DAZonline.ch – A Gallery of Annotated Interactive Pictures for Language Learning

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1. Introduction

Touch-screen devices connected to the internet like mobile phones and tablets are ubiquitous and so are pictures taken, shared and watched with these devices. Pictures are understood as symbols by around 2 years of age (e.g., DeLoache, 1991) and children learn a language when looking at pictures that are described or labeled for them at an even younger age (Smith & Yu, 2008). The use of pictures as an educational resource dates at least to the 17th century when Comenius published his famous book *Orbis Sensualium Pictus* (Comenius, 1658). The Oribis Pictus contains about 150 pictures with numbers that point to bold words in short paragraphs underneath each picture. Pictures are drawings of natural scenes of landscapes, still lifes, schemes, etc. The book had been used for language learning for centuries (Gutek, 1995).

Inspired by this 17th-century picture book designed a web platform for exploring the world through annotated pictures. The platform combines Comenius' idea with web2.0 technology and state-of-the-art knowledge about multimedia and language learning. As of the writing of this chapter, a prototype is running at dazonline.ch. The use of the platform is free. Users can browse through and explore both pictures and picture-related language by themselves or in joint interaction that is similar to joint picture book reading. In addition, web2.0 technology enables teachers and caretakers to contribute to the picture collection and create personalized content for their children.
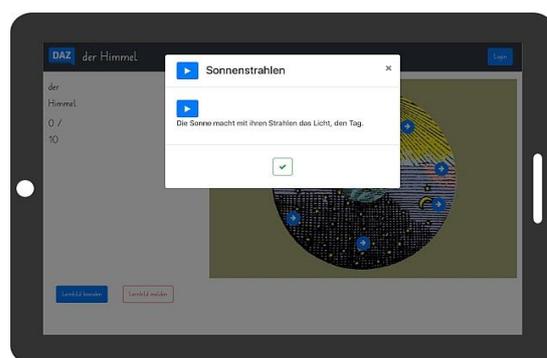

Figure 1
https://dazonline.ch/stundent-lesson/92
A digital version of one of Comenius' images
(source: http://www.hs-augsburg.de/~harsch/Chronologia/Lspost17/Comenius/com_o003.html).

2. Theoretical background

Language development: Children learn most of their language from interaction with other people (e.g., Golinkoff et al., 2019). Language learning is boosted, when the child and the interlocutor share a joint focus of attention – aiding the child to infer the meaning of the accompanying language – and when such interaction occurs frequently and in various

contexts (Hills, Maouene, Riordan, & Smith, 2010; Johns, Dye, & Jones, 2016; Weisleder & Fernald, 2013). Furthermore, children learn novel words best, when their interlocutor is responsive to their interest and talking about objects and events that are in the child's focus of attention (e.g., Farrant & Zubrick, 2012; Tomasello & Farrar, 1986). Even young children indicate their interests by pointing gestures to make their parents provide object labels (e.g., Wu & Gros-Louis, 2015) or action demonstrations (e.g., Begus, Gliga, & Southgate, 2014). Pointing is a very powerful way to indicate and interpret someone's focus of attention (Kita, 2008). Its communicative function is understood by children as young as 12-18 months of age (e.g., Hollich, Hirsh-Pasek, & Golinkoff, 2000).

When providing their children with novel words for something in the joint focus of attention, caretakers tend to first label objects that their children point out and subsequently provide additional information about these objects. For example, properties, taxonomy and further aspects (e.g. Wong & Clark, 2002). In doing so, parents tend to produce variation sets and produce series of utterances with neighboring utterances sharing lexical elements (Küntay & Slobin, 1996; Moran et al., 2019; Tal & Arnon, 2018).

Children, on the other hand, tend to interpret novel words as naming whole objects and interpret subsequent references to the same object as labels for properties, taxonomy, and further aspects labels (e.g., Markman, 1989). Further, children profit form immediate repetition (Schwab & Lew-Williams, 2016) and continuous discourse interaction with multiple references to the same object (Horowitz & Frank, 2015; Schwab & Lew-Williams, 2017) when learning novel words. Furthermore, variation sets might also enhance children's language learning, however, so far this has only been demonstrated for adults learning an artificial language (Onnis, Waterfall, & Edelman, 2008).

Furthermore, children can also learn from the repetition of verbal expressions across different situations (Smith & Yu, 2008). In fact, for most topics – be it vocabulary development in a certain area or grammatical development – require multiple exposures to be learned (Johns et al., 2016; Lieven, 2006; Saji et al., 2011; Unger, Vales, & Fisher, 2018). However, such cross-situational learning depends on memory and is better in older children and children with better memories and prediction skills (Suanda, Mugwanya, & Namy, 2014; Vlach & DeBrock, 2017; Vlach & Johnson, 2013). Memory demands can be decreased by increased predictability. Indeed, enhanced predictability both within a situation (Benitez & Saffran, 2018) and across encounters of the same word in different contexts (Benitez & Smith, 2012; Zettersten, Wojcik, Benitez, & Saffran, 2018) support children's word-learning.

Joint picture book reading: One particularly important way to interact with children to promote their language development is joint picture-book reading. Joint picture-book reading reliably shows positive effects on first and second language and literacy development (e.g., Ennemoser, Kuhl, & Pepouna, 2013; Ludwig, Guo, & Georgiou, 2019; but see Noble et al., 2018). Perhaps this is at least partially because joint picture book reading is a prime example of responsive interaction with a joint focus of attention (c.f., Degotardi, 2017). Furthermore, it has been suggested that book reading fosters language because books provide challenging experiences and present children with highly diverse contexts and pretty complex language (Cameron-Faulkner & Noble, 2013). Various contexts are imported for language development because a corollary of the diversity of contexts is linguistic diversity and repetition of the same words in different contexts – allowing for cross-situational learning. For example, the information in the visual display can provide important additional information for concept development and my aid cross-situational learning (Unger et al., 2018; Zettersten et al., 2018).

However, Children love reading the same book repeatedly (Leavitt & Christenfeld, 2011) and this very practice enhances children's word learning (e.g., Horst, Parsons, & Bryan, 2011; Wilkinson & Houston-Price, 2013). Horst et al. (2011) suggest that repeated reading of the same book facilitated word learning due to a contextual cueing effect – which makes recognition of the referred-to objects easier than in changing contexts (cf., Horst, 2013). However, it is also possible that the exact repetitions of sentences are driving the children's advanced learning from the repeated reading of the same story.

Several design aspects influence children's language learning from joint picture book reading – both in good and in bad ways. For example, highly salient design features such as pop-ups hinder children's word-learning from books (Tare, Chiong, Ganea, & Deloache, 2010). Furthermore, irrelevant design details are particularly harmful to learners with lower executive function skills have difficulties allocating attention to relevant information and ignore extraneous information (e.g., Kaminski & Sloutsky, 2013; McEwen & Dubé, 2015) and might disrupt learning (Horst, Scott, & Pollard, 2010). Therefore, reduction of details can avoid cognitive overload and distraction (c.f., Rey, 2012; Sweller, Ayres, & Kalyuga, 2011). For example, Flack & Horst (2018) demonstrated that children learn words better when presented with one book page at a time. However, oversimplification is not good for learning either, because, learning is increased by a certain degree of (desirable) difficulty (Bjork, 1994; Zosh, Brinster, & Halberda, 2013).

Book design is also relevant for the ease of transfer to the real world. It has been shown that books with realistic photographs lead to better transfer than books with drawings (Ganea, Pickard, & DeLoache, 2008; Simcock & DeLoache, 2006). This suggests that the additional details in the photograph can promote some aspects of learning.

The potential of touchscreens: Manually touching a screen is almost identical to pointing at a book page and receiving a contingent immediate response from the touchscreen device is similar caretakers replies to such pointing gestures in joint book reading. Therefore, it is not surprising, that researchers have been exploring the potential of touchscreen devices for language learning (Xie et al., 2018). In empirical studies, it has been demonstrated that even toddlers can learn words when solitarily interacting with touch screen devices (Dore et al., 2018; Walter-Laager et al., 2017). In addition, caretakers have been found to engage in joint app use and joint reading of interactive books in similar ways to the joint reading of printed books (Strouse & Ganea, 2017; Takacs, Swart, & Bus, 2014).

Furthermore, and also similar to books, the design of digital content can negatively influence learning (Takacs, Swart, & Bus, 2015). Starke, Leinweber, and Ritterfeld (Chapter 7 this volume) suggest that digital educational media should be developed by inter-disciplinary teams including game theorists, designers, computer scientists as well as pedagogical experts following six design principles: 1) Specify your target group and the focused language structure, 2) Determine key language learning methods, 3) Include the target group in the design process, 4) Fine-tune learning and gaming, 5) Implement as much and as less game mechanisms as needed, and 6) Use an iterative process to fine-tune language and general learning principles with game design. When developing our prototype of a gallery of annotated interactive pictures we took a slightly different approach, nevertheless meeting the principles.

3. The Design of DAZonline.ch

Principle 1 - Target group & content: The target group for the first platform for picture-based language learning comprises language learners of all ages and with all backgrounds. There is almost no restriction on the minimum age for the use of annotated interactive pictures. Research has shown that even 2-year-olds can learn words from solitary interaction with an interactive image on a touchscreen (Walter-Laager et al., 2017; Xie et al., 2018). Furthermore, research demonstrated that caretakers engage in high-quality interaction with their children not only when co-reading books but also when co-reading interactive eBooks (Strouse & Ganea, 2017; Takacs et al., 2014). Therefore, it seems likely that such interaction would also occur around annotated interactive pictures. Especially for preschoolers, this is likely to lead to the best learning outcomes (c.f., Dore et al., 2018; Walter-Laager et al., 2017).

The four groups we are focusing on during the first (currently running) feedback-loop (Strake et al.'s principles 3,4,6) are 1) children (pre-schoolers and primary school children) from non-German speaking families, 2) these children's teachers, 3) adults who newly immigrated to a German-speaking country (including refugees) and 4) social workers and teachers working with them. The primary goal of the prototype-testing is to determine additional functionality that would improve interaction quality.

The linguistic focus is on everyday vocabulary as well as on academic and professional vocabulary in various grammatical structures. To make the annotated interactive pictures particularly valuable for language promotion, the annotated interactive pictures must provide not only simple but also complex linguistic constructions. Indeed, one problem with existing educational media is, that it rarely includes sophisticated language (cf., Danielson, Wong, & Neuman, 2019).

Principle 2 - Learning method: The goal is to get as close to natural language acquisition as possible. Therefore, the interaction with the content on the platform simulates responsive interaction with a joint focus of attention to some extent. When opening the platform, users browse and explore the gallery and miniature previews may spark the initial selection of certain pictures. When selecting a miniature, the corresponding annotated picture is shown full screen and the user can touch the hotspot in the image and listen to and read related utterances.

When learners are browsing through the annotated interactive picture gallery will encounter unknown words and structures. Over time and repeated browsing through various annotated interactive pictures, words and phrases will repeat and contrast with one another across the annotated interactive pictures. Therefore, the platform provides users with the possibility of cross-situational learning: Across the annotated interactive pictures, the users will encounter a variety of verbal expressions related to different contexts – both of which might partially overlap with preceding content the user has explored.

For example, in the series "im Garten" (in the yawn) the full variation set comprises seven sentences. First in Picture "im Garten 1" (https://dazonline.ch/student-lesson/94) the following utterances form a variation set:

- ein Velo (a bike)
- Das Velo steht auf der Wiese (The bike is standing on the lawn.)

- ein Rasenmäher (a lawnmower)
- Der Rasenmäher steht auf der Wiese (The lawnmower is standing on the lawn)

The variation set is expanded in the other two pictures in the series:

- Ein Junge (a boy)
- Der Junge schiebt das Velo. (The Boy is pushing the bike.)
- Der Rasenmäher wird vom Jungen geschoben. (The lawnmower is pushed by the boy.)

Content designers are advised to first provide the label of an object. If the user "requests" more information by touching the modal, an expansion containing the label appears. This two-step mini-variation set simulates how parents introduce novel labels to their children (e.g., Wong & Clark, 2002). As shown in the example above, variation sets often spread both across the utterances included in each picture as well as across pictures in a series.

The implementation of Web2.0 technology allows teachers to create content. There is some evidence that personalized content can support language learning (Kucirkova, Messer, & Sheehy, 2014). However, to ensure quality, the user-generated pictures will be reviewed by an expert team. One of the biggest challenges for untrained designers is the fact that experts see and process pictures differently from novices (De Groot, 1948). The most relevant difference for language learning and instruction is that experts attend much more to details than novices (Hoffman & Fiore, 2007; Vaidyanathan, Pelz, Alm, Shi, & Haake, 2014). The effect of this can be seen in many picture-based language learning applications in which images are annotated with a single sentence about a tiny detail in the image – that the learner is highly unlikely to attend to.

Therefore, to ensure that the learner's attention is in the right spot in a complex picture, our content designers use several methods. First, the irrelevant elements in the picture could be blurred or the important elements highlighted – for example by using color, placing them in the center of the image, or have a person in the image, whose attention is directed according to where the learner should look (Axelsson, Churchley, & Horst, 2012; Zoe Martine Flack, 2018; Fletcher-Watson, Findlay, Leekam, & Benson, 2008; K. M. Wilkinson & Light, 2011). Importantly, beyond the hotspots that respond to users' indication of interest by providing related utterances, there are no animations at dazonline, since animations potentially interfere with learning (cf., Starke et al. in this book; Takacs, Swart, & Bus, 2015).

When teachers create annotate interactive pictures for their children, this does not only make the children's digital learning more personalized, it also makes cross-media and blended learning activities possible. For example, teachers can make QR Codes® that contain the URL of certain pictures and place them at relevant real-world locations. This nicely blends digital and real-world activities and potentially could even enhance learning and transfer.

Another possibility of blended learning activities around the picture gallery is to adapt the procedure used by Charitonos and Charalampidi (2015) and Wong, Chin, Tan, and Liu (2010). In these studies, learners were asked to take pictures related to certain linguistic expressions. Together with their caretakers, these pictures can be uploaded to the platform and form new content – thereby providing children with personalized annotated interactive pictures.

Principle 5 - game elements: so far, there are no gamification elements implemented. This is mainly to ensure that the users' focus of attention is on the content and not on game mechanics. We rather suggest creating real-world games around the use of the picture gallery. For example, the above-described cross-media learning scenario of placing QR Codes® at relevant real-world locations can be extended in paper chases and various other games.

4. Discussion and future directions

Annotated interactive pictures are easy-to-access and have a high potential to foster and promote language and literacy development in all children. Most importantly, because pictures are everywhere, an annotated interactive picture gallery such as dazonline might provide us with a way to languageize (cf., Golinkoff, Hoff, Rowe, Tamis-LeMonda, & Hirsh-Pasek, 2019) children´s lives and increase chances for academic success and successful life: Annotated interactive pictures can relate new expressions, rare words, and academic language to everyday situations, but they can also broaden horizons and show situations (both fantastic and real) that are not part of the learners' life and they can open new perspectives and show the world from diverse angles. Annotated interactive pictures can also be used to promote academic language and relate it to real-world situations. However, future research has to establish how effective annotated interactive pictures promote language development.

With the growing number of annotated interactive pictures at dazonline, the diversity will both grow and reveal structures that can be used by AI algorithms to provide recommendations to the learner. Until the algorithms are implemented, the designers must take care of an optimal balance of variation and repetition. The larger the picture gallery the more natural variation and repetition will pattern. To provide learners with an optimal mix of variation and repetition at the platform it is planned to implement a multi-dimensional recommendation system. Multi-dimensional recommendation algorithms are optimal, because 1) the learner maintains navigational control to choose from a variety of suggestion and a sense of autonomy while being optimally guided and 2) it is notoriously difficult to recommend a single optimal picture to continue since learners differ both in their interest and prior knowledge (Hasnine et al., 2018; Hasnine et al., 2019), and 3) algorithms must also consider that the relevance of repetition and variation across successive learning situations varies as a function of age, memory capacity, and mastery of language (Vlach & DeBrock, 2017).

Annotated interactive pictures might be tomorrow's picture books – not least because sharing and viewing pictures is ubiquitous. If designed properly, I suggest that annotated interactive pictures are as valuable for language and literacy development as picture books, maybe even more so, because even less-literate parents will enjoy exploring annotated interactive pictures together with their children and learners can explore annotated interactive pictures even solitarily and independently of an interlocutor. Las but not least, annotated interactive pictures can be used in various blended learning situations which potentially increases transfer to real-world language use.

5. Considerations for parent, educators, and producers

Annotated interactive pictures might outperform joint book reading in the promotion of language and literacy development. In particular, when collected in a gallery with adaptive

filters and recommendation algorithms. When using or producing digital media for language promotion, parents, educators and producers may consider annotated interactive pictures.

1. A gallery of annotated interactive pictures provides a unique and easy-to-access language learning resource. Since teachers and caretakers can upload their content to the gallery, the platform connects well with today's habit of online picture sharing and exploits this for educational purposes. Indeed, even parents with lower language and literacy skills might use such a platform and explore the images together with their children – with the quality of interaction supported by the software.

2. Most of the activities that foster language development in joint book and eBook-reading (joint attention, responsive interaction, the elaborated conversation about the content) are possible also in the joint exploration of annotated interactive pictures. The gallery allows users to explore the content based on their interest and nevertheless profit from tailored progression over time. The gallery provides diverse vocabulary in diverse contexts.

3. Additional implementation of filters and recommendation algorithms allowing the user to select overlapping or constant vocabulary (same words) or contexts (same pictures) makes individualized learning possible. Filtering and recommendation systems can enhance language uptake by optimizing variability across situations according to the learner's skill – something rather difficult to accomplish with books.

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