

Technology Education considering children's needs

Evidence-based development of Inclusive materials for learning with robots
at primary level

Franz Schröder & Claudia Tenberge

1st November 2023

Presentation at The 40th Pupils' Attitudes Towards Technology Conference





„Sachunterricht“

- Primary school subject in Germany
- usual translation into *interdisciplinary science and social studies* (integrates several perspectives)
- Translation does not fit multiperspective approach (Schröder & Tenberge 2023)

→ Usage of German term „Sachunterricht“

Technology Education

- Technology as a realm between human and nature (artifacts, problems, processes, values etc.) (Mitcham 1994; de Vries 2018)
- One of multiple perspectives of learning about living environment
- Internationally common label *Technology Education*

→ Usage of technology education due to connectability

Learning robots

- (Ever) faster development and growing complexity of technological innovations (Schröder und Tenberge 2021)
- Robots for teaching and learning
- Serve as a artifact, medium or tool for technological learning (Janicki & Tenberge 2022)

→ *Bluebots as an example unit*



Inclusive Education

- Minimization of barriers for **all** pupils (Booth & Ainscow 2016)
- not reduced to special needs education
- Mainly pupils at risk for marginalisation
- Focus on individual potentials and needs (e.g. Pech et al. 2019)

→ *Definition focussed on heterogeneity of individuals* (Grosche 2015)

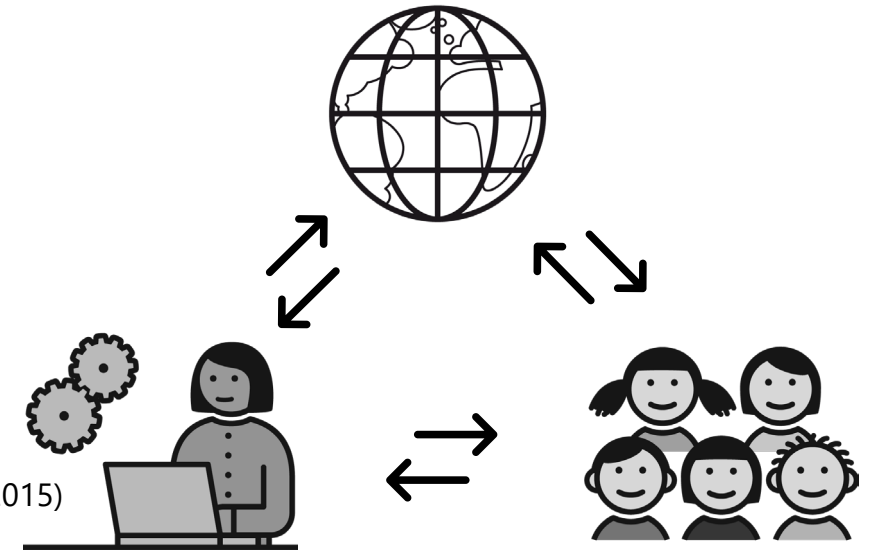




Theoretical Framework - ‚Sachunterricht‘ and Technology Education

Orientation towards pupils prerequisites well established

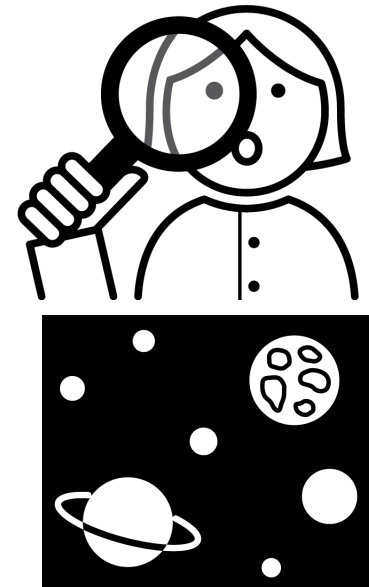
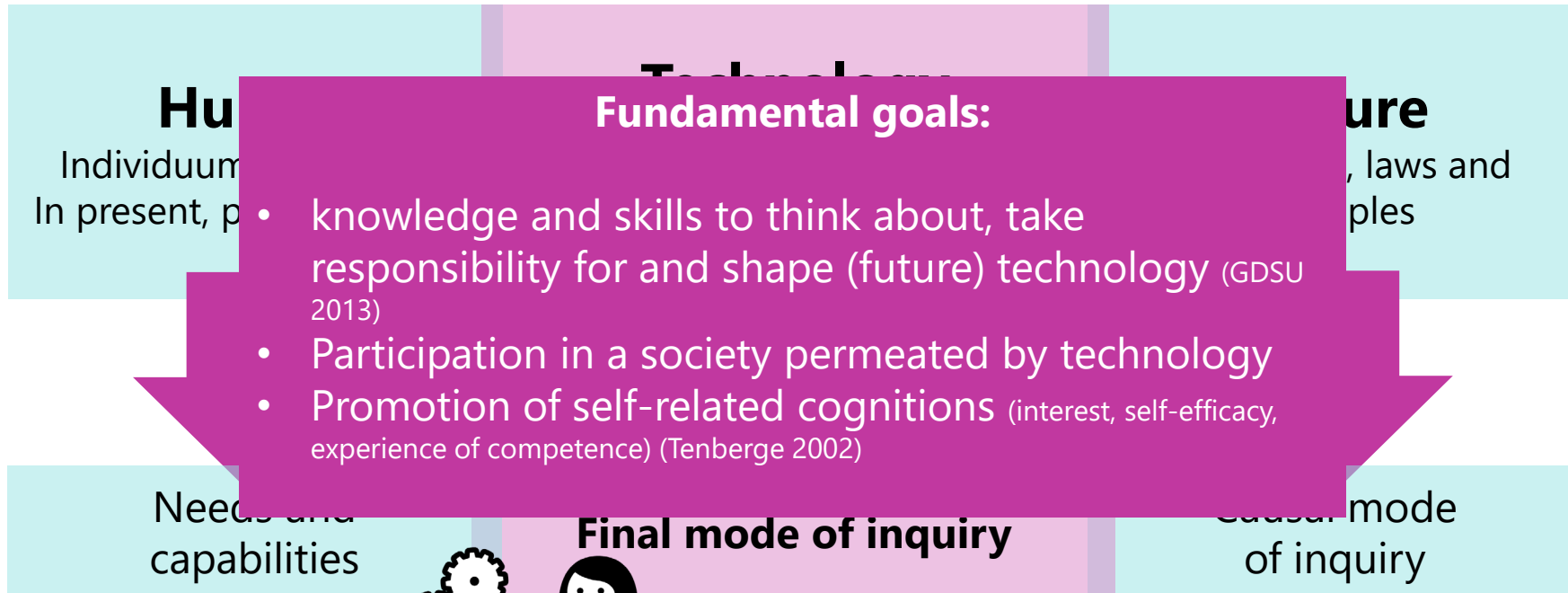
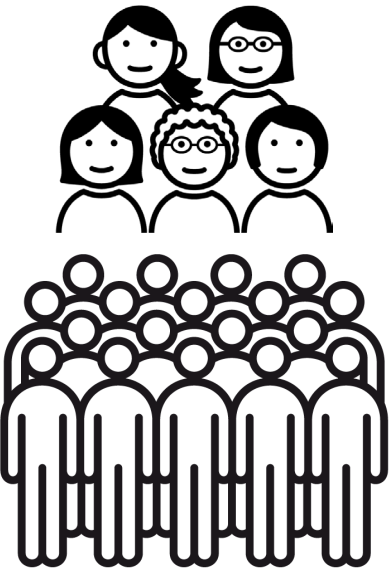
- Fundamental categories of designing teaching and learning
 - child (interests, preconceptions, ideas, questions, needs etc.; Fölling Albers 2015)
 - Living environment (relevant phenomena, artifacts, values etc.; Nießeler 2015)
 - (scientific) domain/realm (knowledge, methods, processes of inquiry; Köhnlein 2015)





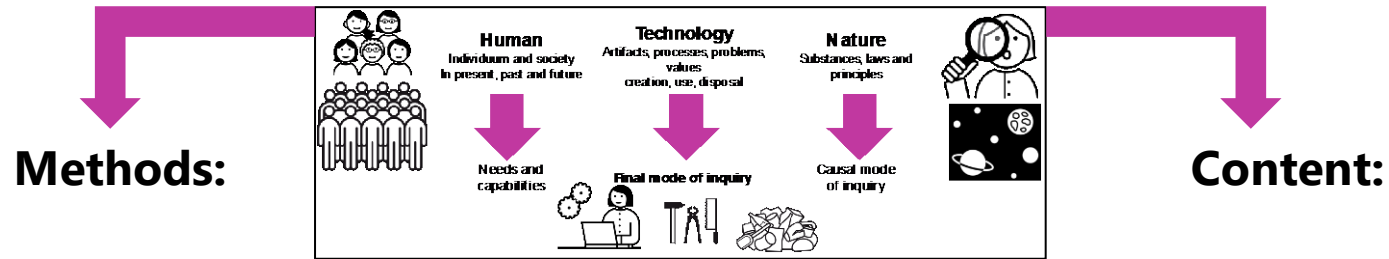
„Sachunterricht“ and Technology Education in German primary schools

Technology as a perspective to learning between human and nature





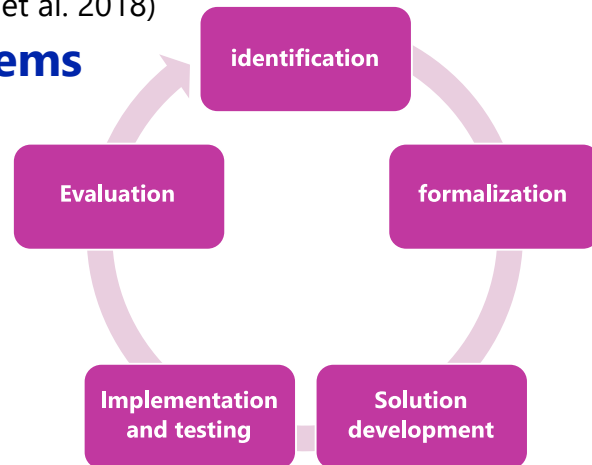
Theoretical Framework – methodical and content orientation



- Problem-orientation scaffolds cognitive activity
Planning, construction, use, evaluation
→ **technological problemsolving**

(Mammes/Zolg 2015, Ahlgrimm et al. 2018)

= **learn to solve problems**



- Problems as a starting point to learning
- to real problem-based tasks
- learning in real contexts (Tenberge 2002, Beinbrech 2015)
= **learning with problems**





Problem outline - All means all (UNESCO 2008)

Research on Inclusive Education in Germany

- controversially discussed (Grosche 2015) but established topic in educational research (Dexel 2022)
- Growing recognition especially in school subject related domains of research (ibid.)
- Increasing number of publications in 'Sachunterricht' related research (Pech et al. 2019)

Yet still ...

... varying degrees of focus on children affected by marginalisation (Grosche 2015)

... varying characteristics of marginalised adressed (gender, race, cultural background, socioeconomical background, (dis-)ability etc.) (ibid.)

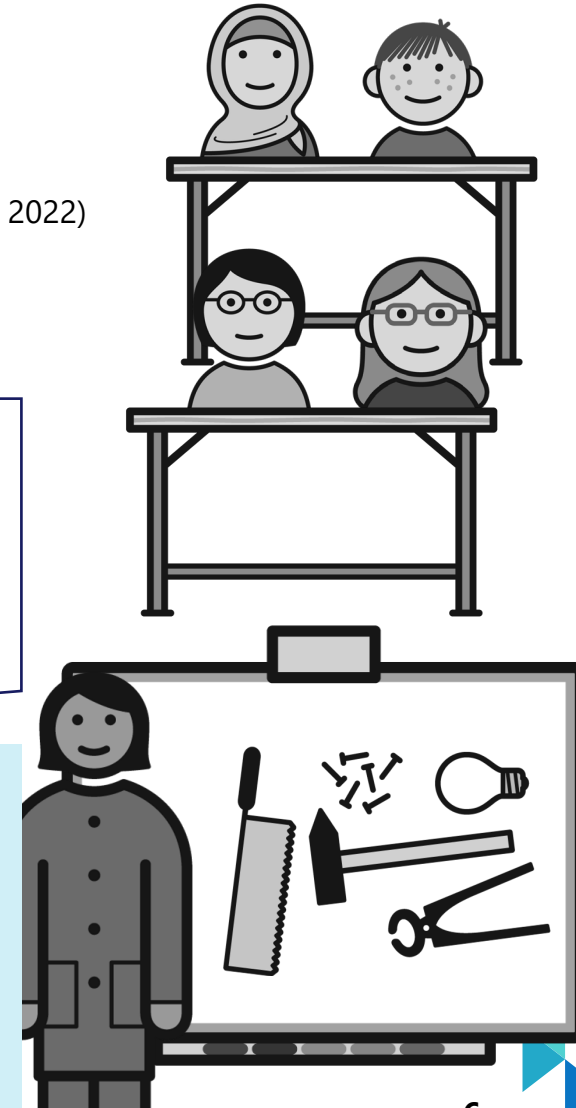
→ *Broad variety of definitions and characteristics demand definition in empirical study contexts (Grosche 2015)*

- As transformation process towards equal participation in education (e.g. Feuser 2011)
- process adressing and responding to the needs of all learners (UNESCO 2005)

Pupils (pre-)determined
attributes and
characteristics

Focus shift

Altered recognition of
Pupils individual
potentials and needs

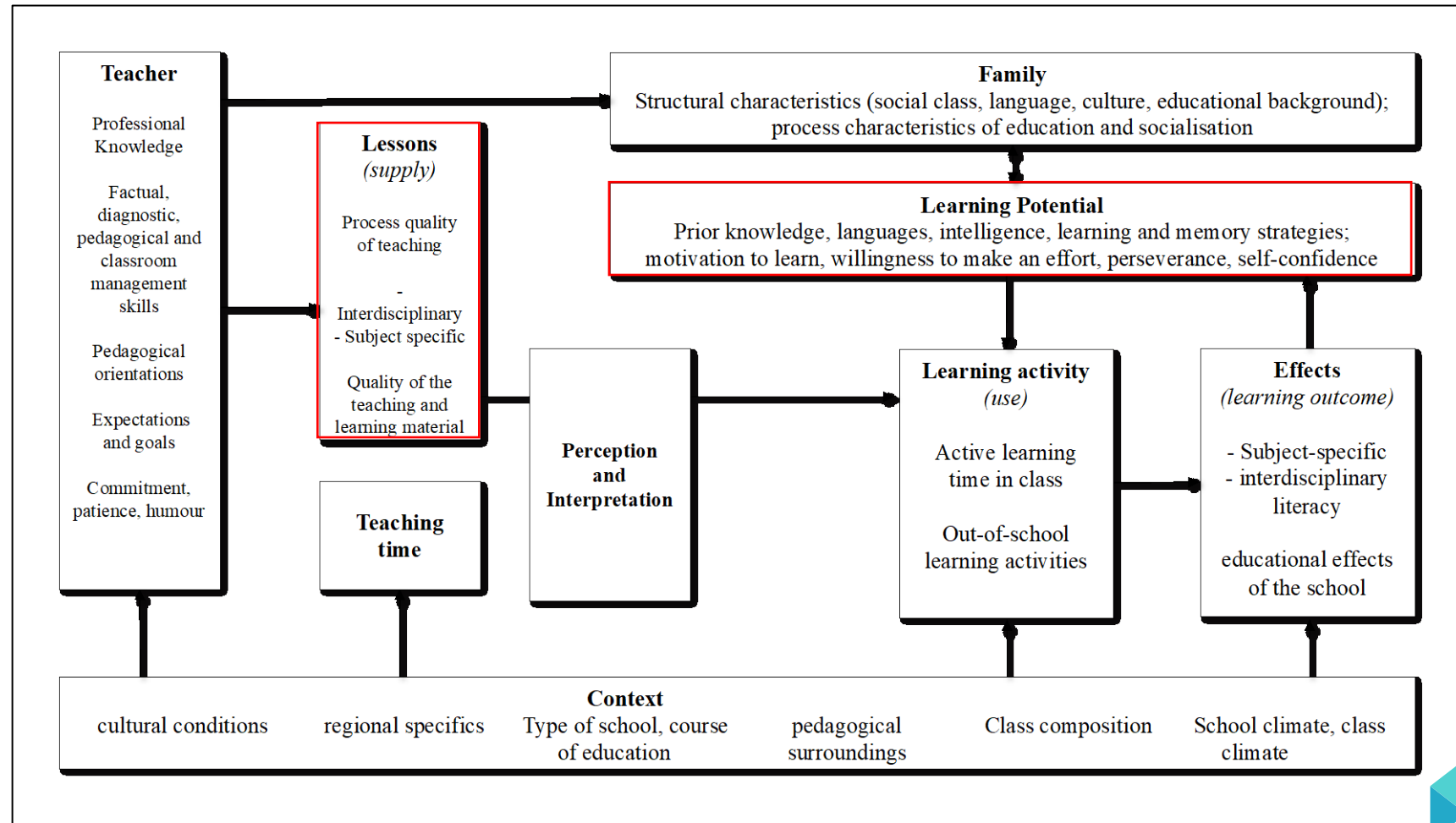




Constructivist approach to learning - supply and use

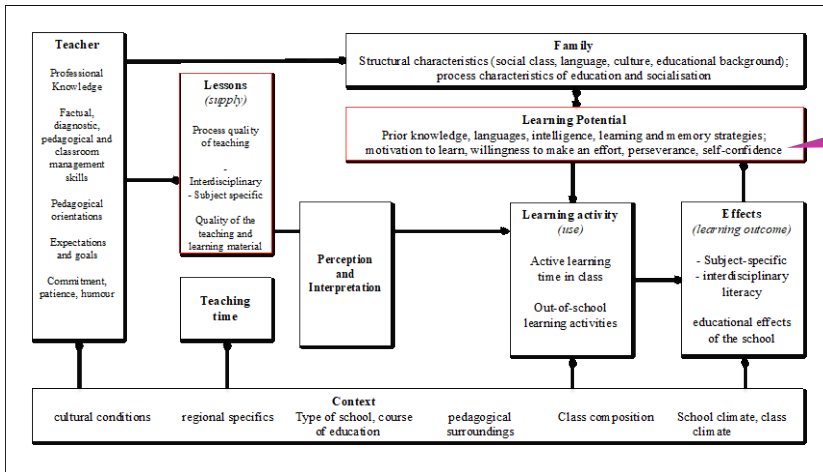
- moderate-constructivist understanding of teaching and learning (Möller 2001)
- use of learning opportunities by all pupils with their individual learning potential (Hardy et al., 2011; Simon, 2015)
- adaptive teaching reacting to diverse learning potentials

→ needs as part of a learning potential





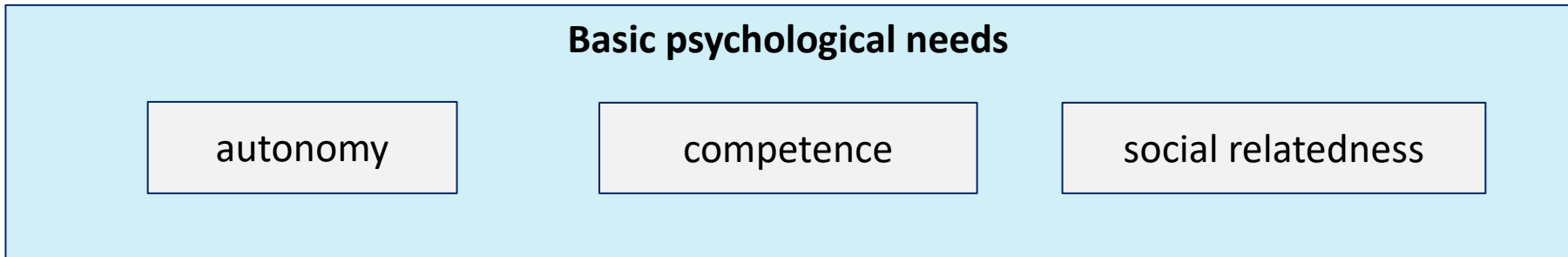
Constructivist approach to learning - supply and use



What is a need?

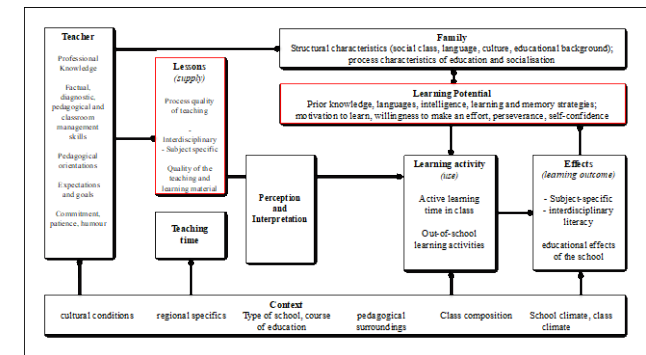
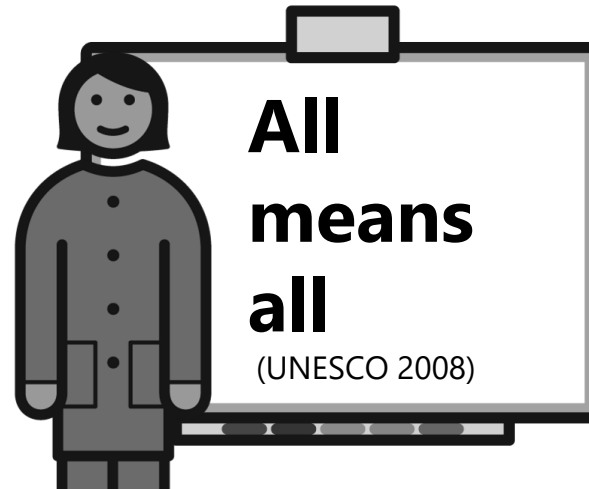
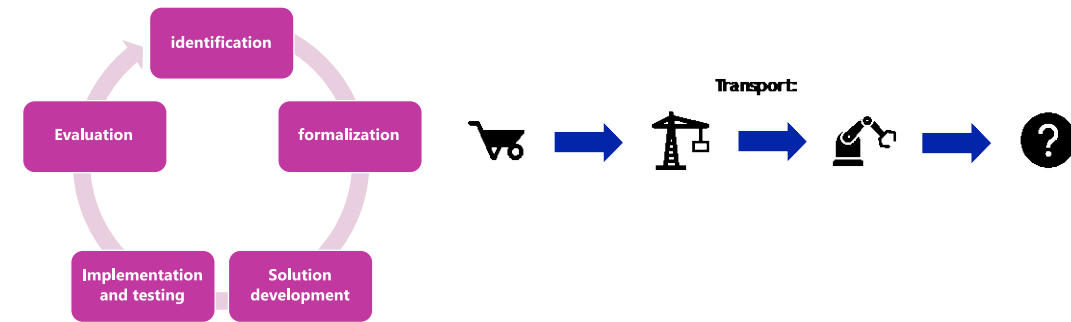
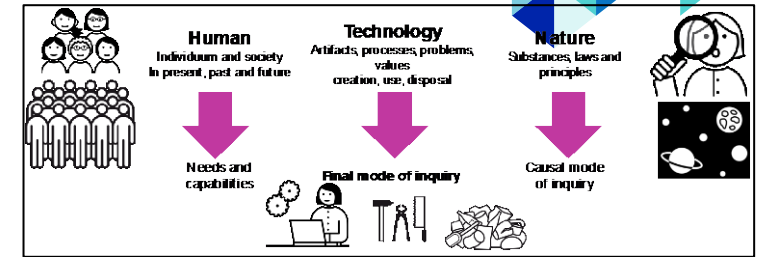
- ...psychological determinants of behaviour (Maslow 1943)
- ...used to causally reconstruct motivated or amotivated behavior (Deci & Ryan 1993; Nuttin 1994)
- ...tends to intensify or expand under favourable conditions (Krapp 2012)

→ heuristic assumption: **Needs differ among pupils and within pupils according to certain environments**



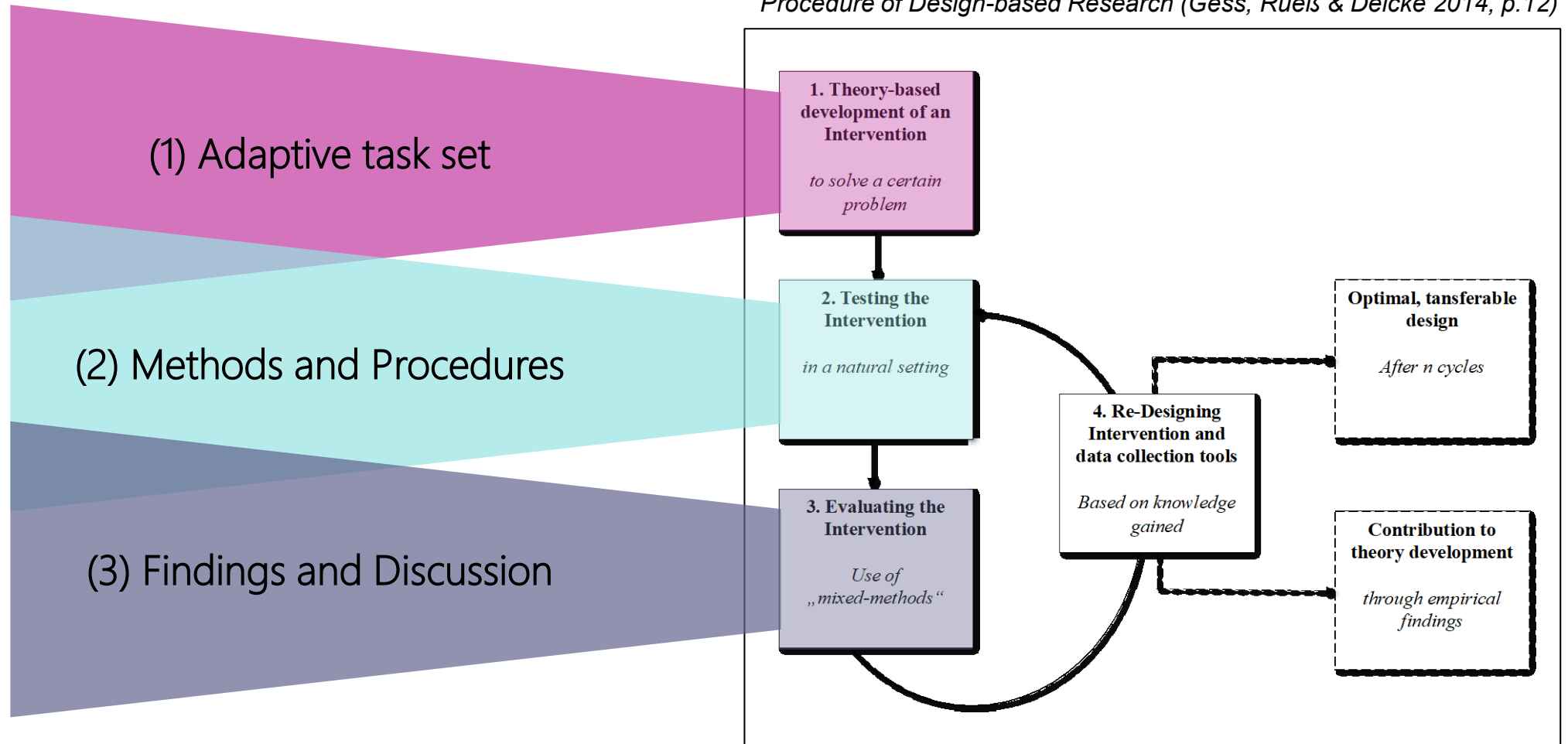
Research questions

- (i) How can an adaptive set of tasks be designed that can take diverse expressions of pupils' needs for autonomy, social relatedness, and competence into account?
- (ii) What are the learning outcomes in terms of problem-solving skills and self-related cognitions (interest, self-efficacy, experience of competence) of lessons adapted based on the tasks designed?





Methods and Procedures

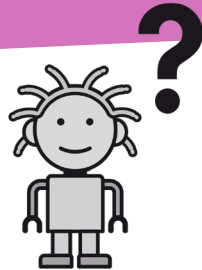




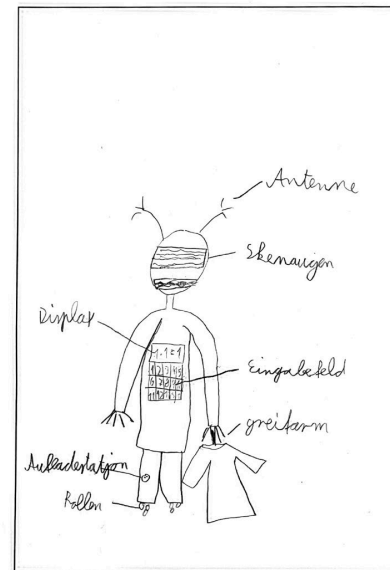
Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

(1) Adaptive task set – transformative unplugged tasks

1) human robot

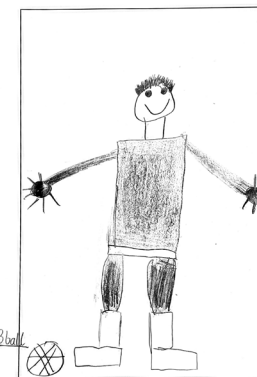
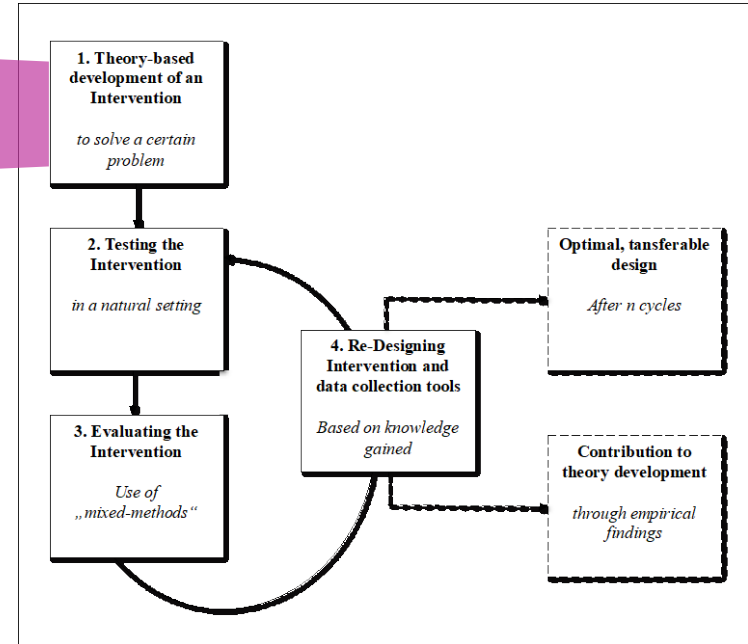


2) Draw and describe your own robot

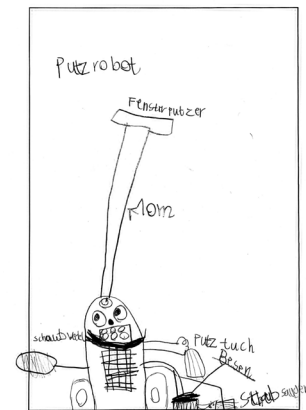


©Franz Schröer - AG Sachunterrichtsdidaktik mit sonderpädagogischer Förderung - Universität Paderborn

3) Naming useful components of a robot



©Franz Schröer - AG Sachunterrichtsdidaktik mit sonderpädagogischer Förderung - Universität Paderborn



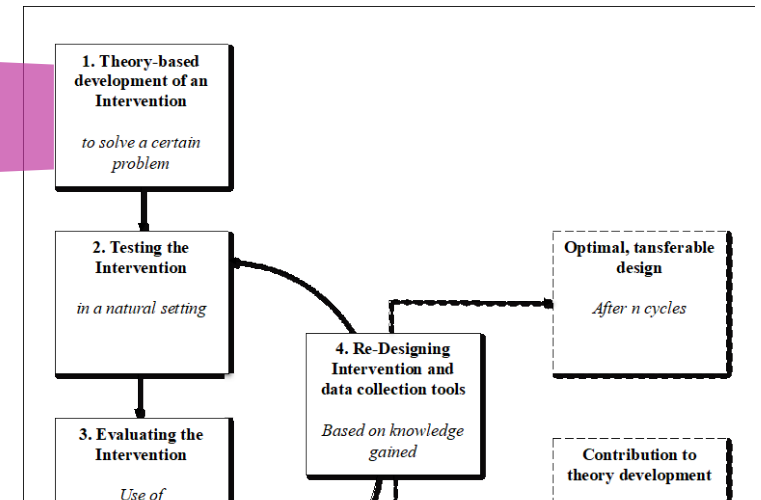
©Franz Schröer - AG Sachunterrichtsdidaktik mit sonderpädagogischer Förderung - Universität Paderborn







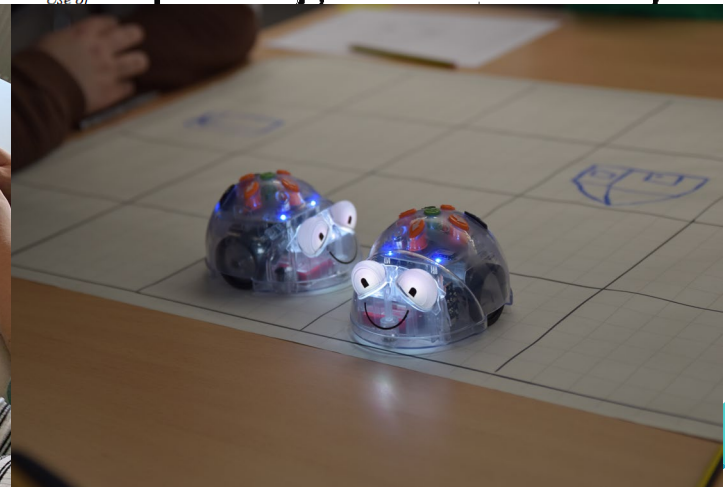


(1) Adaptive task set – transmissive plugged tasks

Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)



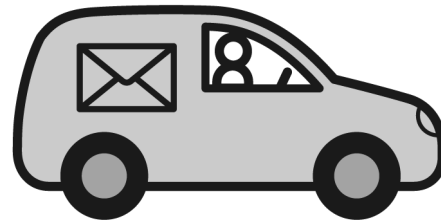
- 1) Postal service robot 
- 2) School bus robot 
- 3) Cleansing robot 
- 4) Two robots dancing 
- 5) A robot doing whatever



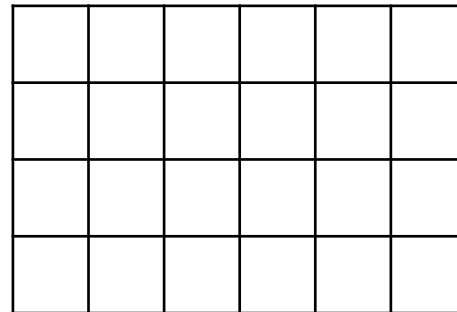


(1) Adaptive task set – transmissive plugged tasks

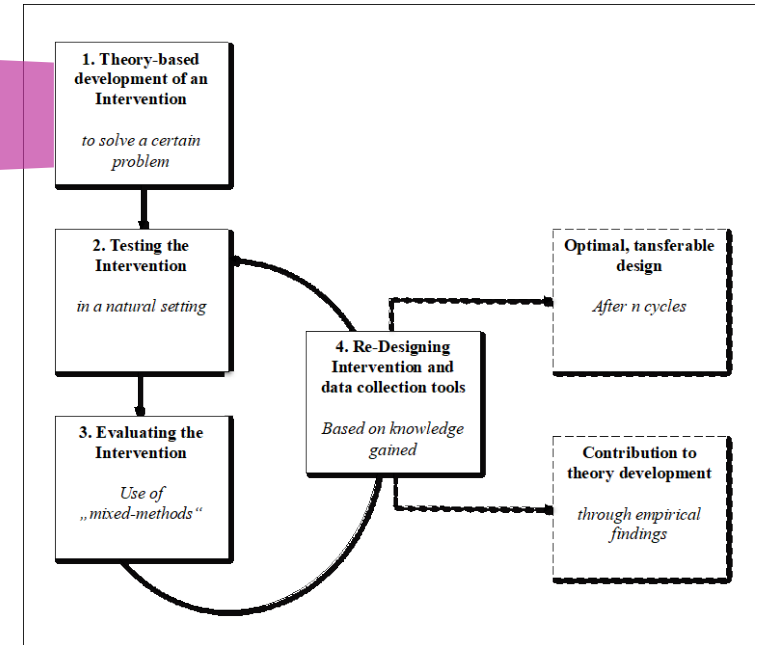
1) Postal service robot



- Varying degrees of freedom
- Multiple levels of difficulty



Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)



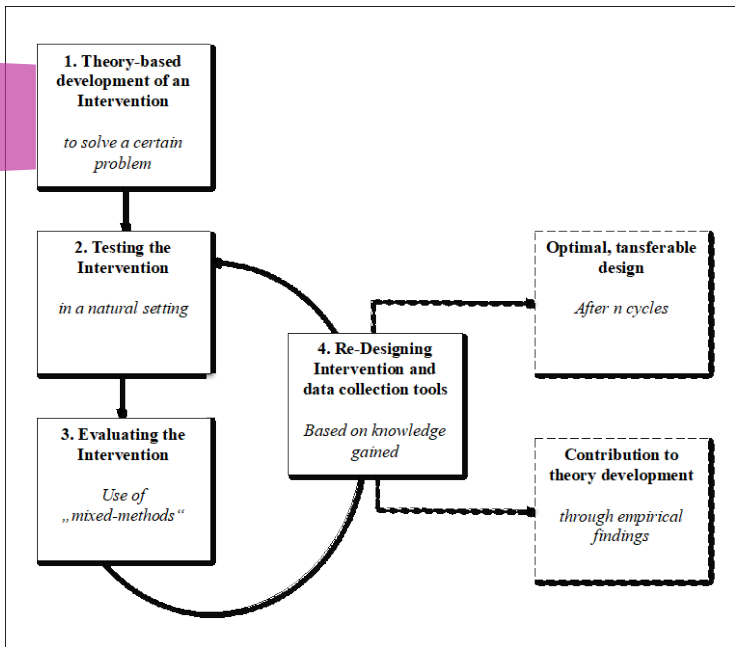
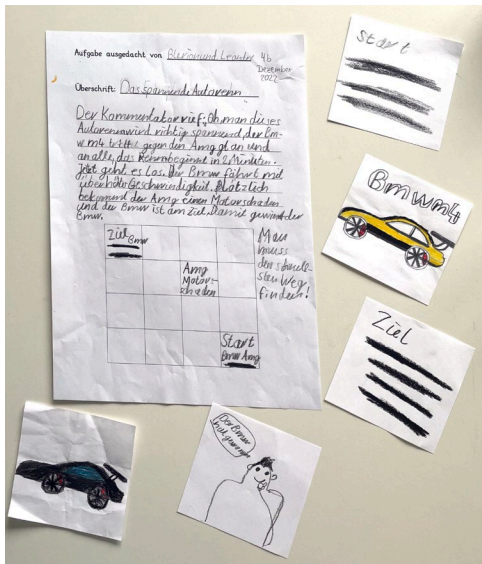


An adaptive set of tasks – transmissive plugged tasks

Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

(1) Adaptive task set – transmissive plugged tasks

5) A robot doing whatever

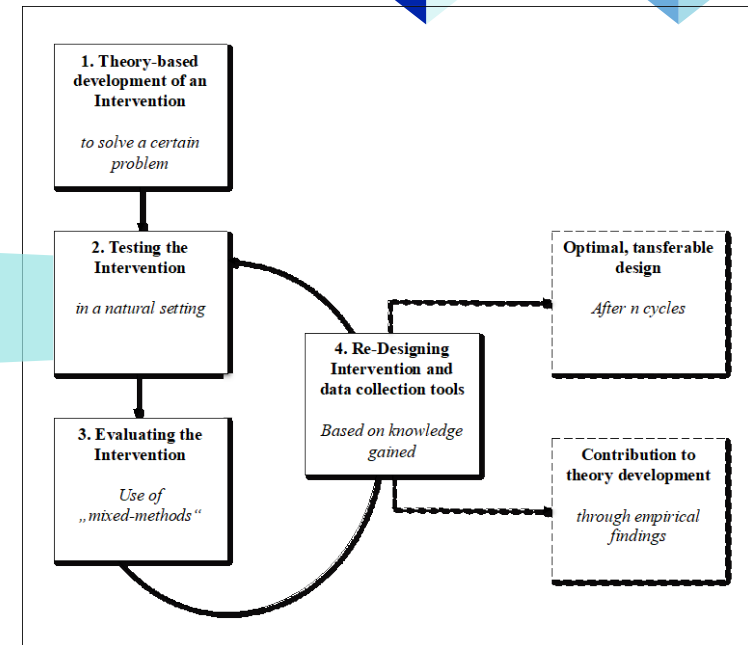
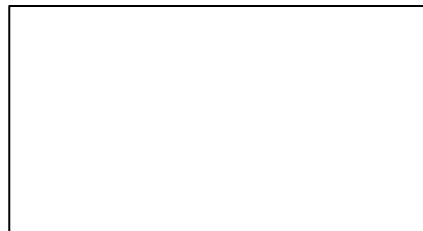


(2) Methods and Procedures

- 1st cycle with a seminar course of pre-service teachers in 2022
- Test of adapted learning environment with 3 primary school classes (**n=71**) – **second grade**

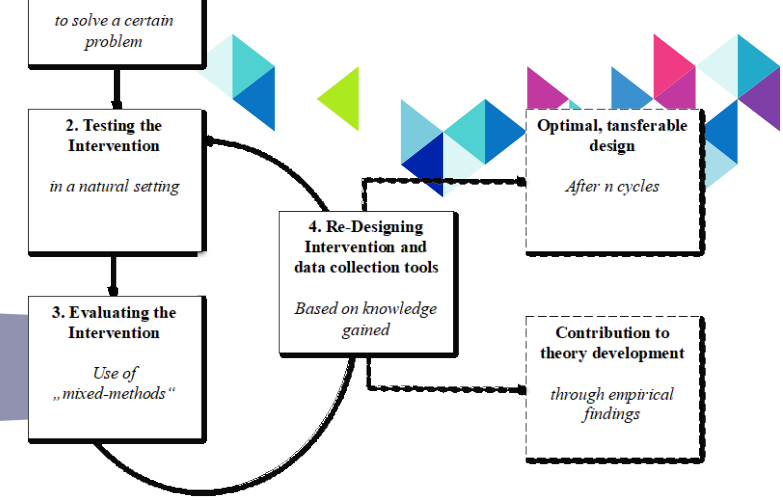
Evaluation datasets

- Problemsolving skills (pre to post)
- Self-related cognitions (situational interest, self-efficacy, experience of competence (Bohrmann 2017))
- Few smaller, not systematically raised datasets (e.g. drawings)



Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

(3) Findings and Discussion



Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

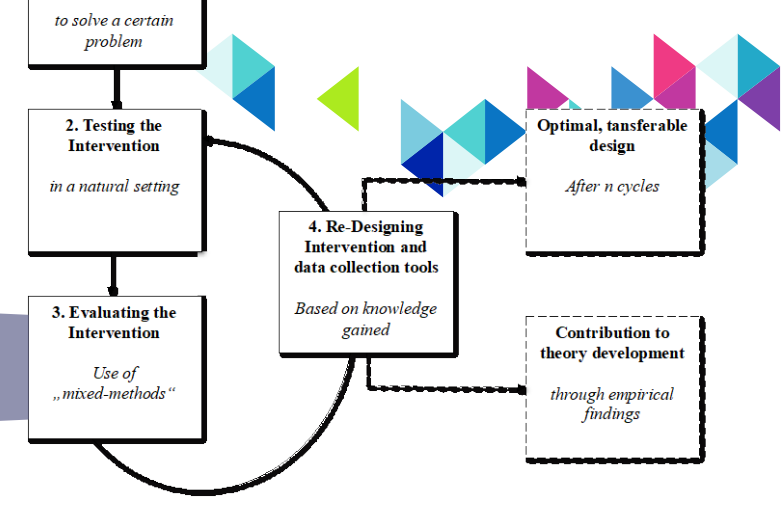
	Pretest (0-5)	Posttest (0-5)
Problemsolving skills Tower of London test 5 tasks with growing complexity	$M = 2.127$ $SD = 1.74$ $\alpha = .762$	$M = 2.953$ $SD = 1.98$ $\alpha = .870$

Find the correct pictures and write the numbers from 1 to 3 under the pictures!
Start with 1 at the starting picture.

start

goal

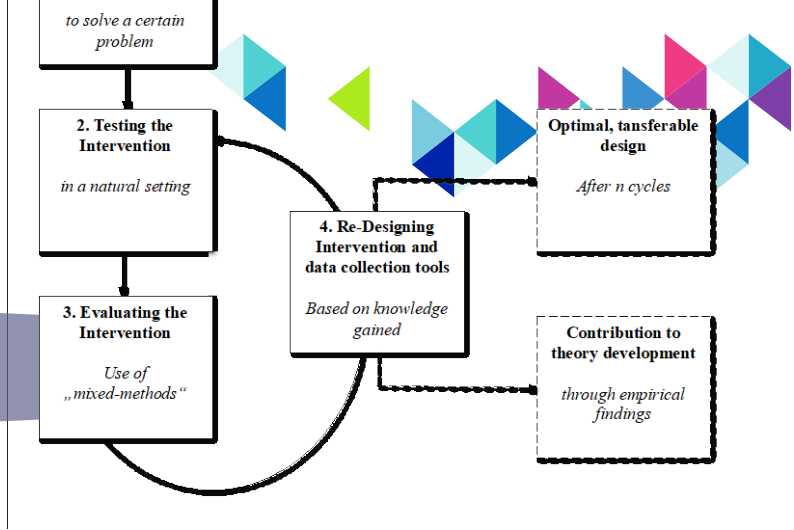
(3) Findings and Discussion



Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

Variable (number of Items)	Pre-Test Likert scale 1-4	Post-Test Likert scale 1-4	
Situational interest (5)	M = 3.067 SD = .527 $\alpha = .636$	M = 3.569 SD = .390 $\alpha = .683$	"I really want to learn more about problemsolving with robots."
Self-efficacy (5)	M = 2.963 SD = .726 $\alpha = .771$	M = 2.991 SD = .646 $\alpha = .737$	"I feel confident to answer difficult questions about robots."
Experience of competence (7)	M = 3,179 SD = .732 $\alpha = .812$	M = 3.396 SD = .448 $\alpha = .822$	"I know a lot about robots."

(3) Findings and Discussion

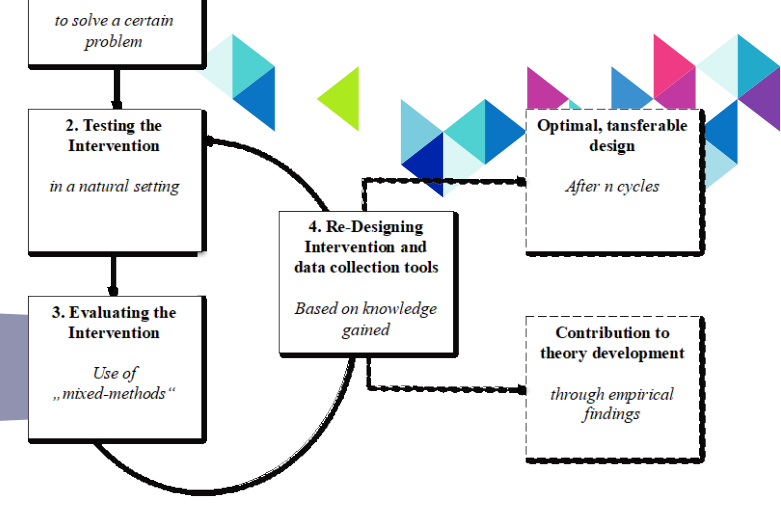


Procedure of Design-based Research (Gess, Rueß & Deicke 2014, p.12)

- comparative mean value from Bohrmann's (2017) pretest (1.6502)
- post-test mean value differs from the comparative value on a highly significant level.
- lessons are associated with a mean effect on problem-solving ability (Coh.-d = .658)

Variable	T	df	bilateral p
Problemsolving (pretest)	2,308	70	.024
Problemsolving (posttest)	5.266	63	<.001

(3) Findings and Discussion



Situational interest

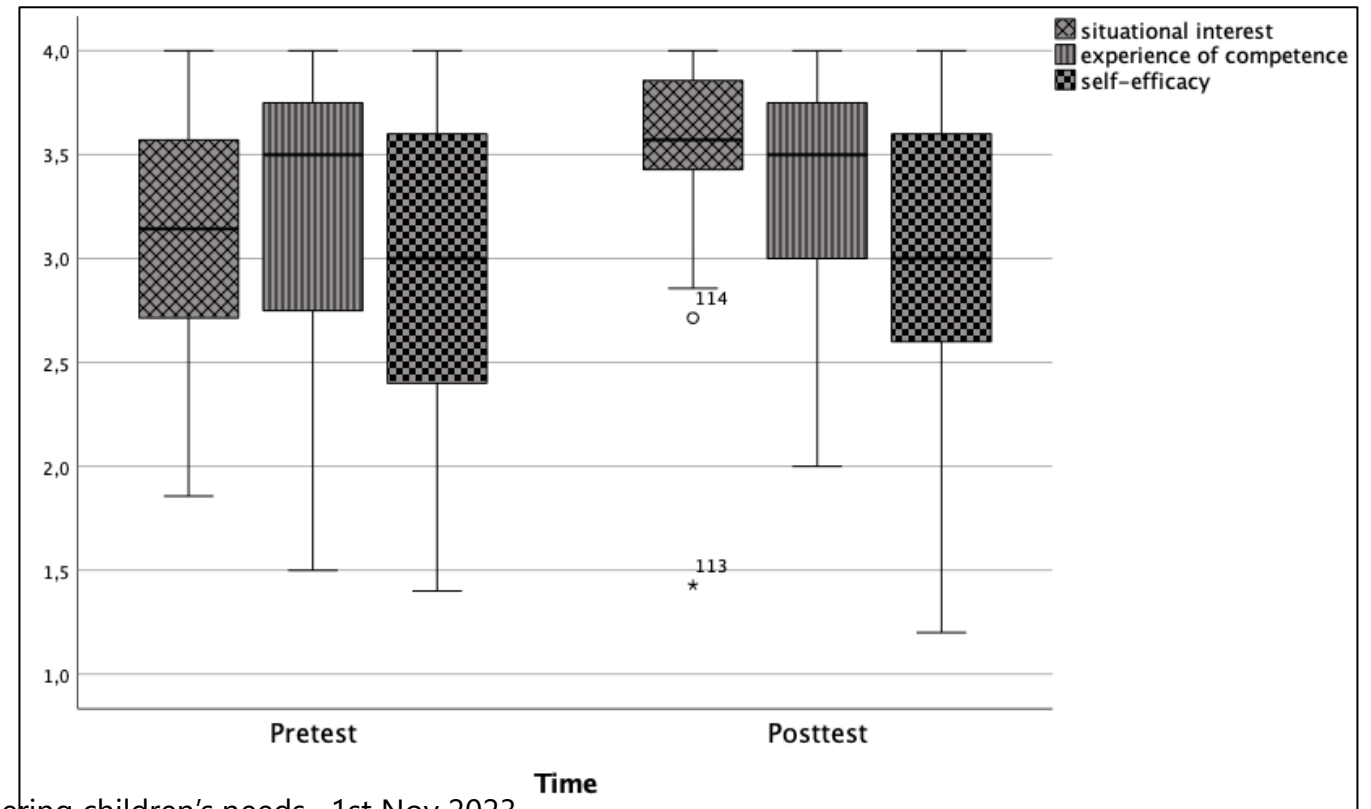
- pupils with low pre-test value seem to benefit as bottom quartile decreases

Experience of competence

- pupils with low pre-test value seem to benefit as bottom quartile decreases

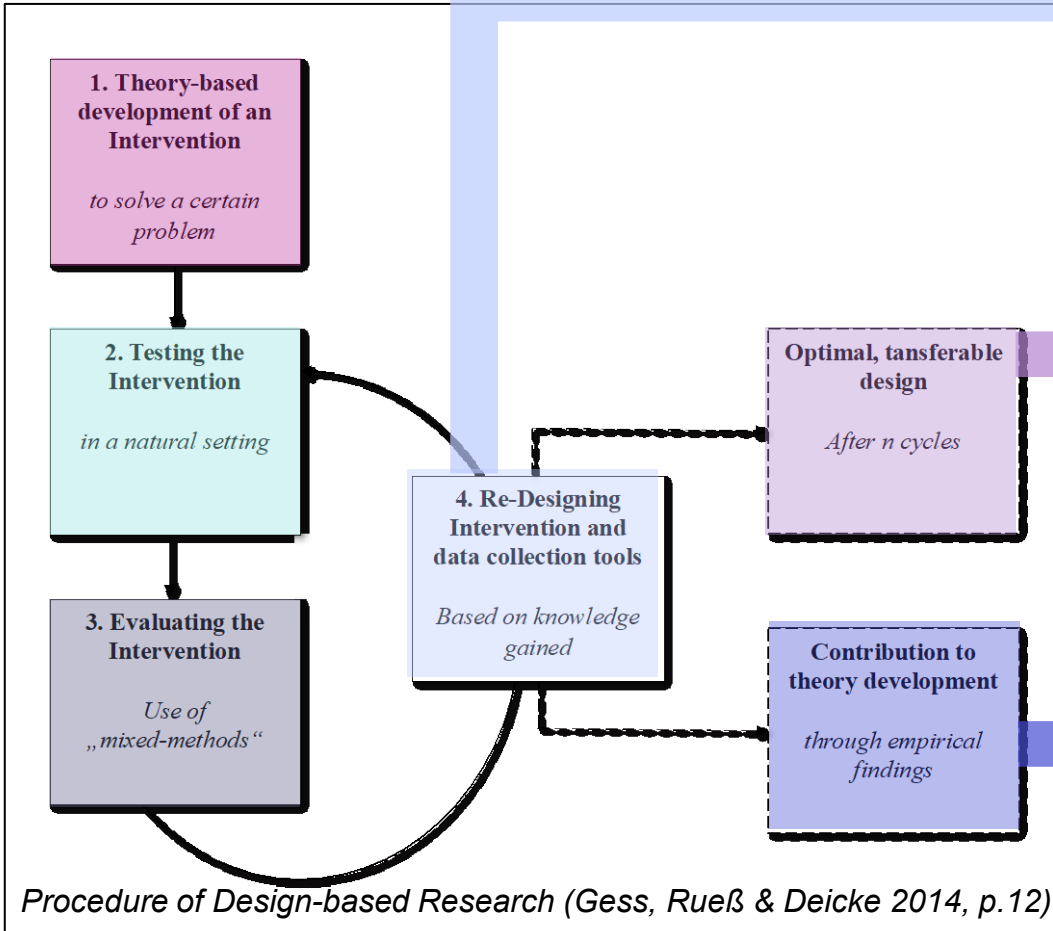
Self-efficacy

- No significant changes visible





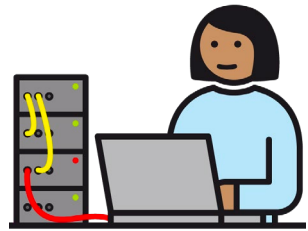
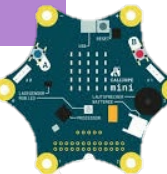
Outlook



- Implementation of further task formats to choose from for pupils and teachers (Bachelor Thesis Marena Meier)
- Find out more about how to professionalize (pre-service) teachers for adaptive teaching (Master Thesis Clara Stuckenbröker)

- Implementation to higher primary and lower secondary education using calliope mini (Seminar course this semester)
- Find out more about the characteristics of pupils needs (My PhD project)

- further empirically based knowledge about pupils needs at primary level (My PhD project)
- Contribution to hands-on and minds-on learning in a digital society (Tenberge et al. in print)





Franz Schröer

Research Associate

Chair for Primary Science and technology Education considering
special needs education

Telephone +49 5251 60-2745

Email franz.schroeer@uni-paderborn.de

Web <https://physik.uni-paderborn.de/tenberge/>

Address Warburger Str. 100, room J3.241



Claudia Tenberge

Professor

+49 5251 60-2766 **Telephone**

claudia.tenberge@uni-paderborn.de **Email**

Web

Warburger Str. 100, room J6.130 **Address**



Thank you for listening and participating!

Technology Education considering children's needs - Evidence-based development of Inclusive materials for learning with robots at primary level

Franz Schröer & Claudia Tenberge

1st November 2023

Presentation at The 40th Pupils' Attitudes Towards Technology Conference

Franz Schröer & Claudia Tenberge





Bibliography

- Ahlgrimm, A., Binder, M., Krekeler, H., Ploog, M., Wiesmüller, C. (2018). Technikkreis – ein Werkzeug für Fach- und Lehrkräfte, die Kinder beim Lösen technischer Probleme begleiten [Technology circle - a tool for professionals and teachers who accompany children in solving technological problems]. GDSU-Journal, (8), 79-89.
- Ainscow, M. (2007). Taking an inclusive turn. Journal of Research in Special Educational Needs, (7), 3-7. <https://doi.org/10.1111/j.1471-3802.2007.00075>.
- Beinbrech, C. (2003). Problemlösen im Sachunterricht der Grundschule [Problemsolving in primary education ‚Sachunterricht‘], ed. University publication (Dissertation), Münster.
- Blümer, H. (2019). Die technische Bildung im Sachunterricht an deutschen Grundschulen [Technology education in ‚Sachunterricht‘ in German primary schools], in: Koch, A.F., Kruse, S., Labudde, P. (Eds.), Zur Bedeutung der Technischen Bildung in Fächerverbänden: Multiperspektivische und interdisziplinäre Beiträge aus Europa (pp. 1-13). Springer Fachmedien, Wiesbaden,. https://doi.org/10.1007/978-3-658-25623-4_1
- Bohrmann, M. (2017). Zur Förderung des Verständnisses der Variablenkontrolle im naturwissenschaftlichen Sachunterricht, Studien zum Physik- und Chemielernen [Promote the understanding of variable control in science education, studies in physics and chemistry learning]. Logos Verlag Berlin, Berlin.
- Booth, T., Ainscow, M. (2016). The Index for Inclusion: a guide to school development led by inclusive values, Fourth edition. ed. Index for Inclusion Network (IfIN), Cambridge.
- De Vries, M.J. (2018). Technological Education: An international History, in: De Vries, M.J. (Ed.), Handbook of Technology Education (pp. 73-84). Springer Berlin Heidelberg, New York, NY.
- Erikson, E.H. (2003). Identität und Lebenszyklus: drei Aufsätze, Sonderausg. zum 30jährigen Bestehen der Reihe Suhrkamp Taschenbuch Wissenschaft [Identity und life cycle: three essays, special edition for the 30th anniversary of the Suhrkamp paperback science series]. ed, Suhrkamp-Taschenbuch Wissenschaft. Suhrkamp, Frankfurt am Main.
- Feuser, G. (1989). Allgemeine integrative Pädagogik und entwicklungslogische Didaktik [General integrative pedagogy and developmental logic] [134]. Zeitschrift für Behindertenpädagogik 28 (1), 4-48.



Bibliography

- Fischer, H.-J. (2014). Lernsituationen und Aufgabenkultur im Sachunterricht [Learning situations and task culture in ‚Sachunterricht‘], in: Fischer, H.-J., Giest, H., Peschel, M., Gesellschaft für Didaktik des Sachunterrichts (Eds., pp. 17-24), Lernsituationen und Aufgabenkultur im Sachunterricht, Probleme und Perspektiven des Sachunterrichts. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Fölling-Albers, M. (2015). Kind als didaktische Kategorie [Child as a didactic category], in: Kahlert, J., Fölling-Albers, M., Götz, M., Hartinger, A., Miller, S., Wittkowske, S. (Eds.), Handbuch Didaktik Des Sachunterrichts (pp. 31-35), UTB-Schulpädagogik. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Gebauer, M., Simon, T. (2012). Inklusiver Sachunterricht konkret: Chancen, Grenzen, Perspektiven [Inclusive ‚Sachunterricht‘ in concrete terms: opportunities, limits, perspectives]. www.widerstreit-sachunterricht.de, (18), 19 pages.
- Gess, C., Rueß, J., Deicke, W. (2014). Design-based Research zur Verbesserung der Lehre an Hochschulen: Einführung und Praxisbeispiel [Design-based research to improve teaching at universities: introduction and practical example]. *Qualität in der Wissenschaft*, (8), 10-16.
- Goecke, L., Stiller, J., Schwanewedel, J. (2021). Algorithmusverständnis in der Primarstufe – Eine Studie im Kontext des Einsatzes von programmierbarem Material [Understanding algorithms in primary education - A study in the context of the use of programmable material], in: Landwehr, B., Mammes, I., Murmann, L. (Eds.), Technische Bildung im Sachunterricht der Grundschule. Elementar bildungsbedeutsam und dennoch vernachlässigt? (pp. 117-132). Verlag Julius Klinkhardt, <https://doi.org/10.35468/5869-07>
- Grosche, M. (2015). Was ist Inklusion? [What is inclusion?], in: Kuhl, P., Stanat, P., Lütje-Klose, B., Gresch, C., Pant, H.A., Prenzel, M. (Eds.), Inklusion von Schülerinnen Und Schülern mit Sonderpädagogischem Förderbedarf in Schulleistungserhebungen (pp. 17-39). Springer VS, Wiesbaden.
- Hardy, I., Hertel, S., Kunter, M., Klieme, E., Warwas, J., Büttner, G., Lühken, A. (2011). Adaptive Lerngelegenheiten in der Grundschule: Merkmale, methodisch-didaktische Schwerpunktsetzungen und erforderliche Lehrerkompetenzen [Adaptive learning opportunities in primary school: characteristics, methodological-didactical focus and required teacher competences]. *Zeitschrift für Pädagogik - Individuelle Förderung und Lernen in der Gemeinschaft*, (57), 19-34. https://doi.org/10.1007/978-3-658-04479-4_2



Bibliography

- Helmke, A. (2021). Unterrichtsqualität und Lehrerprofessionalität: Diagnose, Evaluation und Verbesserung des Unterrichts [Teaching quality and teacher professionalism: diagnosis, evaluation and improvement of teaching], (8. Auflage. Ed.), Schule weiterentwickeln, Unterricht verbessern Orientierungsband. Klett / Kallmeyer, Hannover.
- Hinz, A. (2011). Inklusive Pädagogik—Vision und konkretes Handlungsprogramm für den Sachunterricht? [Inclusive pedagogy - a vision and a concrete programme of action for 'Sachunterricht'] In H. Giest, A. Kaiser, & C. Schomaker (Eds.), Sachunterricht – Auf dem Weg zur Inklusion (pp. 23-38) Verlag Julius Klinkhardt, Bad Heilbrunn.
- Köhnlein, W. (2015). Sache als didaktische Kategorie [Domain as a didactic category], in: Kahlert, J., Fölling-Albers, M., Götz, M., Hartinger, A., Miller, S., Wittkowske, S. (Eds.), Handbuch Didaktik Des Sachunterrichts (pp. 36-40), UTB Schulpädagogik. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Köhnlein, W. (2012). Sachunterricht und Bildung [,Sachunterricht' and education]. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Lütje-Klose, B. (2013). Inklusion – Herausforderung für Schul- und Unterrichtsentwicklung [Inclusion – a challenge for school and teaching development]. Pädagogik (Weinheim).
- Mammes, I. (2001). Förderung des Interesses an Technik: eine Untersuchung zum Einfluss technischen Sachunterrichts auf die Verringerung von Geschlechterdifferenzen im technischen Interesse [Promoting interest in technology: an investigation into the influence of technical subject teaching on reducing gender differences in technical interest], Europäische Hochschulschriften. Reihe XI, Pädagogik, Publications universitaires européennes. Série XI, Pédagogie ; European university studies. Series XI, Education. P. Lang, Frankfurt am Main ; New York.
- Mammes, I., Zolg, M. (2015). Technische Aspekte [Technological aspects], in: Kahlert, J., Fölling-Albers, M., Götz, Margarete, Hartinger, A., Wittkowske, S. (Eds.), Handbuch Didaktik Des Sachunterrichts (pp. 143-149), UTB Schulpädagogik. Klinkhardt, Bad Heilbrunn.
- Mitcham, C. (1994). Thinking through technology: the path between engineering and philosophy. University of Chicago Press, Chicago.
- Möller, K. (2021). Einleitung [Introduction], in: Möller, K., Tenberge, C., Bohrmann, M. (Eds.), Die technische Perspektive konkret, Begleitbände zum Perspektivrahmen Sachunterricht (pp. 11-18). Verlag Julius Klinkhardt, Bad Heilbrunn.
- Möller, K. (2015). Handlungsorientierung im Sachunterricht [Activity orientation in ,Sachunterricht'], in: Kahlert, J., Fölling-Albers, M., Götz, M., Hartinger, A., Miller, S., Wittkowske, S. (Eds.), Handbuch Didaktik des Sachunterrichts (pp. 403-407), UTB Schulpädagogik. Verlag Julius Klinkhardt, Bad Heilbrunn.



Bibliography

- Möller, K. (2012). Konstruktion vs. Instruktion oder Konstruktion durch Instruktion? Konstruktionsfördernde Unterstützungsmaßnahmen im Sachunterricht [Construction vs. instruction or construction through instruction? Support measures that promote construction in the teaching of ‚Sachunterricht‘], in: Giest, H., Heran-Dörr, E., Archie, C. (Eds.), Lernen Und Lehren Im Sachunterricht - Zum Verhältnis von Konstruktion Und Instruktion (pp. 37-50). Julius Klinkhardt, Kempten.
- Möller, K. (1998). Kinder und Technik [Children and Technology], in: Brügelmann, H. (Ed.), Kinder Lernen Anders. Vor Der Schule – in Der Schule. Libelle, Lengwil, 89-106.
- Möller, K., Hardy, I., Jonen, A., Kleickmann, T., Blumberg, E. (2006). Naturwissenschaften in der Primarstufe – Zur Förderung konzeptuellen Verständnisses durch Unterricht und zur Wirksamkeit von Lehrerfortbildungen [Science in Primary Education – On the Promotion of Conceptual Understanding through Teaching and the Effectiveness of Teacher Training Courses], in: Prenzel, M., Allolio-Näcke, L. (Eds.), Untersuchungen Zur Bildungsqualität von Schule. Abschlussbericht Des DFG-Schwerpunktprogramms BiQua (pp. 161-193). Waxmann, Münster.
- Möller, K., Wyssen, H.-P. (2018). Technische Entwicklungen und Umsetzungen erschließen – und dabei Schülervorstellungen berücksichtigen [Exploring technological developments and implementations – taking into account pupil ideas], in: Adamina, M., Kübler, M., Kalcsics, K., Bietenhard, S., Engeli, E. (Eds.), „Wie ich mir das denke und vorstelle...“: Vorstellungen von Schülerinnen und Schülern zu Lerngegenständen des Sachunterrichts und des Fachbereichs Natur, Mensch, Gesellschaft (pp. 157-174). Verlag Julius Klinkhardt, Bad Heilbrunn.
- MSB NRW (2021). Lehrpläne für die Primarstufe in Nordrhein-Westfalen [Curricula for primary education in Northrhine-westphalia]. Düsseldorf.
- MSB NRW (2020). Medienkompetenzrahmen NRW [media literacy framework Northrhine-westphalia]. Münster, Düsseldorf.
- Nießeler, A. (2015). Lebenswelt/Heimat als didaktische Kategorie [living environment/home as a didactic category], in: Kahlert, J., Fölling-Albers, M., Götz, M., Hartinger, A., Miller, S., Wittkowske, S. (Eds.), Handbuch Didaktik Des Sachunterrichts (pp. 27-31). UTB Schulpädagogik. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Reinmann, G. (2005). Innovation ohne Forschung? Ein Plädoyer für den Design-Based Research-Ansatz in der Lehr-Lernforschung [Innovation without research? A Plea for the Design-Based Research Approach in educational Research]. In: Unterrichtswissenschaft, 33(1), 52-69.
- Ropohl, G. (2009). Allgemeine Technologie: eine Systemtheorie der Technik [General technology: a systems theory of technology], (3. rev. Ed.) University press, Karlsruhe.
- Ryan, R.M., Deci, E.L. (2018). Self-determination theory: basic psychological needs in motivation, development, and wellness, The Guilford Press, New York London.



Bibliography

- Schomaker, C. (2019). Auf dem Weg zur Inklusion!? - Inklusiver Sachunterricht im Spannungsfeld von Fachdidaktik und Pädagogik [On the Way to Inclusion!? - Inclusive ‚Sachunterricht‘ in the field of tension between subject didactics and pedagogy], in: Baumert, B., Willen, M. (Eds.), Zwischen Persönlichkeitsbildung und Leistungsentwicklung. Fachspezifische Zugänge zu inklusivem Unterricht im interdisziplinären Diskurs (pp. 105-110). Julius Klinkhardt, Bad Heilbrunn.
- Schröer, F., Tenberge, C. (2023). Inclusion and the Development of Technology Education - Thinking towards an inclusive curriculum for technology education in German primary schools, in: Wooff, D., Gill, D., McLain, M., Irving-Bell, D. (Eds.), Bloomsbury Handbook of Technology Education (pp. 156-169). Bloomsbury Publishing, London.
- Schröer, F., Tenberge, C. (2022). Sachunterricht - Theorien und Konzeptionen inklusiven Sachunterrichts [‚Sachunterricht‘ - Theories and concepts of inclusive ‚Sachunterricht‘], in: Dexel, T. (Ed.), Theorien Und Konzepte Inklusiver (Fach-)Didaktik in Der Primarstufe – Ein Lehrbuch (pp. 158-185). Waxmann, Münster und New York.
- Schröer, F., Tenberge, C. (2021). Technological and Inclusive Education: Considering Students’ Needs towards Technological Learning in Primary Schools. *Techne serien - Forskning i slöjdpedagogik och slöjdvetenskap* (28), 322-331.
- Schumann, B. (2009). Inklusion statt Integration – eine Verpflichtung zum Systemwechsel [Inclusion instead of integration - a commitment to system change]; *Deutsche Verhältnisse auf dem Prüfstand des Völkerrechts. Sonderdruck Pädagogik*, (2), 51-53.
- Simon, T. (2015). Adaption – woran und wofür? Adaption als Kerngeschäft inklusionsorientierter Sachunterrichtsdidaktik [Adaptation - to what and for what? Adaptation as a core business of inclusion-oriented didactics of ‚Sachunterricht‘ education], in: Liebers, K., Landwehr, B., Marquardt, A., Schlotter, K. (Eds.), *Lernprozessbegleitung und Adaptives Lernen in der Grundschule: Forschungsbezogene Beiträge* (pp. 229-234). Springer Fachmedien Wiesbaden, Wiesbaden. https://doi.org/10.1007/978-3-658-11346-9_30
- Tenberge, C. (2002) *Persönlichkeitsentwicklung und Sachunterricht: Eine empirische Untersuchung zur Persönlichkeitsentwicklung in handlungsintensiven Lernformen im naturwissenschaftlich-technischen Sachunterricht der Grundschule* [Personality development and science teaching: An empirical study on personality development in action-intensive forms of learning in science and technology teaching in primary school]. Münster: University publication (Dissertation).
- Thomas, B. (2015). Vielperspektivischer Sachunterricht [Multi-perspective ‚Sachunterricht‘], in: Kahlert, J., Fölling-Albers, M., Götz, M., Hartinger, A., Miller, S., Wittkowske, S. (Eds.), *Handbuch Didaktik des Sachunterrichts* (pp. 249-256), UTB Schulpädagogik. Verlag Julius Klinkhardt, Bad Heilbrunn.
- Trumpa, S., Franz, E.-K. (2014). Inklusion: Aktuelle Diskussionslinien auf Makro-, Meso- und Mikroebene des Bildungssystems [Inclusion: Current lines of discussion at the macro, meso and micro levels of the education system], in: Trumpa, S., Franz, E.-K., Esslinger-Hinz, I. (Eds.), *Inklusion – Eine Herausforderung für die Grundschulpädagogik* (pp. 12-23). Schneider Verlag Hohengehren, Baltmannsweiler.