InGAs. L play through MHD twice. Then T asks for opinion on game strategy by show of hands.	plenary discussion (PD), solo work (SW)	PPP, InGAs tablets

	Tran- sition	“Pigeon in experiment no coincidence. In fact, pigeons have shown remarkable skills. After a trial-and-error phase, they applied a change strategy in 96 % of cases. Today, we’re going to document this experiment ourselves.”		
10	Pre-Task Phase	L understand task of text production. T explains task, works with L to develop descriptions for first two scenes (S) of experiment and writes sentences on board: “How could you describe what is happening?” (EO: <i>active construction</i>)	PD	InGAs, white- board
10	Work Phase	L write first draft of experimental protocol. L draft experimental protocol, T provides individual help.	instruction, SW	PPP, tablets, WS
10	Interim Reflection I	a) L present drafts and receive feedback, b) understand how to control lamps and feedback through light bulbs. L present drafts. T praises attempts and points out that InGAs can be used to improve texts: „Texts correctly describe what happens. However, they don’t sound like genuine scientific experimental protocols. In protocols, passive voice is commonly used.” T demonstrates InGAs second function, i.e. focusing participants with lamps, and highlights that sentences are evaluated through light bulbs. To apply this understanding, T and L revise sentence for S1 into passive construction.	PD	InGAs, white- board
5	Work Phase II	a) L revise drafts, b) develop hypotheses on formal and semantic aspects. T gives TI: “Now, use InGAs to revise your texts, scene by scene; pay attention to feedback.” L work on task; T provides individual support.	instruction, SW	tablets WS
10	Interim Reflection II	L understand relation between semantic focusing and formal structure. Halfway through revision, T initiates reflection, i.e. systematising grammatical characteristics. Form: “How do researcher and containers differ when standing in light?” (EO: <i>researcher is subject with containers as direct object OR containers are subject with researcher as supplement; pigeon as indirect object stays unchanged; predicate: conjugated full verb resp. auxiliary + past participle</i>) Relation of form and semantics: “Both researcher in S1 and pigeon in S2 can be subject in active construction; what do they have in common? What about containers?” (EO: <i>researcher/pigeon are actors/doers; containers are things of the action, with which sth. is done</i>); information added to rule sheet Semantics: “Why passive construction better in S1?” (EO: <i>researcher not relevant</i>)	PD	PPP rule sheet
1	Tran- sition V	“Then it would be best if you could fade the researcher out.” a) L finalise text products, b) develop hypotheses on pragmatic usage of passive		

		constructions.		
		T demonstrates third function, i.e. fading in/out of researcher, and gives TI: “Improve your texts scene by scene with help of InGAs; pay attention to feedback. Collect three light bulbs for each scene.”	instruction	InGAs
		L work on task; T provides individual support.	SW	tablets, WS
5	Reflection	a) L recognise the usefulness of passive constructions for the experimental protocol, b) identify the usefulness of passive constructions for other types of text.		
		L read out their products and receive feedback from T. Pragmatics: “What is passive voice used for in experimental protocol? What is its function?” (EO: <i>makes text objective, neutral, factual</i>); “In which other texts could passive constructions be useful?” (EO: <i>manuals, recipes, reports etc.</i>); information added to rule sheet	PD	PPP rule sheet
10	Prac-tice	L practise formal, semantic, and pragmatic aspects of passive constructions. L work on scenario-based exercises.	SW	tablets
5	Wrap-up	a) Elimination of remaining ambiguities, b) L recognise solution to MHD. Clarification of uncertainties, answers to open questions, resolution of MHD.	PD	PPP

Appendix B. Coding Book

		Definition	Anchor Example	
Level: Content Structure	Theme: InGA	Category: Didactics	<ul style="list-style-type: none"> contributions that describe the processes and products of language learning with the help of the InGAs, including those that present findings and insights into the grammatical phenomenon in terms of its form, meaning, and function; also those that identify difficulties and problems when the InGAs hindered learning assuming that linguistic input promotes language learning, contributions that refer to the words, sentences, or other linguistic structures used in the animations, which can be described using linguistic metalanguage (e.g. verb, noun, subject etc.) contributions that suggest ways to optimise the InGAs for language learning (which may sometimes include how they work – in this case, the category “InGA: functional” should also be selected) 	<p>“And in a second step, I think that graphic (.) the gra (.) the motion pictures could be much more optimised, you know. It was hard to connect to the games or whatever, clicking them, pictures. [I: Uh-huh] That’s my opinion.”</p> <p>(IP 00:01:11 EE#4)</p>
		Function	<ul style="list-style-type: none"> technical and functional aspects of the InGAs, including their graphical representation (e.g. control elements, figures, colours, font) and their interactive functionality (e.g. turning lights on/off, showing/hiding participants, selecting/playing/repeating scenes and thus generating verbalisations, feedback, help) 	<p>“Yes, it was really helpful, actually. In all the different colours, but, really helpful or different parts (.) words, they were separated, actually.”</p> <p>(IP 00:03:03-8 EE#4)</p>

Teaching- Learning Unit	Process	<ul style="list-style-type: none"> · structural, organisational, and interactional aspects within the context of the lesson: teaching unit as a whole (goal, topic, content); the function of teaching phases (introduction, reflection, practice – interviewees may refer to them as tasks, exercises, experiments etc.) · internal structure of the lesson (method, steps, instruction), and social behaviour of everyone involved (social form, roles) · contributions that describe progression, developments, or specific moments in the teaching-learning process, or that suggest adjustments, changes, or additions in this regard 	<p>“So, at the start, it was a little bit confusing, but as time passed on, it was getting better.” (IP 00:00:13 EE#4)</p>
	Resources	<ul style="list-style-type: none"> · contributions about resources used for language learning in addition to InGAs: specific materials (worksheets, PowerPoint presentation, whiteboard/blackboard), work assignments, explanations, rules, and examples that were conveyed through these materials · contributions about the learners’ own (text) products that were created during the learning process, including any errors, and about the language knowledge that the learners brought to the classroom · deficiencies in resources, such as a lack of materials or language knowledge 	<p>“I think that the structure, you know, the instruction of the task must (.) could be much described in the beginning and the words (.) some words were completely new to us. [I: Uh-huh] And I think that was the main reason.” (IP 00:01:11 EE#4)</p>
	Meta-Level	<ul style="list-style-type: none"> · contributions that go beyond the teaching unit: e.g., contributions relating to the lesson preparation or follow-up work, to the research project on InGAs, or to other specific teaching units before or after 	<p>“... Passiv jetzt noch nicht kennen, und ich glaube, in der ersten Gruppe kannten das viele schon [I: Mhm]. So, das war so mein Eindruck. Oder es war wirklich auch dieser Holperer mit der Zeitform.”** (IT 00:00:00)</p>
Scaling Structure	Positive*	<ul style="list-style-type: none"> · positive attitudes toward aspects of the InGAs or the teaching-learning process expressed through agreement, affirmation, or approval · statements that identify moments of success, achievement, or improvement in working, understanding, or learning 	<p>“But, ideas in the different colours and the possibility to see from one point of view and the from another, I think that was good.” (IP 00:03:39 EE#1)</p>
	Negative*	<ul style="list-style-type: none"> · negative attitudes toward aspects of the InGAs or the teaching-learning process expressed through rejection, devaluation, or displeasure · statements that identify problems, difficulties, and shortcomings in terms of working, understanding, and learning 	<p>“In the beginning, I don’t understand the main purpose of task 1 and task 2, and then when I reached the task 3, then I think the topic is about revision of active and passive sentence.” (IP 00:00:38 EE#3)</p>

*The categories ‘Negative’ and ‘Positive’ are diametrically opposed. However, contributions may be neutral (e.g., descriptive or hypothetical) or ambivalent, i.e., they cannot be clearly assigned to one side or may reflect both, in which case neither or both categories should be selected.

** English translation: “... know passive voice not yet, and I think many in the first group already knew it [I: Mhm]. Well, that was my impression. Or maybe it was really that hiccup with the tense.”

About the Author

As a philologist in German and English, I have worked at the Department of German Studies at Otto von Guericke University Magdeburg since 2020, where I teach and conduct research in the fields of German didactics, German linguistics, and German as a foreign and second language.

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