



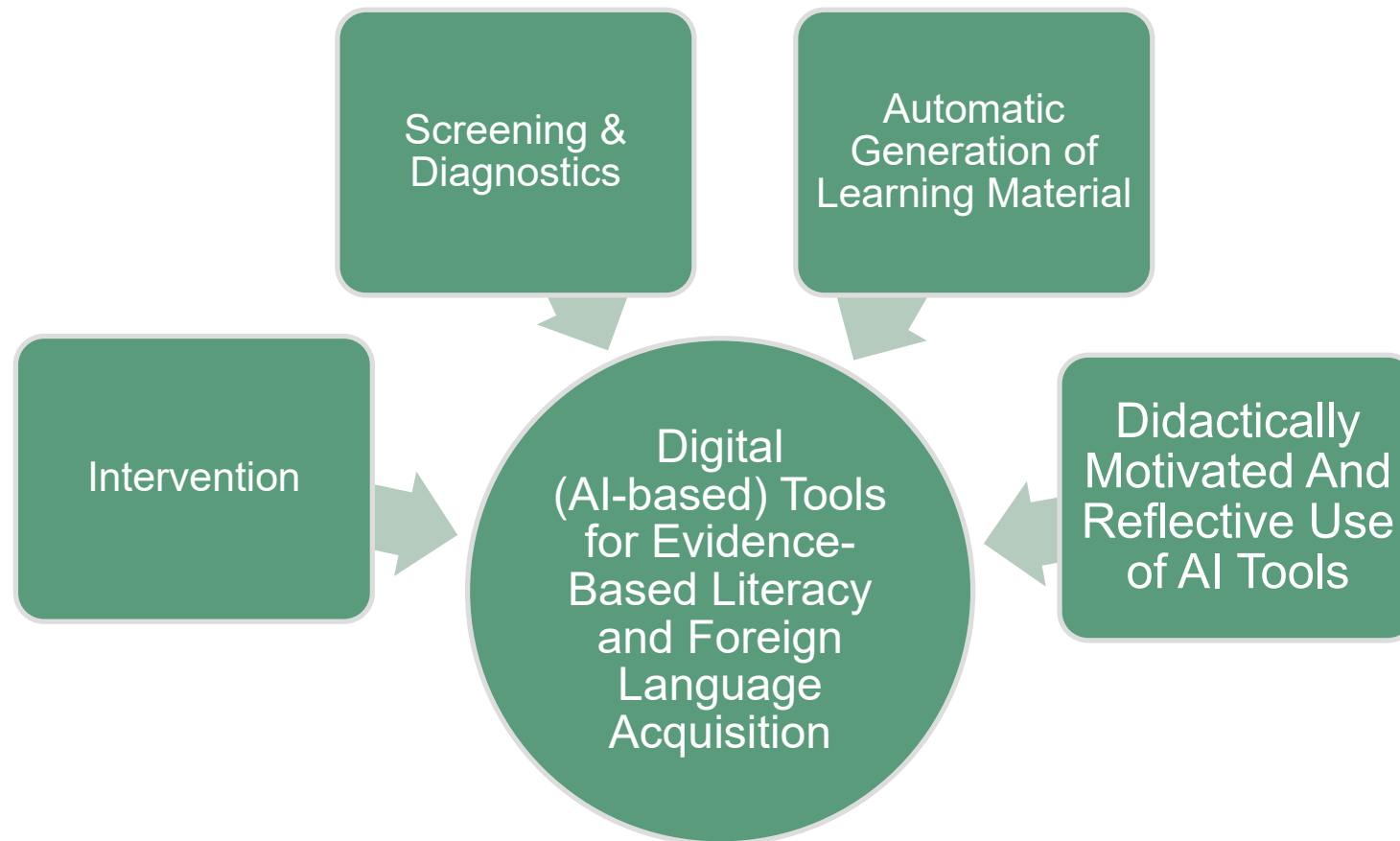
Juniorprof. Dr. Heiko Holz & Prof. Dr. Detmar Meurers

(Gen)AI in Language Learning and Teaching

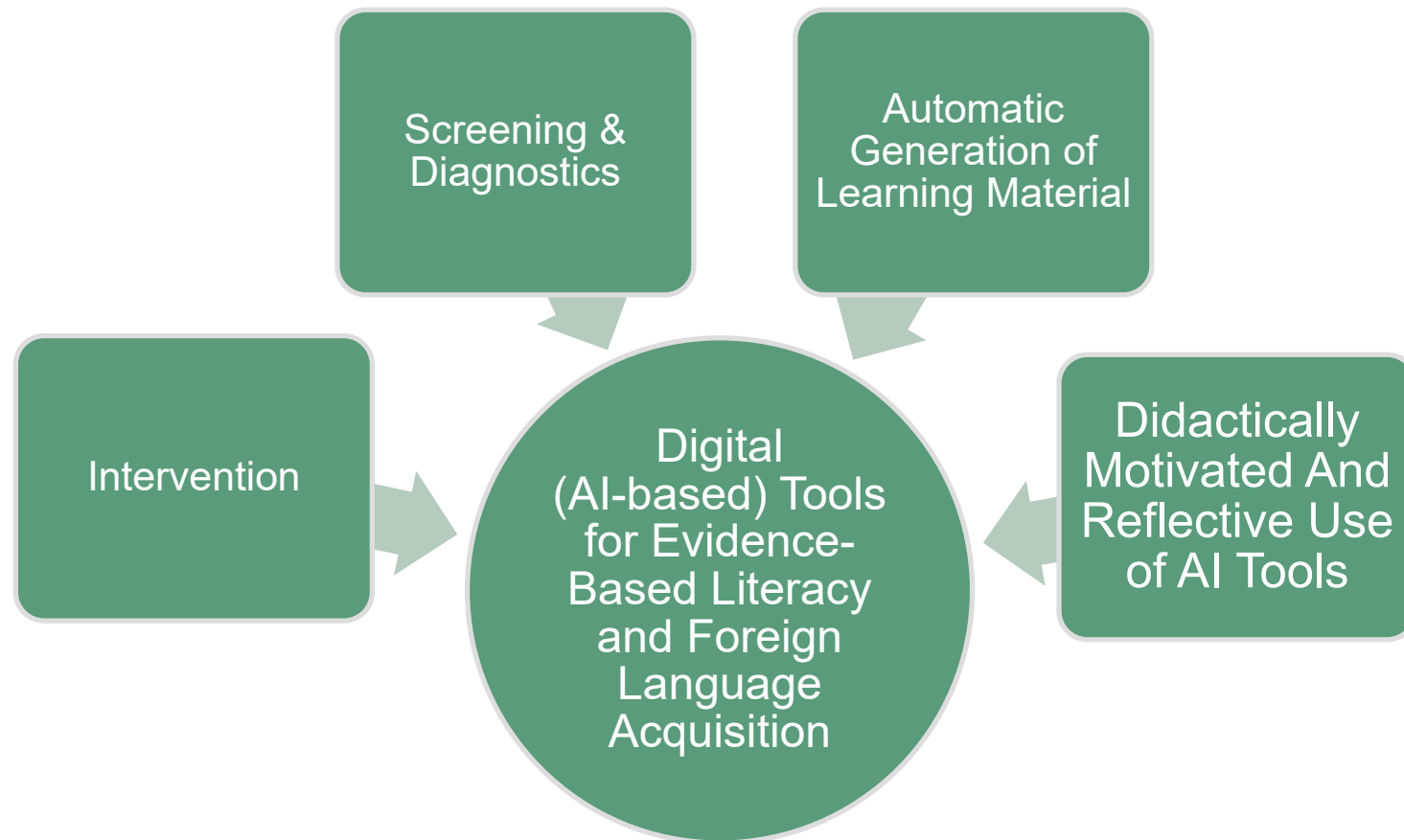
Insights Into Tools, Prospects, & Future Directions



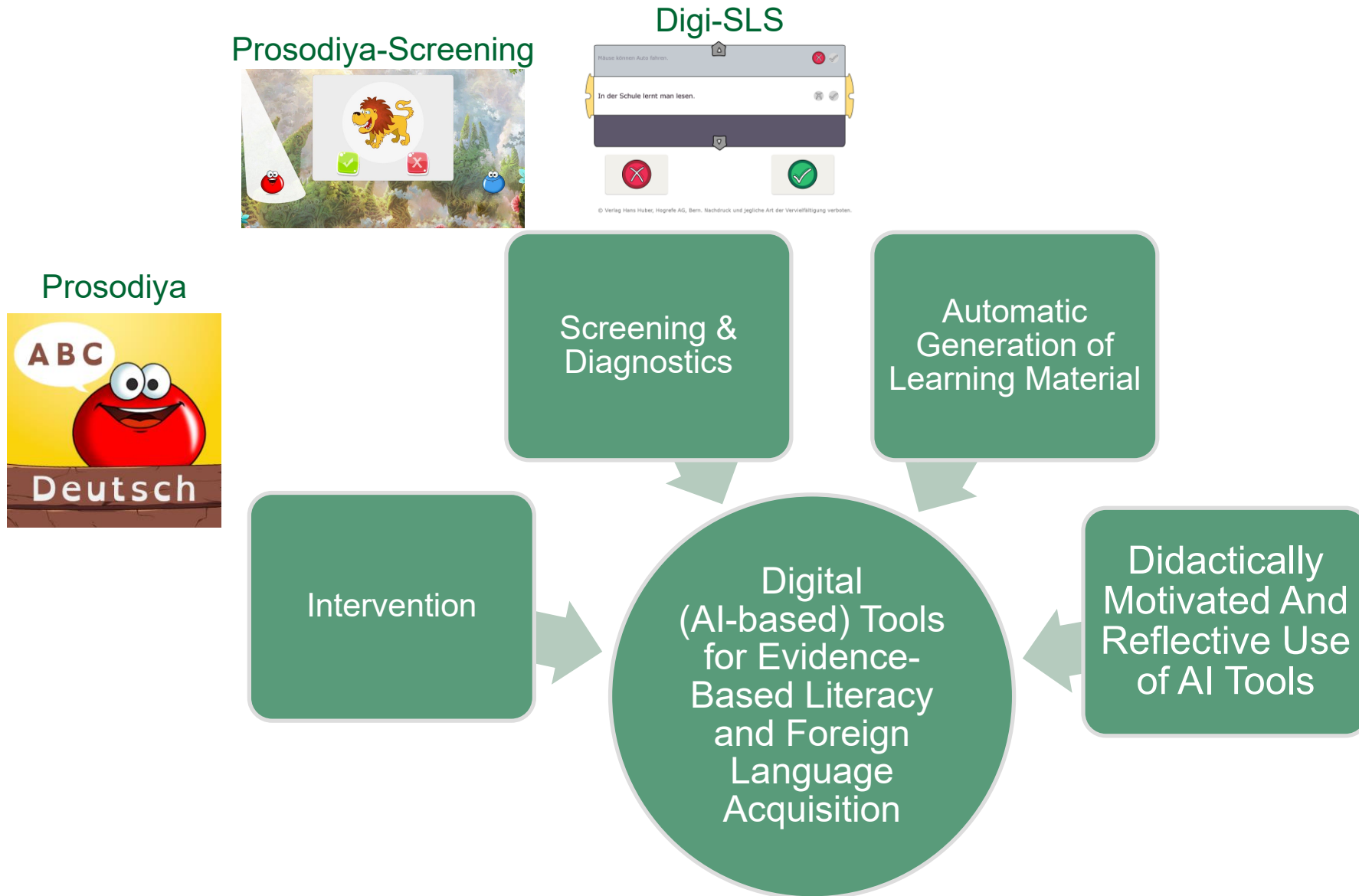
How Can AI Support Literacy Acquisition?



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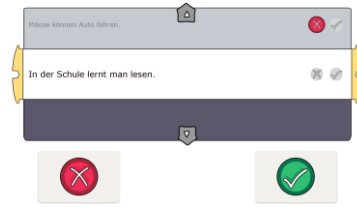


How Can AI Support Literacy Acquisition?

Prosodiya-Screening



Digi-SLS



COAST

Ich **ber**at**sch**lag**te**
mein **Me**ist**er**w**er**k
mit **ei**n**e**m
El**fan**t**e**n und **ei**n**e**r
Rie**sen**sch**lan**g**e**.

Prosodiya



Screening &
Diagnostics

Automatic
Generation of
Learning Material



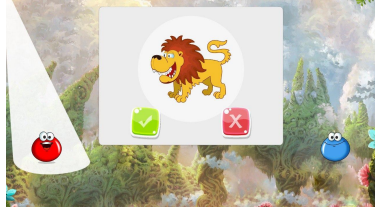
Intervention

Digital
(AI-based) Tools
for Evidence-
Based Literacy
and Foreign
Language
Acquisition

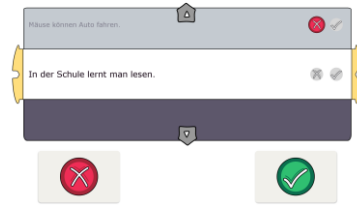
Didactically
Motivated And
Reflective Use
of AI Tools

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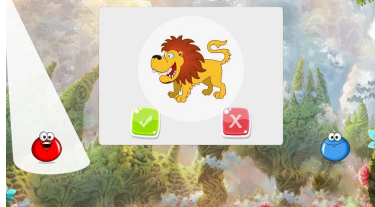
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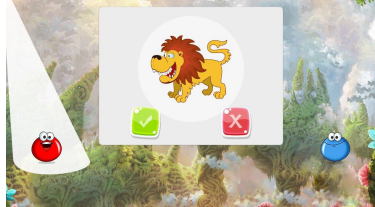
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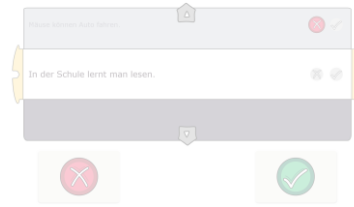


How Can AI Support Literacy Acquisition?

Prosodiya-Screening



Digi-SLS



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Ich beratschlagte
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Prosodiya



Screening &
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Which Disciplines Are Involved?

Subject-specific
Science and Didactics



Empirical Educational
Research / Science



Which Disciplines Are Involved?

Subject-specific
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Empirical Educational
Research / Science

Which Disciplines Are Involved?

Subject-specific
Science and Didactics

Computer Science

Empirical Educational
Research / Science

Which Disciplines Are Involved?

Subject-specific
Science and Didactics

Comp. / Cogn. Science

Empirical Educational
Research / Science

PROSODIYA



A DIGITAL GAME-BASED SPELLING TRAINING FOR GERMAN PRIMARY SCHOOL CHILDREN



• EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

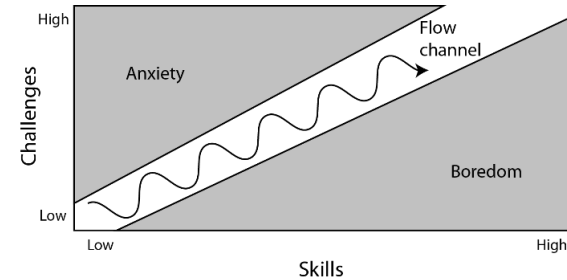


• IWM
Leibniz-Institut für
Wissensmedien



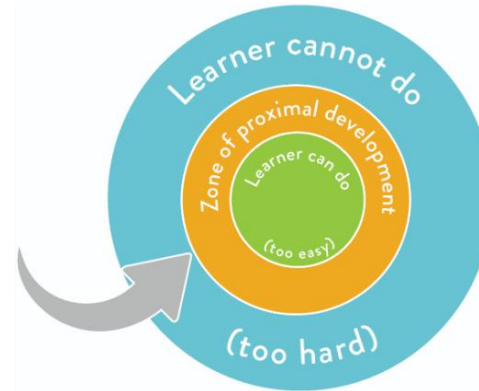
Opportunities of Digital (Game-Based) Learning

- learner modeling allows to adapt to individual learning curves
 - Flow (Csikszentmihalyi, 1975)
 - Zone of proximal development (Vygotsky, 1978)



Opportunities of Digital (Game-Based) Learning

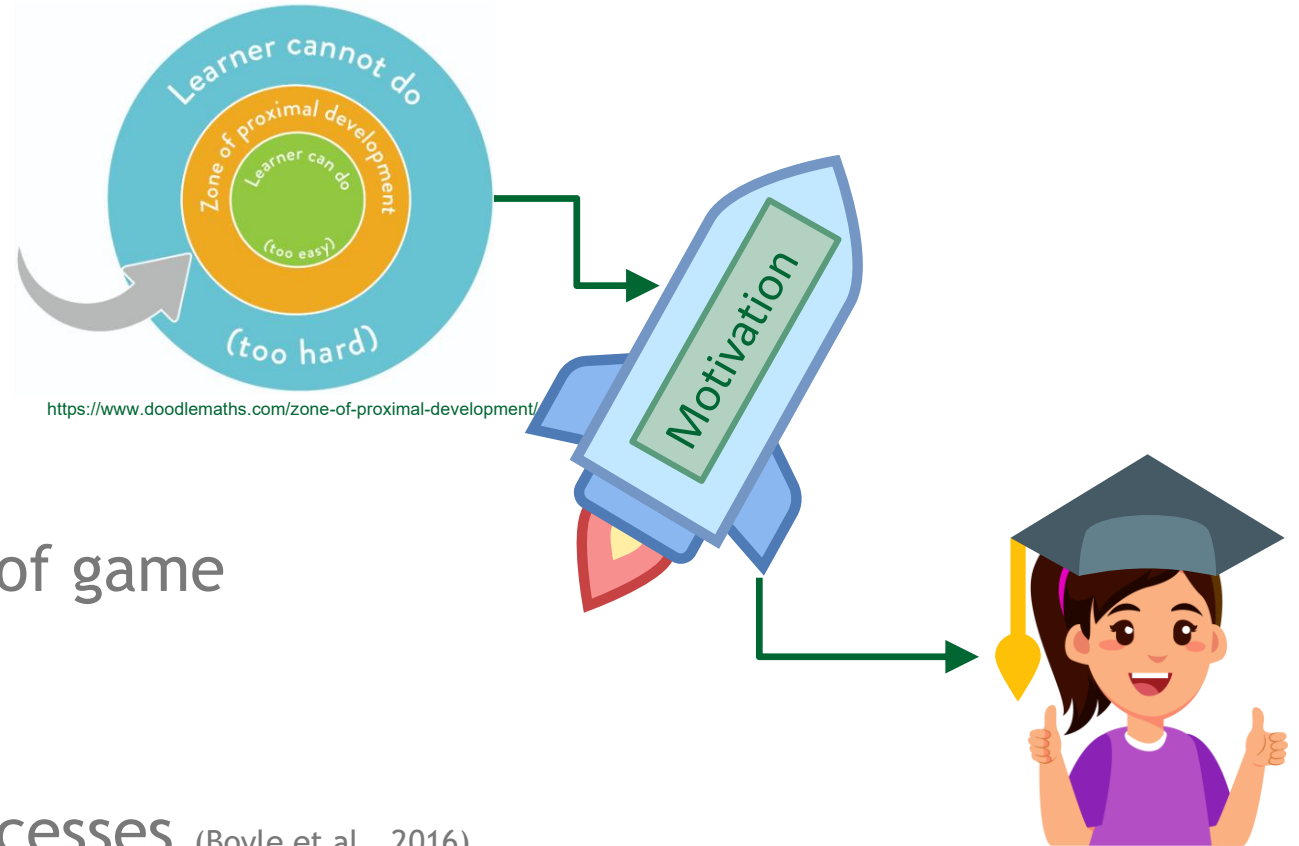
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<https://www.doodlemaths.com/zone-of-proximal-development/>

Opportunities of Digital (Game-Based) Learning

- learner modeling allows to adapt to individual learning curves
 - Flow (Csikszentmihalyi, 1975)
 - Zone of proximal development (Vygotsky, 1978)
 - boosting motivation with the use of game elements (Deterding et al., 2011)
- leading to successful learning processes (Boyle et al., 2016)

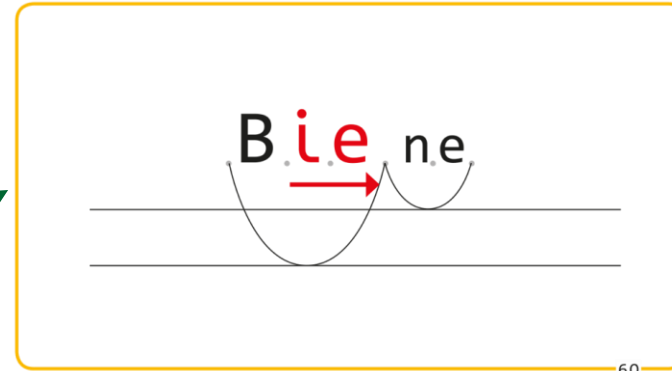
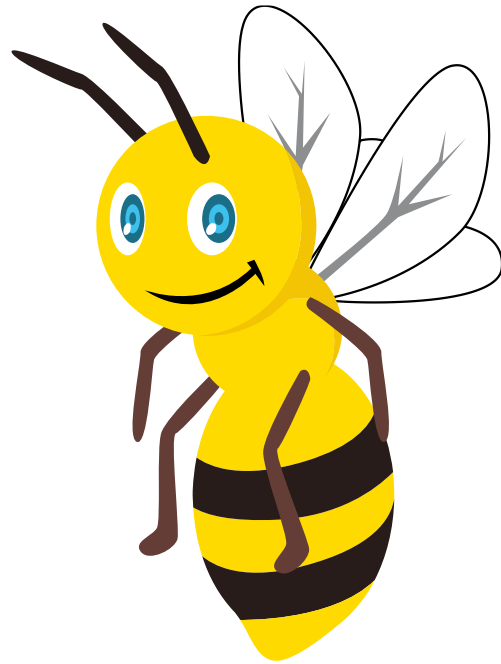


Design Principles

- **Feasibility and Applicability**
 - feasibility in home environment
 - engagement / motivation of children (with dyslexia) over a period of several months
- **Effectiveness**
 - efficacy under „real-world“ / everyday conditions
- **Validity**
 - linguistically sound and based on empirical findings
 - effective implementation of the pedagogical content



Prosodiya: From Speech Rhythm to Spelling







Prosodiya

Game 1: “Find the stressed syllable”



Potential use of AI: Analyze children's pronunciation
(stress) automatically

Prosodiya

Game 2: “Open and closed syllables”



Prosodiya

Game 2: “Open and closed syllables”



Potential use of AI: automatic generation of spoken minimal pairs (Holz et al., 2018)

Prosodiya

Game 4: "Spelling"



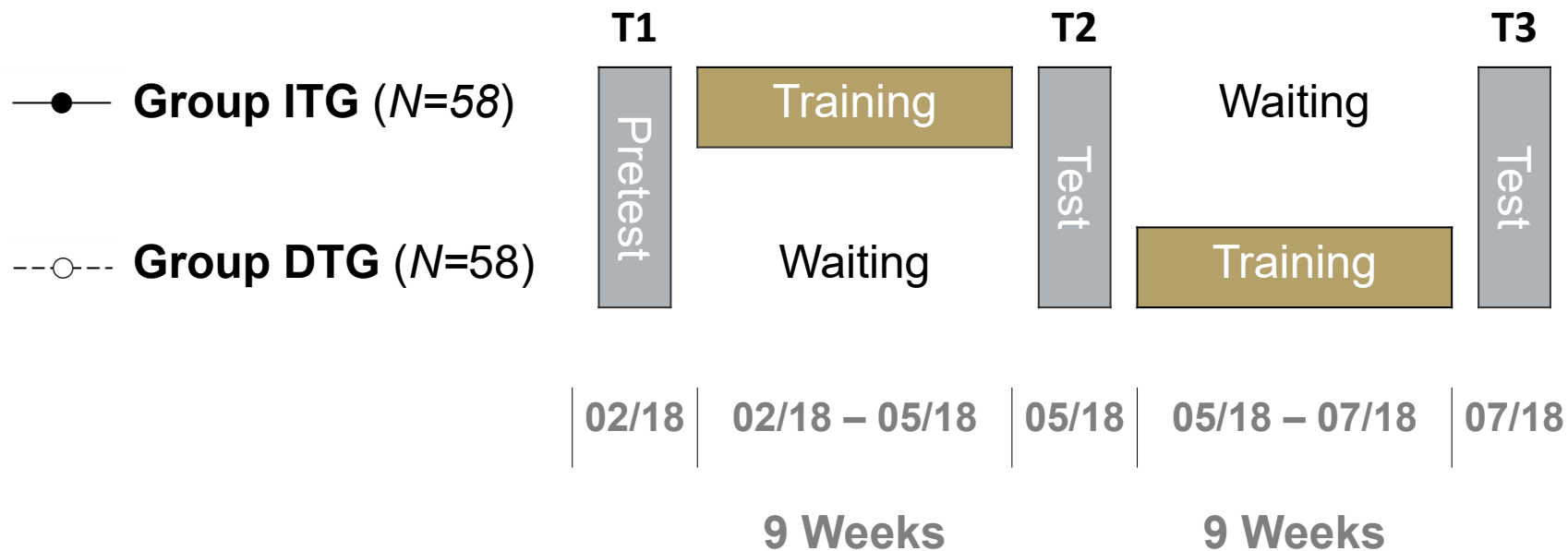
Prosodiya

Game 4: "Spelling"



Evaluation of Prosodiya: Randomized Controlled Field Trial (Holz et al., 2023)

- In 2018, 116 primary school children from the area of Tübingen (Germany) participated in the Prosodiya intervention study
- Two-period, wait-list controlled crossover treatment design



Summary of the Results

(Holz et al., 2023)

- **Validity:**

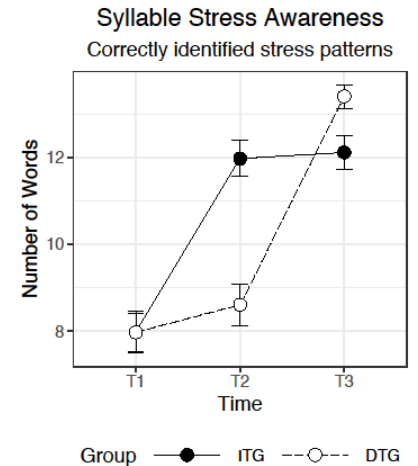
- ✓ Correlation between stress perception and reading and spelling performance demonstrated/replicated.
- ✓ Correlation between training and spelling performance indicates effective implementation.

- **Effectiveness:**

- ✓ Prosodiya improves syllable stress awareness and spelling of primary school children

- **Feasibility:**

- ✓ Prosodiya is feasible for use at home
- ✓ Prosodiya motivates children over longer periods and is well received by parents and teachers



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Outlook: Game Experience/Playfulness

- Development of a self-report measurement to assess game-based learning experience
- Systematic literature review on game features in digital interventions for dyslexic primary school children
- Implementation of a selected game/playfulness feature
- Investigation in an RCFT



Outlook: Scaffolded Feedback

Error rules derived from literature, practice and empirical evidence

Nr	Regel und Bedingung	Auswirkung	Kriterium	Distraktor	Beispiele
1	Stummes h hinzufügen. Gilt bei allen Wörtern (auch bei geschlossenen)	Falsche Schreibweise Langvokal. Aus Kurzvokal Langvokal machen	Regel 1-4	H	malen, mah <u>l</u> en, Felsen, Fe <u>h</u> lsen
2	Verdoppeln des Vokals der betonten Silbe. Gilt bei allen Wörtern. Außer bei ie und Diphthong	Falsche Schreibweise Langvokal. Aus Kurzvokal Langvokal machen	Vokal der betonten Silbe	Vokal der betonten Silbe	malen, ma <u>a</u> len, Felsen, Fe <u>e</u> lsen
3	Verdoppeln der Konsonanten am Anfang aller unbetonten Silben nach der betonten Silbe bei allen Wörtern. Aber nie derselbe Konsonant doppelt. Regel gilt auch bei Langvokalen mit Vokallängenmarkierung. Bei Konsonantenverdoppelung wird diese Regel für die Silbe direkt nach der betonten Silbe ausgelassen	Falsche Schreibweise Kurzvokal. Aus Langvokal Kurzvokal machen	Konsonanten am Anfang der unbetonten Silben	Konsonante n am Anfang der unbetonten Silben	verbinden, verbind <u>en</u> , malen, ma <u>ll</u> en
...



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...



Prosodiya Screening

Sing Sang

Options

Code: EINTRAGEN!

PROSODIYA PRE-SCREENING

DISSERTATION OF BENEDIKT BEUTTLER: [OSF.IO/HRBDV](https://osf.io/HRBDV)

A DIGITAL, PLAYFUL AND GROUP-BASED SCREENING FOR PRE-READERS AT RISK FOR DYSLEXIA



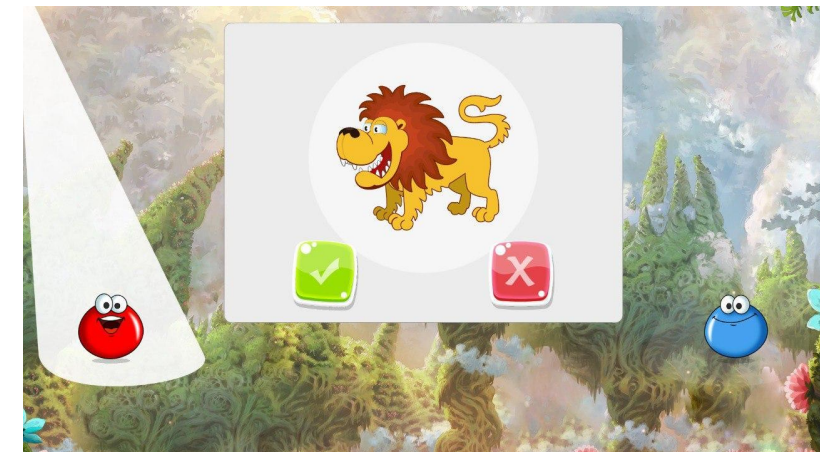
Til
Tübinger Institut für Lerntherapie

• EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

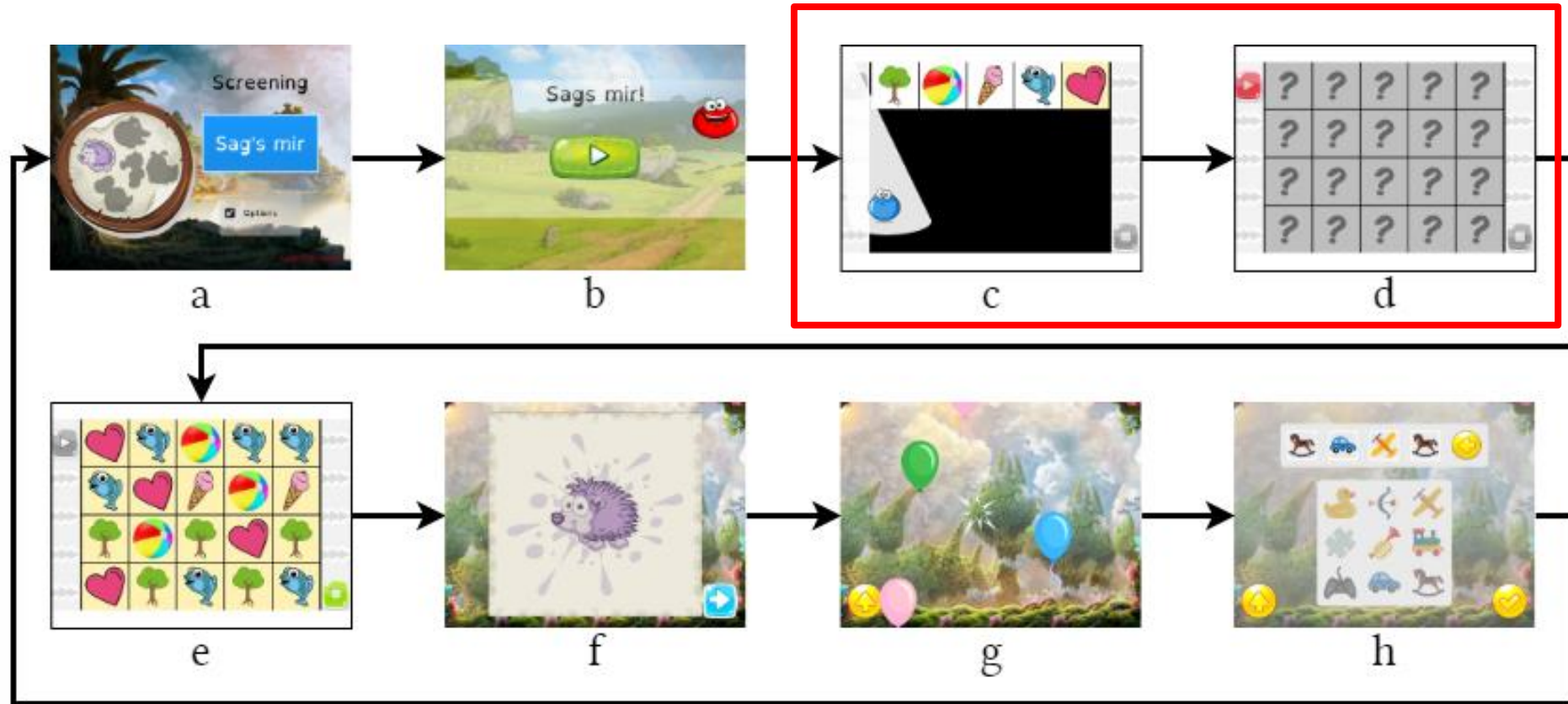


Tutorials + Tasks

- Group testing
- Tutorials for each task
 - Kugellichter as companions
- Requirements
 - self-explanatory
 - interactive
 - motivating
 - easy to use
 - valid and reliable

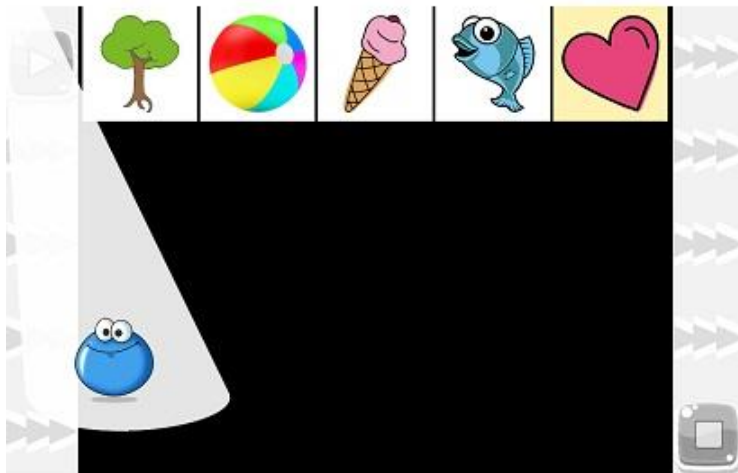


Exemplary Procedure of a Task



Screening Task „Tell Me“

- Background: Rapid Automated Naming (RAN)
(Catts, Fey, Zhang, & Tomblin, 2001)
 - Loud naming of monosyllabic symbols (naming speed)
 - Group differences between dyslexic and non-dyslexic in time per item



Interactive tutorial



Before the task starts

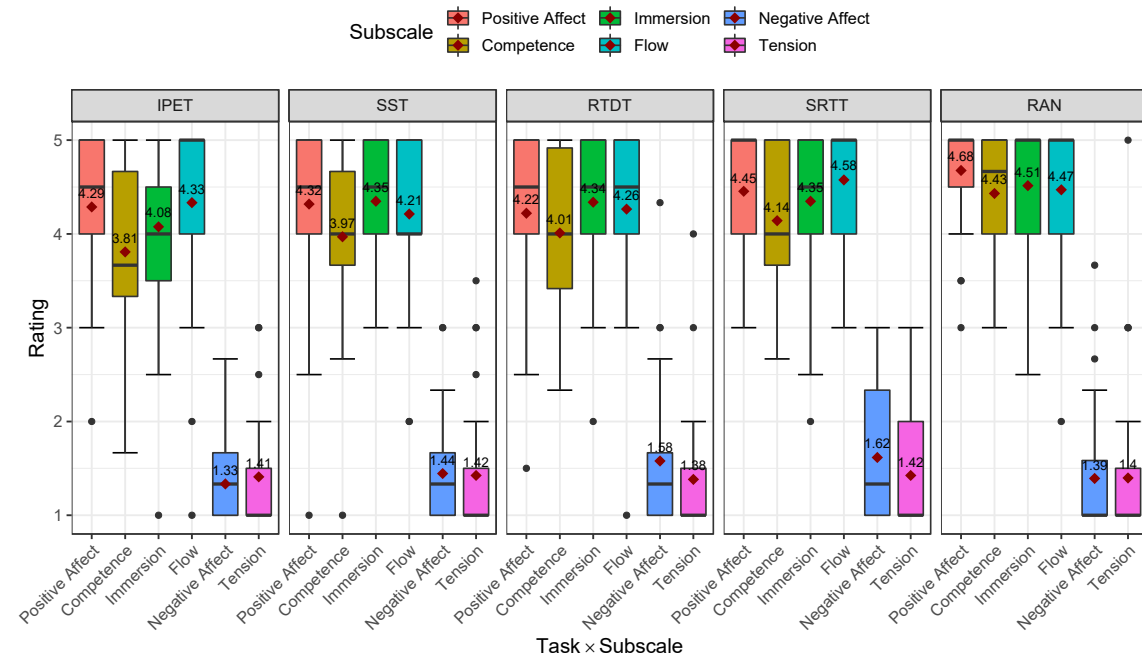
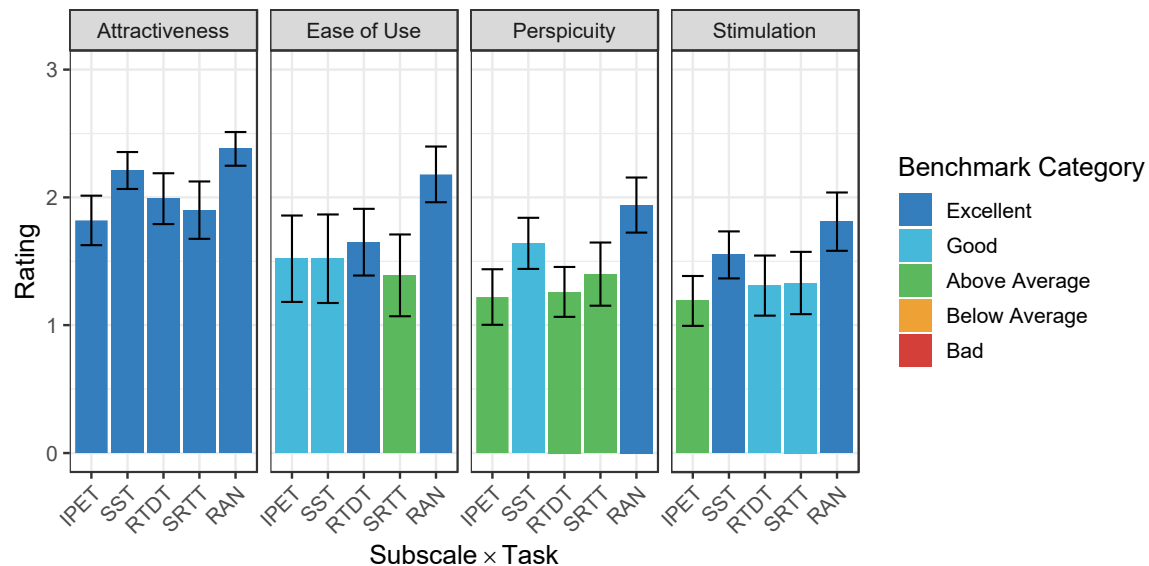


Task, page 1/2

Screening as “Playful Assessment”

Results of a Feasibility Study (Holz, Beuttler et al., 2024)

- **Group testing works:** children use the app independently without distracting others
- **Positive gaming and user experience:** tasks are fun and playful (considered more as a game than exercise/test), improving concentration and motivation

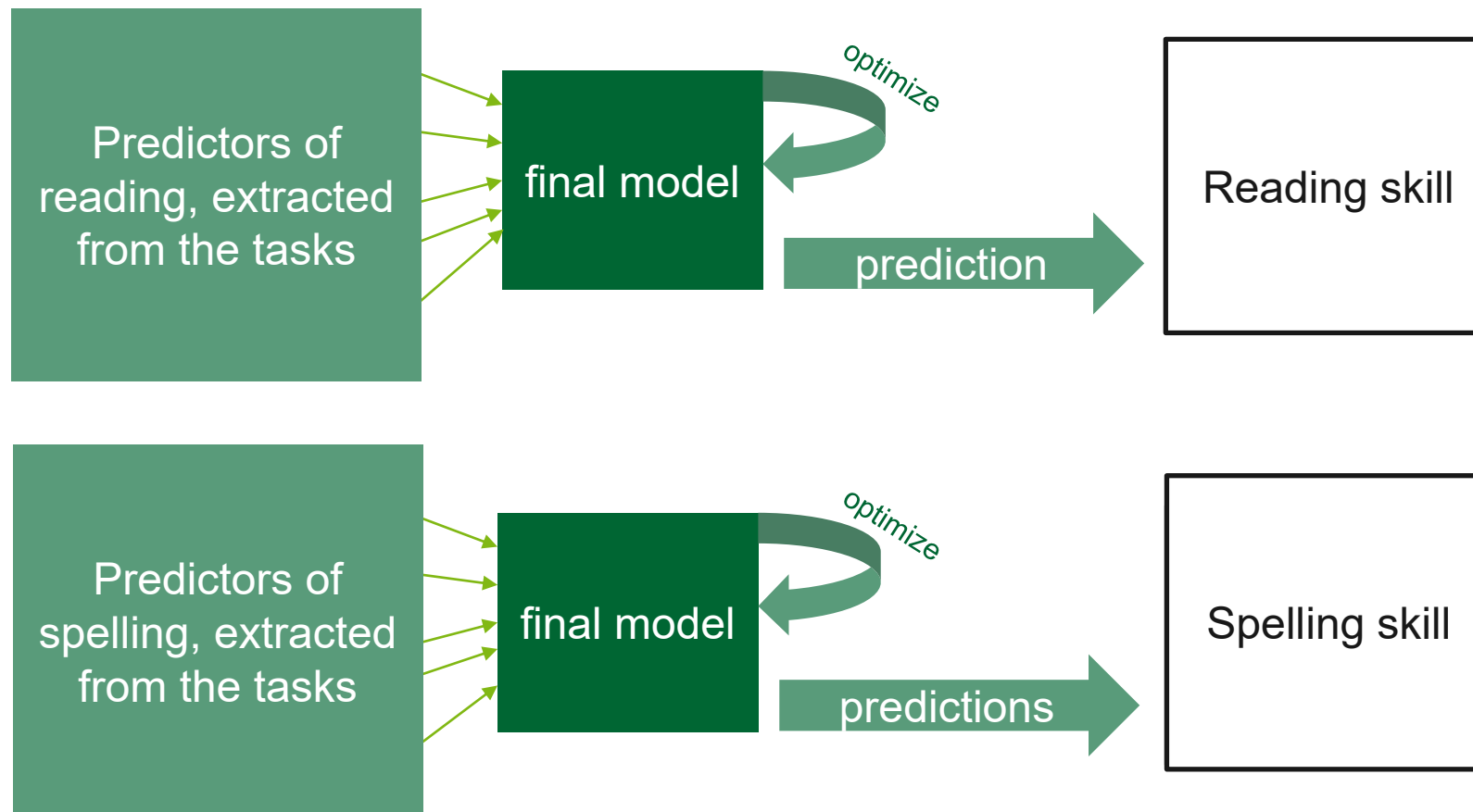


Results of the Game Experience Questionnaire (GEQ)

Prediction Models

(Beuttler, 2024)

- Regression and Classification

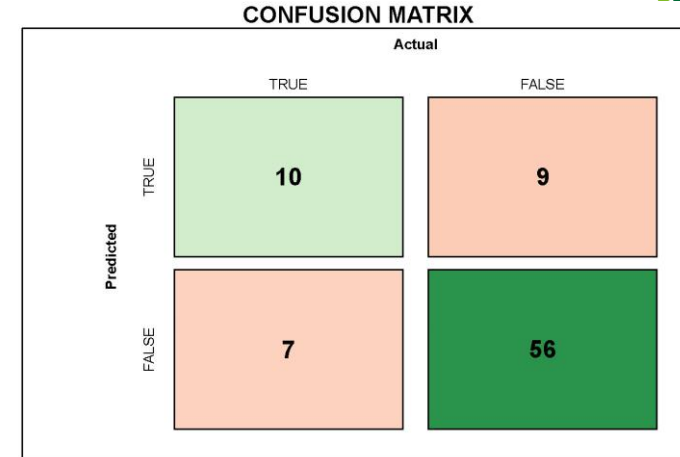


Evaluation of the Final Random Forest Model

(Beuttler, 2024)

- Overall performance

Literacy skill	RMSE	r^2	MAE
Reading	7.92	0.18	6.56
Spelling	4.63	0.12	3.90



DETAILS

Sensitivity	Specificity	Precision	Recall	F1
0.588	0.862	0.526	0.588	0.556
Accuracy		NIR*	Balanced Accuracy	
0.805		0.793	0.725	

- Prediction exemplarily in three children

Reading	predicted	lower	upper
<i>Child_a</i>	23.12	22.17	30.74
<i>Child_b</i>	32.49	26.14	44.62
<i>Child_c</i>	31.64	25.29	42.58

Spelling	predicted	lower	upper
<i>Child_a</i>	11.51	10.95	17.41
<i>Child_b</i>	11.44	10.84	16.23
<i>Child_c</i>	15.49	12.38	22.15

Comparison of German Screenings for Dyslexia in Pre-Literate Children (Beuttler, 2024)

Screening	Year	RATZ	PPV	Sens.	Spec.	Test Type	Duration (min)	Medium
DP (Differenzierungsprobe)	1975	25%	20%	33%		Individual	7	Paper
BISC (Bielefelder Screening)	1999/2020	14-44%	50%	50%		Individual	25	Paper
RdH (Rundgang durch Hörhausen)	2002/2014	25% reading 77% spelling	63%	38-48%	80%	Individual	45	Paper
PB-LRS	2004/2019	55%	36%	63%	87%	Group	60	Paper
MÜSC (Münsteraner Screenings)	2005	60% (not replicated)	66%	50%	86%	Gruppe (8 kids)	50	Paper
HASE (Heidelberger Auditives Screening in der Einschuluntersuchung)	2007/2008	49-59%	4-28%	69-76%	60-66%	Individual	10	Paper and Digital
WÜSC (Würzburger LRS-Screening Laute, Reime, Sprache)	2020	73%	54%	80%	83%	Individual	25	Paper
SCHWUPP	2022		39%	80%	83%	Individual	38	Paper and Digital (Tablet)
LOGiK-S (Logopädie im Kindergarten - Screening)	2022		40%	84%	85%	Individual	10	Paper
Prosodiya-Screening	2024	46%	53%	59%	86%	Group	45	Digital (Tablet)





FUTURE WITH GEN AI - LIMITLESS POSSIBILITIES?

Individually Adapted Reading (Learning) Stories by Combining AI Tools

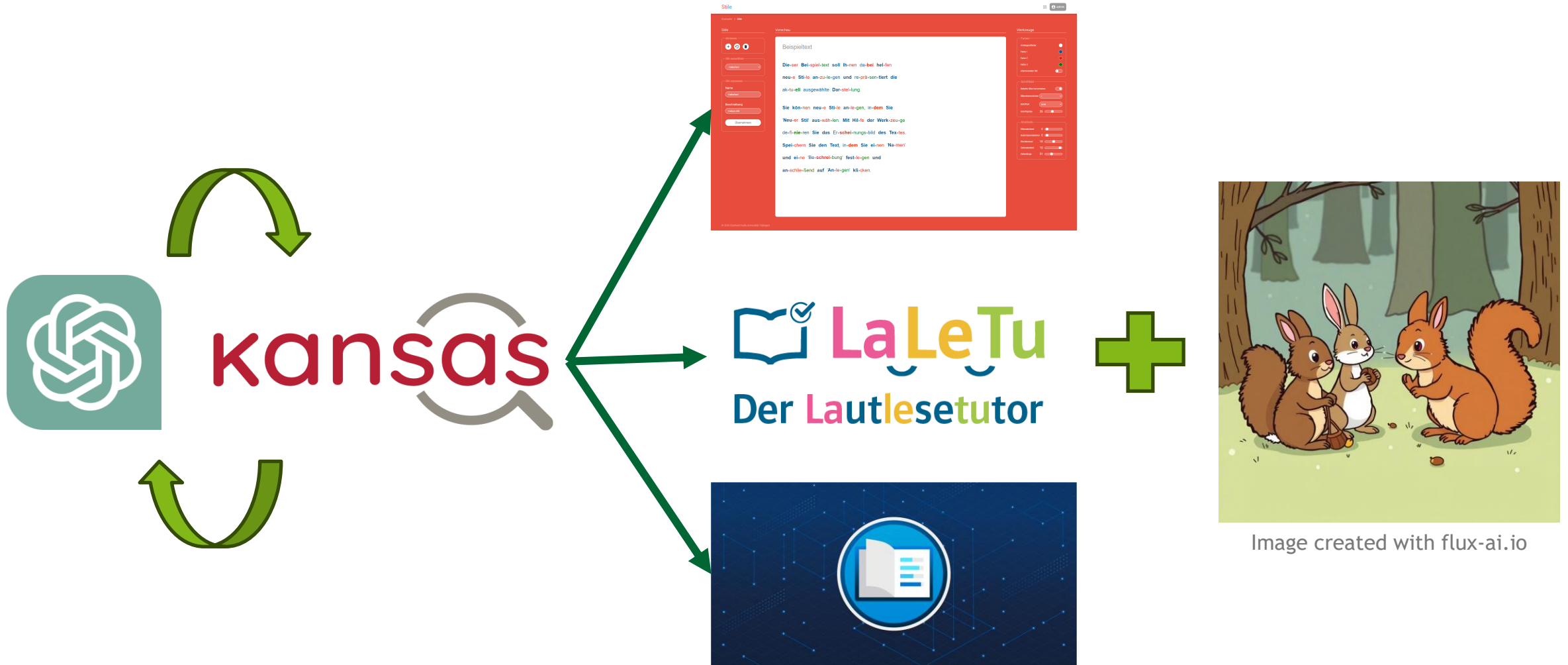


Image created with flux-ai.io



AI-LIT

AI-SUPPORTED LITERACY DEVELOPMENT IN KINDERGARTEN FOR EDUCATIONAL SUCCESS, EQUITY AND SOCIAL PARTICIPATION



Team & Cooperations

dgs Baden-Württemberg
 Institut für
 Bildungsanalysen (IBBW)
 Deutsche Gesellschaft für Sprachheilpädagogik e.V.

(ii) Design & Development

 Pädagogische Hochschule
 Ludwigsburg
 University of Education



Heiko Holz



Marco Ennemoser

(i) Dialogic Reading

dgs Pädagogische Hochschule
 Ludwigsburg
 University of Education



Karin Reber
 Expert for E &
 Participation Books



Kristin Cordes
 Expert for
 Dialogic Reading
 w. Digital Storybooks

(iv) ASR for Child Speech

 Leibniz
 Universität
 Hannover



Hanna Ehlert



Jörn Ostermann



(iii) Adaptivity

IWM
 Leibniz-Institut für
 Wissensmedien



Detmar Meurers



Kordula De Kuthy

Established Approach: Dialogic Reading

P: What did
the kids do?



Established Approach: Dialogic Reading

P: What did the kids do?



Ball broke



Established Approach: Dialogic Reading

E: Yes, that's right! The ball is broken.

R: How did that happen?



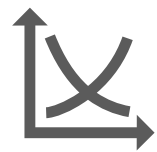
Ball broke



Established Approach: Dialogic Reading

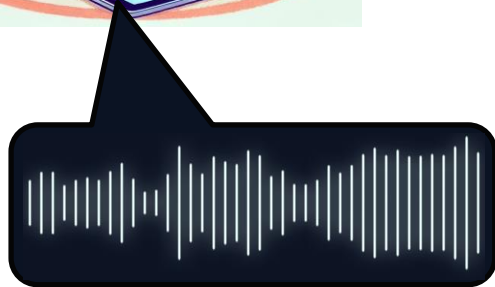


Dialogic reading requires 1 trained educator per 2-3 children.

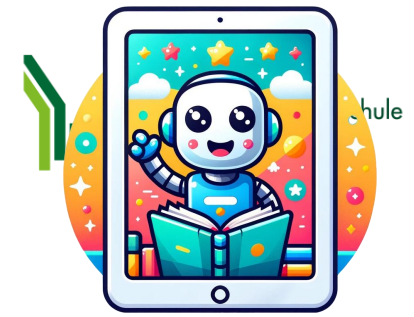


This does not scale in practice with the limited personnel that is available.

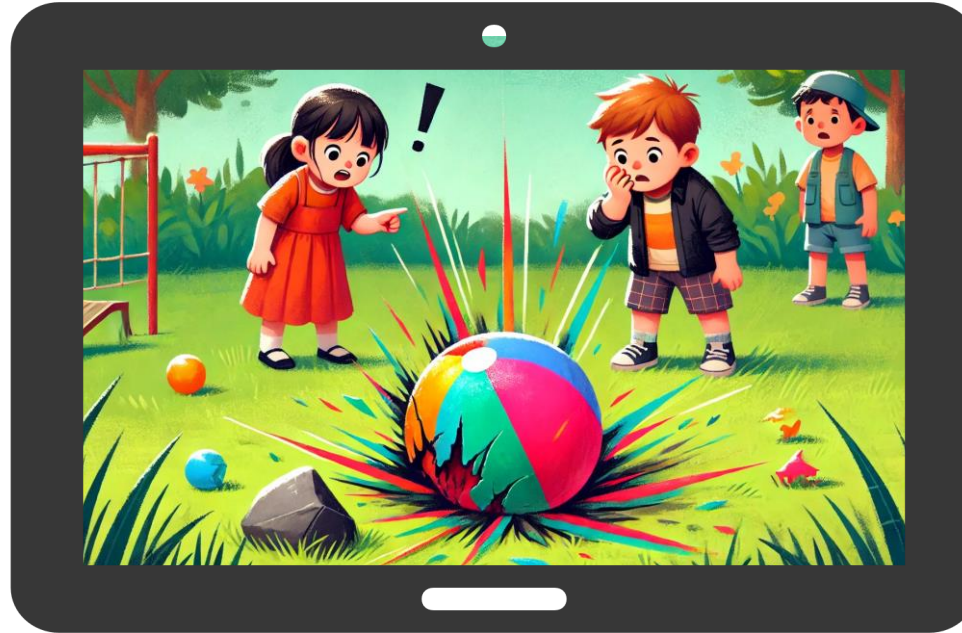
Our Approach: Dialogic Reading 2.0 - With Individual AI-App



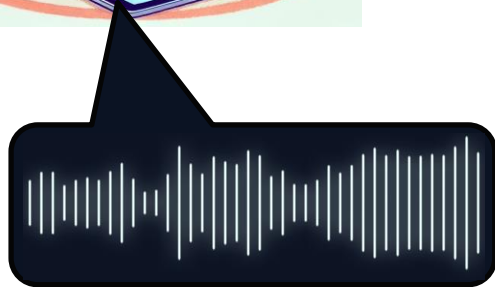
Our Approach: Dialogic Reading 2.0 - With Individual AI-App



P: Was haben die
Kinder gemacht?



Our Approach: Dialogic Reading 2.0 - With Individual AI-App



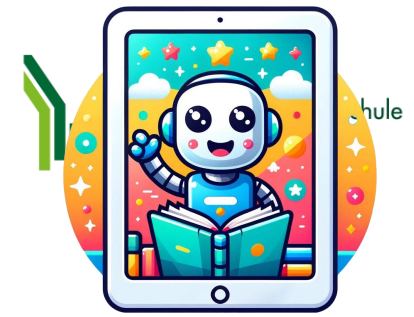
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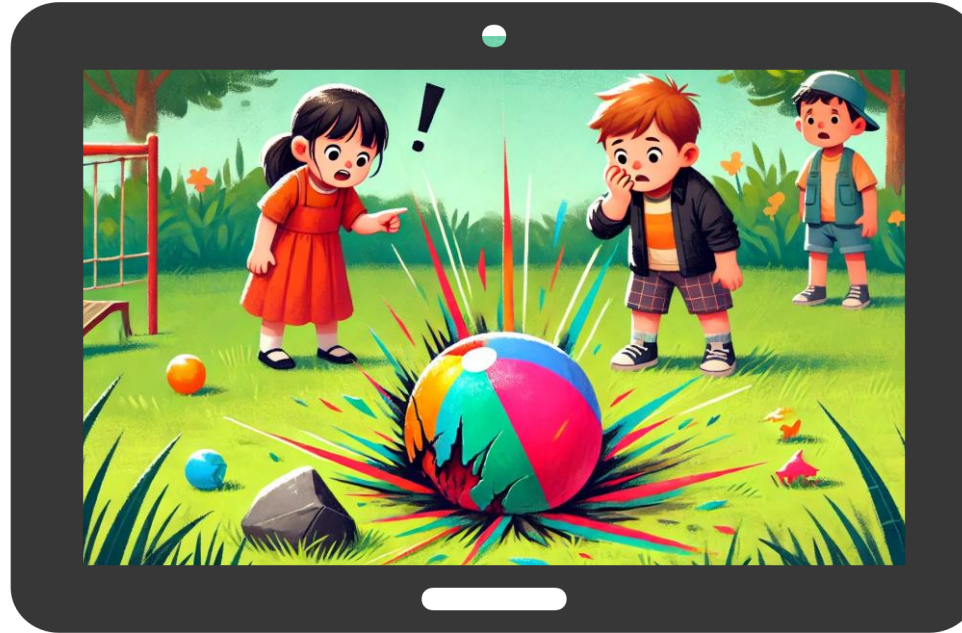
E: Ja, genau.
Der Ball ist **kaputt**.



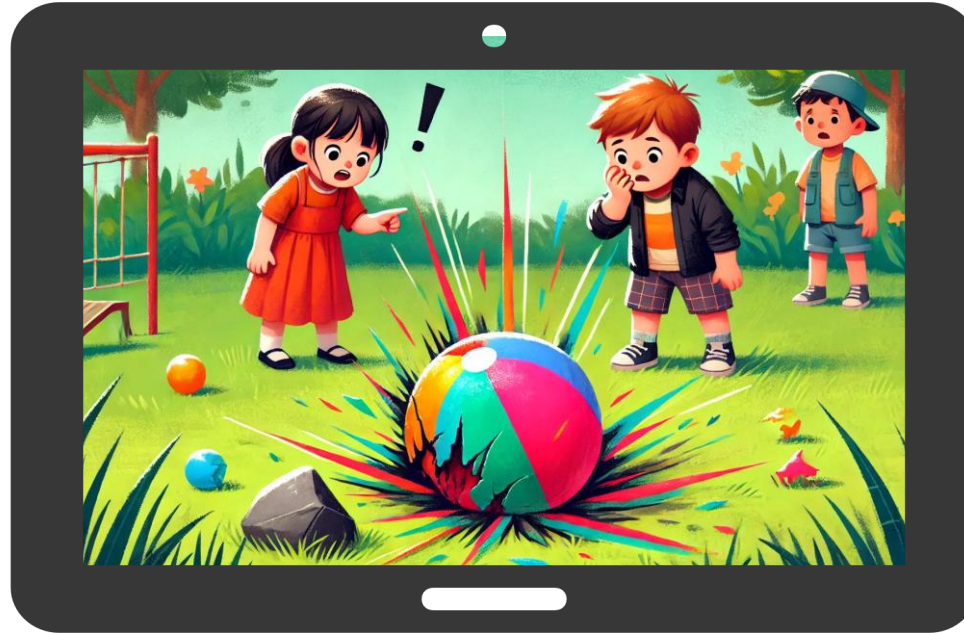
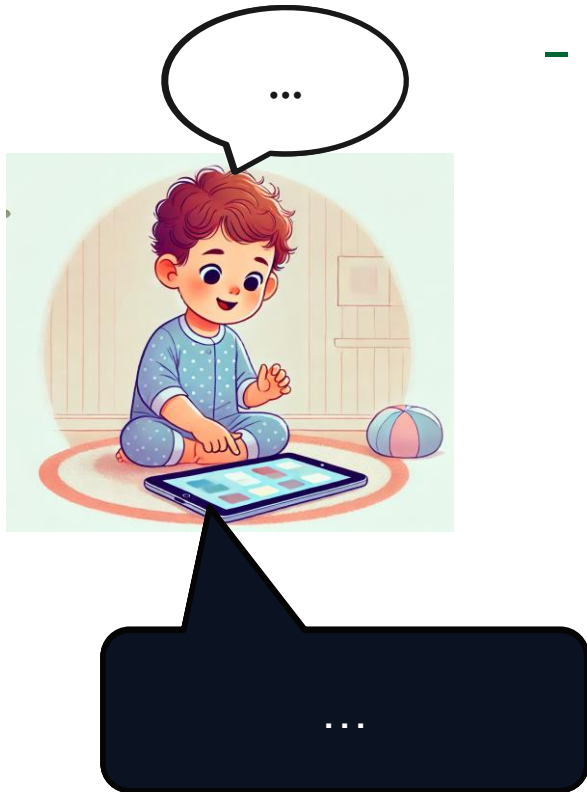
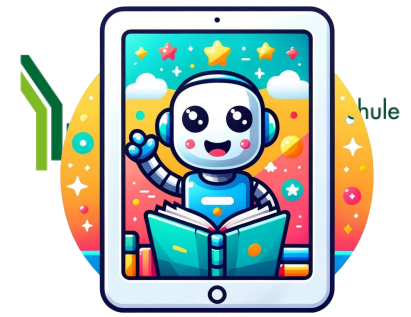
Our Approach: Dialogic Reading 2.0 - With Individual AI-App







R: Wie ist denn das passiert?

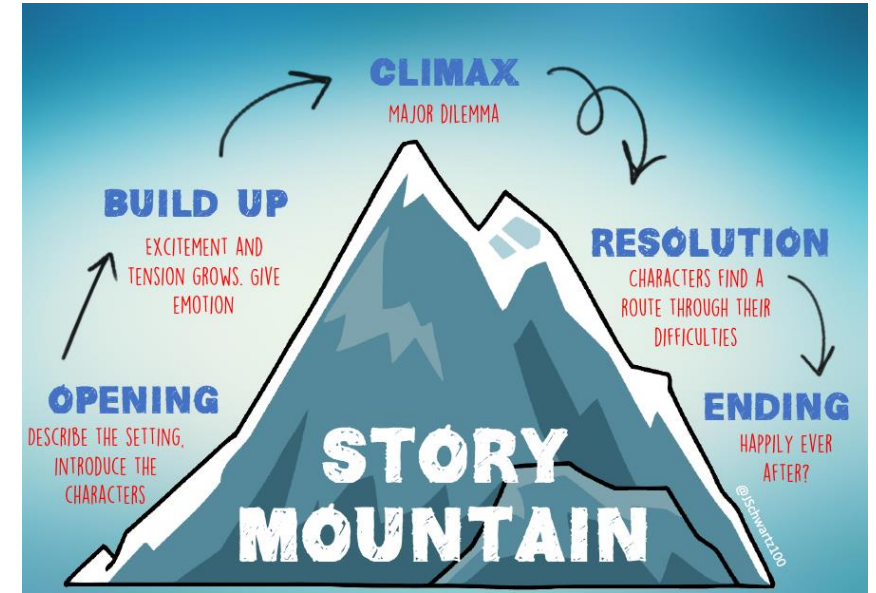


Our Approach: Dialogic Reading 2.0 - With Individual AI-App

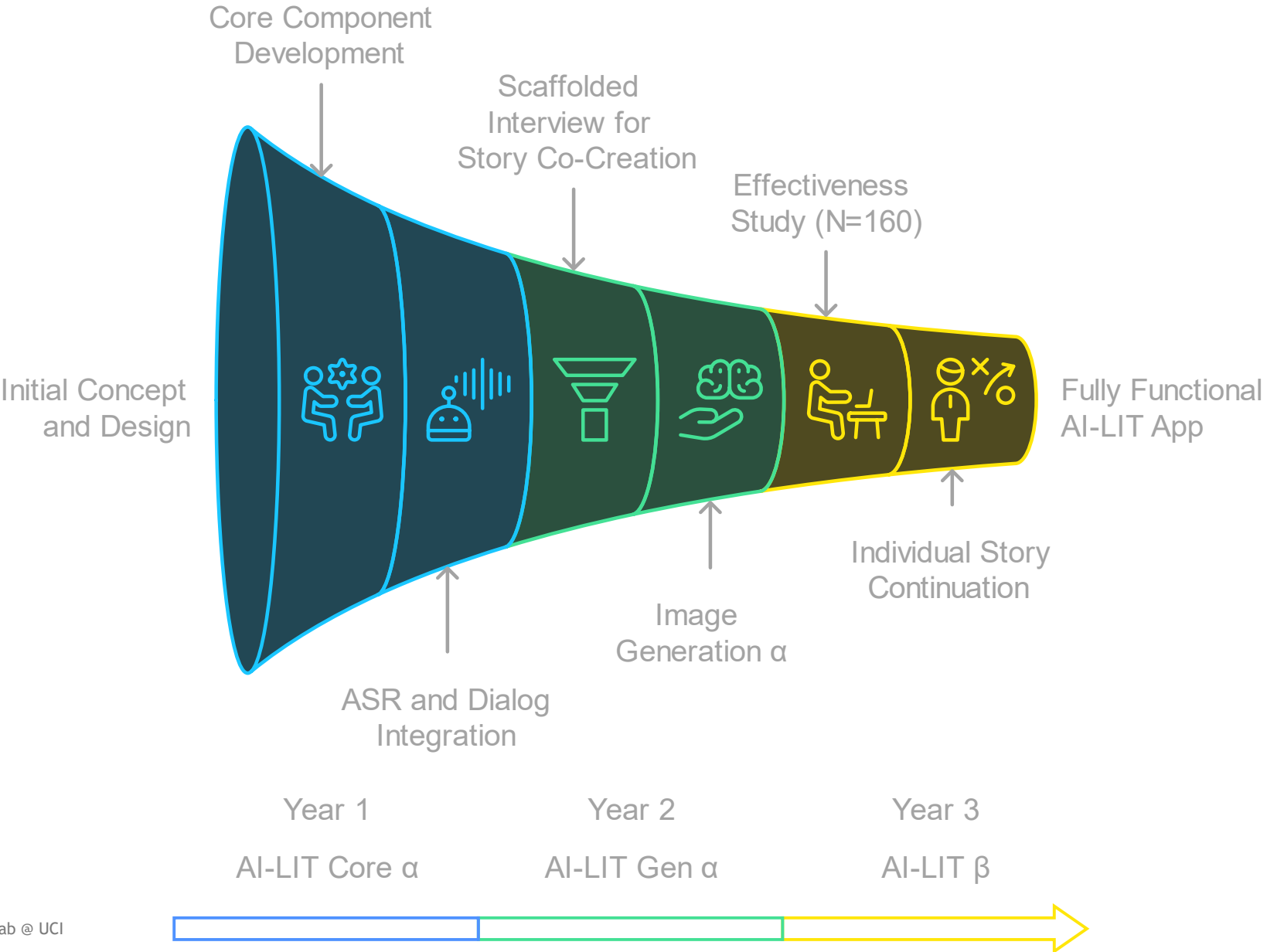


Co-Creation: Professionals and Kids can Create Their Own Stories With Scaffolded AI

-  co-create the story
-  automatic picture book creation
-  actively participate: decide how it continues
-  input enrichment: educators can align the story with children's language development



Schedule and Milestones





Child ASR

- How good is the German child ASR with 2.5–4-year-olds?
 - In recognizing malformed/incorrect language?



Dialog

- LLMs vs traditional conversational agents



Co-creation of the story (text)

- How many degrees of freedom?
- Implement the co-creation process with respect to child-computer interaction
- Validation of the stories w.r.t. linguistic adequacy, interest, arc of tension ...



Picture book generation

- Congruency between text and pictures
- Consistency across pictures (→ <https://token-verse.github.io>)



WOLKE
WWW.WOLKE.SCHULE

WO BIETEN KI-METHODEN LÖSUNGEN FÜR FACHDIDAKTISCHE HERAUSFORDERUNGEN?

COMPUTERLINGUISTISCH FUNDIERTE KONZEPTION UND EVALUATION CURRICULAR VERANKERTERT LEHRVERANSTALTUNGEN FÜR DIE SPRACH- UND MINT-DIDAKTIK

finanziert vom



Baden-Württemberg

MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST



PH Schwäbisch Gmünd
University of Education



“WoLKE” (wolke.schule) is an acronym for the core of the issue addressed in the project:

*„**Wo** bieten KI-Methoden **L**ösungen für fachdidaktische Herausforderungen? Computerlinguistisch fundierte **K**onzeption und **E**valuation curricular verankerter Lehrveranstaltungen für die Sprach- und MINT-Didaktik.“*

(engl) "Where do AI methods offer solutions for didactic challenges? Computational linguistics-based design and evaluation of curriculum-based courses for language and STEM didactics."

finanziert vom



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MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

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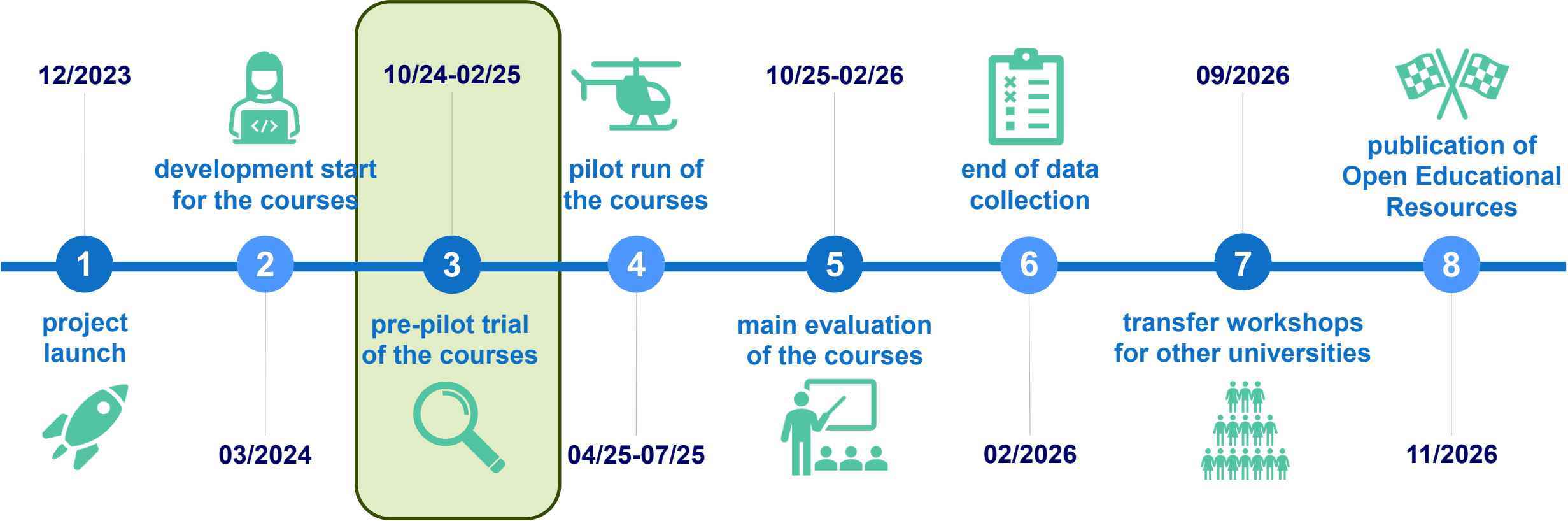
Prof. Dr. Detmar Meurers



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



Roadmap



Overview - System and Project Websites

- **Prosodiya.de**: digital spelling training for German primary school children (with and w/o developmental dyslexia)
- **COAST** (<http://coast.whysoseriousgames.de/>): web-based tool for automatic visual enhancement of reading material
- **KANSAS-Suche.de**: linguistically aware search engine for English and German teachers
- **WoLKE.schule** project: development and evaluation of seminars for student teachers on the didactically motivated and critical reflective use of AI in language and STEM teaching
- **TuCAN** (<https://tucantest.org>): tablet-based screening tool for neuropsychiatric disorders

Are You Interested in a Collaboration?

Heiko's Research Interests

- Intelligent Computer-Assisted (Language) Learning → ICA(L)L
- Digital Game-Based Learning
- Human-/Child-Computer Interaction
- Development and Evaluation of Digital Learning Assessment and Screenings
- Automatic Input Enhancement



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Thank You!

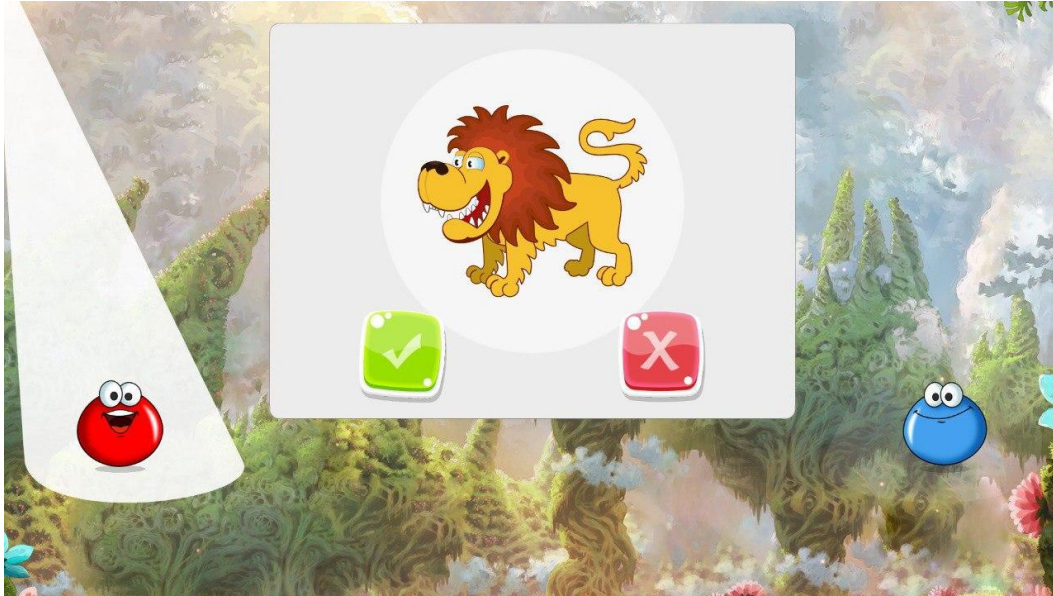


Questions?

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FURTHER PROJECTS

... SO YOU'VE HEARD OF IT



COAST

AUTOMATIC VISUAL ENHANCEMENT OF READING MATERIAL

The "Syllable Method" (Silbenmethode)

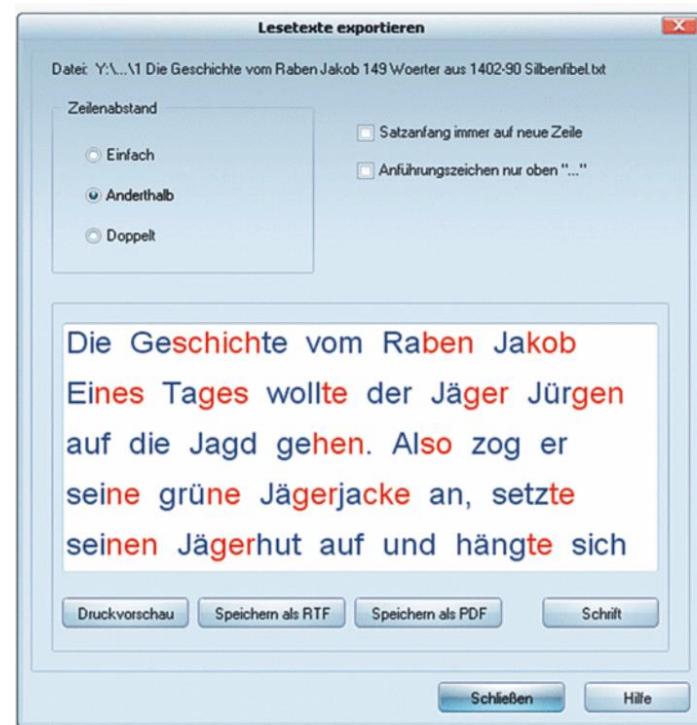
Im Land der Kängurus 

„Den **ersten** Platz hat Mio **gewonnen**.
Glück**wunsch**, Mio!“, sagt Frau Wieland
und gibt ihm die Hand.
Mio wird ein **bisschen** rot im **Gesicht**.
Er hat nicht **damit gerechnet**,
beim **Geschichtenwettbewerb**
einen Platz zu **machen**,
und schon gar nicht den **ersten**.



„Nun **wollen alle** deine **Fantasiegeschichte**
aber auch **hören**“, sagt Frau Wieland und **lächelt**.
„Mio, Mio!“, **rufen** die **anderen Kinder**
und **schlagen** mit der **flachen** Hand auf den Tisch.
Mio **nimmt** sein Heft und **beginnt** zu **lesen**:

Auszug aus „Eine Einführung in die Silbenmethode“
(Mildenberger Verlag, 2018)



ABC der Tiere - Silben-Generator
(Müller, 2013)

Stile

Aktionen



Stil auswählen

Heikofant

Stil anpassen

Name

Heikofant

Beschreibung

Heiko's Stil

Übernehmen

Vorschau

Beispieltext

Die•ser Bei•spiel•text soll Ih•nen da•bei hel•fen

neu•e Sti•le an•zu•le•gen und re•prä•sen•tiert die

ak•tu•ell ausgewählte Dar•stel•lung.

Sie kön•nen neu•e Sti•le an•le•gen, in•dem Sie

'Neu•er Stil' aus•wäh•len. Mit Hil•fe der Werk•zeu•ge

de•fi•nie•ren Sie das Er•schei•nungs•bild des Tex•tes.

Spei•chern Sie den Text, in•dem Sie ei•nen 'Na•men'

und ei•ne 'Be•schrei•bung' fest•le•gen und

an•schlie•ßend auf 'An•le•gen' kli•cken.

Werkzeuge

Farben


Hintergrundfarbe Farbe 1 Farbe 2 Farbe 3 Alternierender Stil

Schriftbild

Betonte Silbe hervorheben Silbentrennzeichen Schriftart Schriftgröße 26

Abstände

Silbenabstand 0 Buchstabenabstand 0 Wortabstand 10 Zeilenabstand 10 Zeilenlänge 51



TUCAN
TUEBINGEN
COGNITIVE ASSESSMENT FOR NEUROPSYCHIATRIC DISORDERS

TUCAN

A TABLET-BASED SCREENING TOOL FOR NEUROPSYCHIATRIC DISORDERS



kan^sas

KANSAS

LINGUISTICALLY-AWARE, USER-ORIENTED SEARCH ENGINE FOR AUTHENTIC LANGUAGE LEARNING TEXTS TO SUPPORT TEACHERS IN ALPHABETIZATION, BASIC EDUCATION AND GERMAN-AS-A-SECOND-LANGUAGE