

INSTRUCTOR GUIDE

STEM Teaching: Focus on Pedagogical Approaches and Best Practices

Information

Titel	STEM Teaching: Focus on Pedagogical Approaches and Best Practices
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As part of QUADIS (Improving the Quality of Technology-Enhanced Teaching at Bavarian Universities), the teaching and learning centers from all nine Bavarian universities (members of the ProfiLehrePlus network), the Bavarian Center for Innovative Teaching and the Virtual University of Bavaria have joined forces. The project is coordinated by the Bavarian Rectors' Conference – Universität Bayern e.V. The objective is to digitize high-quality faculty development materials, while also making the process more flexible. Instructors are offered a comprehensive professional development program centered around technology-enhanced teaching in the form of blended learning seminars (BLS).

Accessibility Statement

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Evaluation

If you are a trainer conducting this blended learning seminar, we would be very pleased if you could take part in our short survey:

<https://survey.unibw.de/quadis/>

Your feedback is an important component of the project's internal quality management and helps us to further optimize our blended learning seminars and make them even more user-friendly. Thank you very much for your support.

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Introduction

Students and teachers alike often face major challenges in STEM subjects. For students, the abstractness and complexity of the content is often very different from what they learn at school, and the connection to their future careers is often not obvious - to name just two of the many difficulties. Lecturers often express frustration at the heterogeneous level of knowledge among students and sometimes seem unable to grasp the students' way of thinking. This leads to high failure and dropout rates.

This seminar explores the unique aspects of teaching STEM subjects. It enables participants to examine the common challenges in their discipline and to address them in a didactically effective way in their teaching. Participants will explore common student misconceptions and examine effective teaching methods and course formats in STEM education.

These materials have been translated from a German-language blended learning seminar (BLS) "MINT-Lehre: Didaktische Ansätze und bewährte Methoden im Fokus" with the help of DeepL and ChatGPT. The complete materials in German can be found at <https://oer.vhb.org/edu-sharing/components/collections?id=9c1d1749-af0c-4166-923e-f1afc094739f>.

The original seminar consists of 6 modules as follows:

Module	Topic	Format	Work Units (AE)
Module 1	Discovering the Challenges and Unique Features of STEM Education	synchronous	3
Module 2	Effectively Organizing STEM Education	asynchronous	2
Module 3	Recognizing and Resolving Students' Misconceptions	asynchronous	2
Module 4	Evidence-Based Approaches for STEM Teaching	asynchronous	2
Module 5	STEM Teaching Methods	asynchronous	3
Module 6	Wrap-Up	synchronous	4

Here we provide a translated version of module 3 and a shortened combination of modules 4 and 5 together as module 4, both as one H5P-File. The videos are in German language, but English subtitles can be found in the vhb repository and on YouTube. The infographics "Peer Instruction" and "Just-in-Time Teaching" can be found in English.

Target Audience and Course Objectives

This seminar is suitable for faculty in STEM subjects, regardless of their previous teaching experience.

After completing this seminar, participants will be able to:

- explain the emergence and effect of misconceptions.
- explain the differences between conceptual and conventional questions.
- describe the principle behind 'elicit, confront and resolve'.
- describe the definition and core concepts of active learning methods and their learning theory foundations.
- explain the concepts of evidence-based teaching and discipline-based educational research and apply them to their own teaching.
- describe the basic principles of inductive teaching methods (as opposed to deductive teaching methods).
- describe the basic concepts of Peer Instruction, Just-in-Time Teaching and Tutorials and recognize how these methods can improve (conceptual) understanding, correction of misconceptions and learner motivation.
- compare Peer Instruction, Just-in-Time Teaching and Tutorials and evaluate their suitability and effectiveness for their own teaching context.

Module 3: Recognizing and Resolving Students' Misconceptions

In this module the participants will become acquainted with students' misconceptions through texts, videos, and exercises. Participants will learn how to identify students' misconceptions and work with them to correct those. For this purpose, they are prompted to devise conceptual questions.

Participants are asked to email the seminar instructor their learning outcomes, suspected misconceptions, and conceptual questions upon completing the third module. In your role as the seminar instructor, you provide feedback through written comments or during one-on-one sessions. Please provide feedback by addressing the following questions, in line with the feedback given by the small group.

For the learning outcomes:

- Do the learning outcomes fall into a particular taxonomy level or competence area?
- Do the learning outcomes include specific content or behavioral components?
- Are the learning outcomes assessable?

For the misconceptions/conceptual questions:

- Are the points about the misconceptions clear?
- Is there a sufficient connection between the conceptual questions and the misconceptions?
- Does the question require conceptual understanding?
- Are all possible answers plausible?

Module 4: Evidence-Based Approaches for STEM Teaching

In this module participants explore activating teaching methods, evidence-based teaching, discipline-based education research (DBER), and inductive teaching methods through texts, videos, and exercises. Additionally, they will learn about three evidence-based, active learning approaches, namely Peer Instruction, Just-in-Time Teaching and Tutorials.

At the end of the module, we recommend that the participants are asked to consider which of the teaching methods presented - Peer Instruction, Just-in-Time Teaching and Tutorials - best fits their own teaching, the learning objectives formulated in the previous modules and their suspected misconceptions. They could create specific tasks (teaching concept, learning materials, etc.) using the chosen method, based on the learning objectives they have formulated or the misconceptions they have identified. The developed tasks (teaching concept, learning materials, etc.) could be presented in small groups in the final session and for mutual feedback.

References

The following is a list of all the works used to create this blended learning course. Artificial intelligence (ChatGPT, Perplexity) was also used to create these materials. This applies in particular to the activating elements.

Abulawi, J., Alber, I., Dürschnabel, K., Goll, C., Grabowski, S., Hampe, M., Kautz, C., Klocke, M., Knutzen, S., Mooraj, M., Müller, C., Müller, G., Müller, W., Nacken, H., Petermann, M., Riegler, P., Vörtler, S., Waldherr, F. & Zarnitz, P. (2017). Curriculare Lehre neu gestalten: Chancen und Hindernisse: Empfehlungen eines Runden Tisches Ingenieurwissenschaften des Projekts nexus der HRK.

Baily, C., Dubson, M. & Pollock, S. J. (2013). Developing tutorials for advanced physics students: Processes and lessons learned. Physics Education Research Conference Proceedings 2013. <https://arxiv.org/abs/1309.0734>

Bauer, T. & Skill, T. (2019). Einsatz von Peer Instruction zur Förderung des Beweisverständnisses in mathematischen Vorlesungen. In B. Meissner, C. Walter, B. Zinger, J. Haubner & F. Waldherr (Vorsitz), 4. Symposium zur Hochschullehre in den MINT-Fächern. Symposium im Rahmen der Tagung von Technischen Hochschule Nürnberg.

Bauer, T. & Skill, T. (2022). Mid-Proof Peer Instruction: Aufgabenkonstruktion als Herausforderung für Lehrende. In C. Maas & P. Riegler (Hrsg.), *Scholarship of teaching and learning in der Mathematik: Mathematik-Lehre forschend betrachten*. DUZ Medienhaus. <https://doi.org/10.36197/DUZOPEN.030>

Bausch, I., Biehler, R., Bruder, R., Fischer, P. R., Hochmuth, R., Koepf, W., Schreiber, S., Wassong, T. & Fischer, P. R., (Hrsg.). (2014). *Konzepte und Studien zur Hochschuldidaktik und Lehrerbildung Mathematik. Mathematische Vor- und Brückenkurse: Konzepte, Probleme und Perspektiven*. Springer Spektrum.

Benegas, J. & Flores, J. S. (2014). Effectiveness of tutorials for introductory physics in argentinean high schools. *Physical Review Special Topics - Physics Education Research*, 10(1). <https://doi.org/10.1103/PhysRevSTPER.10.010110>

Bentley, F. & Foley, T. (2010). Promoting course alignment: Developing a systematic approach to question development. University of Colorado Science Education Initiative. https://cwsei.ubc.ca/sites/default/files/cwsei/resources/instructor/PromotingCourseAlignment_CU-SEI.pdf

Bonwell, C. C. & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. George Washington University.

Bordia, D. (2021). The inductive method of teaching. Teachmint. <https://blog.teachmint.com/the-inductive-method-of-teaching/>

Brame, C. (o. D.). Just-in-Time Teaching (JiTT). Vanderbilt University Center for Teaching. <https://cft.vanderbilt.edu/guides-sub-pages/just-in-time-teaching-jitt/>

Bransford, J. D., Brown, A. L. & Cocking, R. R. (Hrsg.). (2000). *How people learn: Brain, mind, experience, and school*. National Academies Press. <https://nap.nationalacademies.org/catalog/9853/how-people-learn-brain-mind-experience-and-school-expanded-edition>

Brog, E. (2007). A theoretical background on a successful implementation of lecture-tutorials. *Astronomy Education Review*, 6(1), 50–58. <https://doi.org/10.3847/AER2007005>

Brunnhuber, M., Hank, B., Hoechstatter, K., Kämper, A. & Wolf, K. (2021). Nicht ins Leere lehren - Feedback und Interaktion in MINT-Lehrveranstaltungen. In F. Waldherr & C. Walter (Hrsg.), *Didaktisch und praktisch: Methoden und Medien für die Präsenz- und Onlinelehre* (3., überarbeitete und erweiterte Auflage, S. 169–180). Schäffer-Poeschel Verlag.

Buskist, W. & Groccia, J. E. (2011). Editors' notes. *New Directions in Teaching and Learning*, 2011(128), 1–3. <https://doi.org/10.1002/tl.462>

Buskist, W. & Groccia, J. E. (2011). Evidence-based teaching: Now and in the future. *New Directions in Teaching and Learning*, 2011(128), 105–111. <https://doi.org/10.1002/tl.473>

Camp, M. E., Middendorf, J. & Sullivan, C. S. (2010). Using Just-in-Time Teaching to motivate student learning. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), *Just-in-Time Teaching: Across the disciplines, and across the academy*. Stylus Publishing.

Center for Advancing Faculty Excellence. (o. D.). Discipline-based educational research. Missouri University of Science and Technology.

<https://cafe.mst.edu/educationalresearch/discipline-basededucationresearch/>

Center for Excellence in Teaching and Learning. (o. D.). Socratic questions. University of Connecticut. <https://cetl.uconn.edu/resources/teaching-your-course/leading-effective-discussions/socratic-questions/>

Chaudhury, S. R. (2011). The lecture. *New Directions for Teaching and Learning*, 2011(128), 13–20. <https://doi.org/10.1002/tl.464>

ChemCollective. (o. D.). *Concept Tests*. <https://chemcollective.org/tests>

Code, W., Piccolo, C., Kohler, D. & MacLean, M. (2014). Teaching methods comparison in a large calculus class. *ZDM Mathematics Education*, 46(4), 589–601.

<https://doi.org/10.1007/s11858-014-0582-2>

Cornell, D. (2023). Inductive learning: Examples, definition, pros, cons. *Helpful Professor*. <https://helpfulprofessor.com/inductive-learning/>

Crouch, C. H. & Mazur, E. (2001). Peer Instruction: Ten years of experience and results. *American Journal of Physics*, 69(9), 970–977. <https://doi.org/10.1119/1.1374249>

Cruz, É., O'Shea, B., Schaffenberger, W., Wolf, S. & Kortemeyer, G. (2010). Tutorials in introductory physics: The pain and the gain. *The Physics Teacher*, 48(7), 453–457. <https://doi.org/10.1119/1.3488188>

Derboven, W. & Winker, G. (2009). *Ingenieurwissenschaftliche Studiengänge attraktiver gestalten: Vorschläge für Hochschulen (German Edition)*. Springer.

Deslauriers, L., Schelew, E. & Wieman, C. (2011). Improved learning in a large-enrollment physics class. *Science*, 332(6031), 862–864. <https://doi.org/10.1126/science.1201783>

Deslauriers, L. & Wieman, C. (2011). Learning and retention of quantum concepts with different teaching methods. *Physical Review Physics Education Research*, 7(1). <https://doi.org/10.1103/PhysRevSTPER.7.010101>

Digitaler Freischwimmer. (o. D.). Just-in-Time Teaching (JiTT). <https://www2.tuhh.de/zll/freischwimmer/just-in-time-teaching-jitt/>

Digitaler Freischwimmer. (o. D.). Peer Instruction. <https://www2.tuhh.de/zll/freischwimmer/peer-instruction/>

Dolan, E. L., Elliott, S. L., Henderson, C., Curran-Everett, D., St. John, K. & Ortiz, P. A. (2018). Evaluating discipline-based education research for promotion and tenure. *Innovative Higher Education*, 43(1), 31–39. <https://doi.org/10.1007/s10755-017-9406-y>

Duncan, D. (2006). *Clickers in the astronomy classroom: How to enhance astronomy teaching using classroom response systems*. Pearson/Addison Wesley.

Emigh, P. J., Passante, G. & Shaffer, P. S. (2018). Developing and assessing tutorials for quantum mechanics: Time dependence and measurements. *Physical Review Physics Education Research*, 14(2). <https://doi.org/10.1103/PhysRevPhysEducRes.14.020128>

Fagen, A. P., Crouch, C. H. & Mazur, E. (2002). Peer Instruction: Results from a range of classrooms. *The Physics Teacher*, 40(4), 206–209. <https://doi.org/10.1119/1.1474140>

Falk, S. & Marschall, M. (2021). Abbruch des Erststudiums bei MINT-Studierenden: Welche Rolle spielen Informations- und Unterstützungsangebote bei Studienbeginn? In M. Neugebauer, H.-D. Daniel & A. Wolter (Hrsg.), *Studienerfolg und Studienabbruch* (S. 353–366). Springer Fachmedien Wiesbaden GmbH.

Fazio, C. (2020). Active learning methods and strategies to improve student conceptual understanding: Some considerations from physics education research. In J. Guisasola & K. Zuza (Hrsg.), *Challenges in Physics Education. Research and Innovation in Physics Education: Two Sides of the Same Coin*. Springer.
https://link.springer.com/chapter/10.1007/978-3-030-51182-1_2

Felder, R. M. & Brent, R. (2016). *Teaching and learning STEM: A practical guide*. Jossey-Bass.

Felder, R. M., Woods, D. R., Stice, J. E. & Rugarcia, A. (2000). The future of engineering education: II. Teaching methods that work. *Chemical Engineering Education*, 34(1), 26–39.
<https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=5fb8f2c1991f2316ff1941ffde7194556cf6d09e>

Formica, S. P., Easley, J. L. & Spraker, M. C. (2010). Transforming common-sense beliefs into Newtonian thinking through Just-In-Time Teaching. *Physical Review Special Topics - Physics Education Research*, 6(2). <https://doi.org/10.1103/PhysRevSTPER.6.020106>

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, 111(23), 8410–8415. <https://doi.org/10.1073/pnas.1319030111>

Fuhrmann, T. A. & Kautz, C. (2022). Understanding of differential equations in a highly heterogeneous student group. In H.-M. Järvinen, S. Silvestre, A. Llorens & B. Nagy (Hrsg.), *Proceedings of the SEFI 50th Annual Conference, 2022: Towards a new future in engineering education, new scenarios that European alliances of tech universities open up*. (S. 288–297). Universitat Politècnica de Catalunya. <https://doi.org/10.5821/conference-9788412322262.1280>

FutureLearn. (2021). How to effectively teach STEM subjects in the classroom.
<https://www.futurelearn.com/info/blog/effectively-teach-stem-subjects>

Galindo, J. H. (o. D.). Revealing & dealing with misconceptions. Harvard Graduate School of Education. <https://ablconnect.harvard.edu/revealing-and-dealing-misconceptions>

Gavrin, A. D. (2010). Using Just-in-Time Teaching in the Physical Sciences. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), *Just-in-Time Teaching: Across the disciplines, and across the academy*. Stylus Publishing.

Gavrin, A. D., Watt, J. X., Marrs, K. A. & Blake, R. E. (Hrsg.) (2003). *Just In Time Teaching (Jitt): Using the web to enhance classroom learning*. <https://peer.asee.org/just-in-time-teaching-jitt-using-the-web-to-enhance-classroom-learning.pdf>

Goertzen, R. M., Brewe, E., Kramer, L. H., Wells, L. & Jones, D. (2011). Moving toward change: Institutionalizing reform through implementation of the Learning Assistant model and Open Source Tutorials. *Physical Review Special Topics - Physics Education Research*, 7(2). <https://doi.org/10.1103/PhysRevSTPER.7.020105>

Gomes, A. d. J., Mendes, A. J. & Marcelino, M. J. Computer Science Education Research: An overview and some proposals. In R. Queirós (Hrsg.), *Innovative teaching strategies and new learning paradigms in computer programming* (S. 1–29). <https://doi.org/10.4018/978-1-4666-7304-5.ch001>

Gonzalez, J. (2014). How to teach an inductive learning lesson. *Cult of Pedagogy*. <https://www.cultofpedagogy.com/inductive-learning/>

Green, P. J. (2002). *Peer instruction for astronomy*. Pearson Education.

GSI Teaching & Resource Center. (o. D.). Social constructivism. Berkeley University of California. <https://gsi.berkeley.edu/gsi-guide-contents/learning-theory-research/social-constructivism/>

Guertin, L. (2023, 28. November). Just-in-Time Teaching (JiTT) WarmUp activity: Life on the moon and mars. SERC Pedagogic Service. <https://serc.carleton.edu/introgeo/justintime/examples/lifemoonmars.html>

Guertin, L., Ormand, C., Novak, G., Gavrin, A., Simkins, S., Clerici-Arias, M. & Goodman, R. J. (2023, 19. Oktober). Why use Just-in-Time Teaching? <https://serc.carleton.edu/introgeo/justintime/why.html>

Guertin, L., Ormand, C., Novak, G., Gavrin, A., Simkins, S., Clerici-Arias, M. & Goodman, R. J. (2023, 21. Oktober). How to use Just-in-Time Teaching. <https://serc.carleton.edu/introgeo/justintime/how.html>

Guertin, L., Ormand, C., Novak, G., Gavrin, A., Simkins, S., Clerici-Arias, M. & Goodman, R. J. (2023, 21. Oktober). What is Just-in-Time Teaching? <https://serc.carleton.edu/introgeo/justintime/what.html>

Guertin, L., Ormand, C., Novak, G., Gavrin, A., Simkins, S., Clerici-Arias, M. & Goodman, R. J. (2023, 13. November). Example JITT activity. SERC Pedagogic Service. https://serc.carleton.edu/sp/library/justintime/examples/example_jitt_activity.html

Guertin, L., Ormand, C., Novak, G., Gavrin, A., Simkins, S., Clerici-Arias, M. & Goodman, R. J. (2024, 30. Januar). Just in Time Teaching (JiTT). SERC Pedagogic Service. <https://serc.carleton.edu/sp/library/justintime/index.html>

Guertin, L. A. (2010). Using Just-in-Time Teaching in the Geosciences. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), *Just-in-Time Teaching: Across the disciplines, and across the academy*. Stylus Publishing.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1), 64–74. <https://doi.org/10.1119/1.18809>

Halloun, I. A. & Hestenes, D. (1985). The initial knowledge state of college physics students. *American Journal of Physics*, 53(11), 1043–1055. <https://doi.org/10.1119/1.14020>

Hamilton, E., Novak, G., Patterson, E. & Self, B. (2005). Just-in-Time Teaching: Potential uses in mechanics courses. In American Society for Engineering Education (Hrsg.), 2005 annual conference proceedings. ASEE Conferences.

HAW Hamburg. (o.J.). via MINT Eine Online-Lernumgebung zur Studienvorbereitung: Für die Fächer Matenatik, Physik, Chemie, Informatik.

<https://viamint.de/Content/Frontpage/viaMINT-Flyer-Webansicht.pdf>

HD MINT. (o. D.). Just-in-Time Teaching (JiTT).

<https://www.hd-mint.de/lehrkonzepte/verstehen/just-in-time-teaching-jitt/>

HD MINT. (o. D.). Peer Instruction.

<https://www.hd-mint.de/lehrkonzepte/verstehen/peer-instruction/>

HD Mint TH Nürnberg. (2016). Just in Time Teaching an der TH Nürnberg. YouTube.

<https://www.youtube.com/watch?v=1ImPB5ghsHw>

Hefendehl-Hebeker, L. (2016). Mathematische Wissensbildung in Schule und Hochschule. In A. Hoppenbrock, R. Biehler, R. Hochmuth & H.-G. Rück (Hrsg.), Konzepte und Studien zur Hochschuldidaktik und Lehrerbildung Mathematik. Lehren und Lernen von Mathematik in der Studieneingangsphase: Herausforderungen und Lösungsansätze (S. 15–30). Springer Spektrum.

Heiner, C. & Newbury, P. (2011, 5. Dezember). Creating good clicker questions in physics and astronomy. Carl Wieman Science Education Initiative.

https://cwsei.ubc.ca/sites/default/files/cwsei/resources/workshops/ClickerQsWorkshop_HeinerNewbury.pdf

Herzfeld, J. (o. D.). Index of /~herzfeld/conceptests.

<https://people.brandeis.edu/%7Eherzfeld/conceptests/>

Herzog, U. (2016, 27. September). Spannung und Potential in der Elektrotechnik. Zentrum für Lehre und Lernen (ZLL), Technische Universität Hamburg.

<https://www2.tuhh.de/zll/blog/spannung-und-potential-in-der-elektrotechnik/>

Hestenes, D., Wells, M., Swackhamer, G., Halloun, I., Hake, R. & Mosca, E. Force Concept Inventory.

<https://web.archive.org/web/20170809233640id/http://www.sfu.ca/phys/140/FCI-Rv95.pdf>

Hochstetter, K., Libon, I., Köhler, T. & Nissler, A. (o. D.). Just-in-Time Teaching und Peer Instruction: Interaktive und lernerzentrierte Physiklehre an der Hochschule. HD MINT.

https://www.hd-mint.de/wp-content/uploads/2014/08/2014_DPG_JiTT-u-PI_HM_KH1.pdf

Hoppenbrock, A., Biehler, R., Hochmuth, R. & Rück, H.G. (Hrsg.). (2016). Konzepte und Studien zur Hochschuldidaktik und Lehrerbildung Mathematik. Lehren und Lernen von Mathematik in der Studieneingangsphase: Herausforderungen und Lösungsansätze. Springer Spektrum.

<https://doi.org/10.1007/978-3-658-10261-6>

Huang, W. (2019). Don't lecture me! A discussion of active learning with Nobel laureate Carl Wieman. Lindau Nobel Laureate Meetings. <https://www.lindau-nobel.org/al/>

IUBCITL. (2016, 6. Dezember). Brian D'Onofrio - JITT. YouTube.

<https://www.youtube.com/watch?v=RAKboG-uPqs>

Jiang, S. & Lamm, M. (o. D.). Inductive Teaching. Iowa State University of Science and Technology. <https://www.engineering.iastate.edu/alit/inductive-teaching/>

Jones, M. E., Antonenko, P. D. & Greenwood, C. M. (2012). The impact of collaborative and individualized student response system strategies on learner motivation, metacognition, and knowledge transfer. *Journal of Computer Assisted Learning*, 28(5), 477–487.
<https://doi.org/10.1111/j.1365-2729.2011.00470.x>

Kaduk, S. & Lahm, S. (2018). "Decoding the Disciplines": ein Ansatz für forschendes Lehren und Lernen. In J. Lehmann & H. A. Mieg (Hrsg.), *Forschendes Lernen: Ein Praxisbuch* (S. 83–95). Verlag der Fachhochschule Potsdam.

Kamph, T., Salden, P., Schupp, S., Kautz, C. (2013). Just-In-Time Teaching für Software-Engineering. In Tagungsband des 13. Workshops "Software Engineering im Unterricht der Hochschulen". <https://dblp.org/rec/conf/seuh/KamphSSK13.html>

Kaufmann, D. (2017). *Gute Lehre in den Naturwissenschaften: Der Werkzeugkasten: Einfach, Schnell, Erfolgreich*. Springer.

Kautz, C., Neubersch, D., Direnga, J. & Riegler, P. (o. D.). Concept Inventories. Abteilung für Fachdidaktik der Ingenieurwissenschaften, Technische Universität Hamburg-Harburg; Zentrum für erfolgreiches Lehren und Lernen, Ostfalia Hochschule für angewandte Wissenschaften. <https://cgi.tu-harburg.de/~zllwww/fachdidaktik/ci/?lang=de>

Kautz, C. (2014). Verständnisschwierigkeiten und Fehlvorstellungen in Grundlagenfächern des ingenieurwissenschaftlichen Studiums. In M. Rentschler & G. Metzger (Hrsg.), *Report - Beiträge zur Hochschuldidaktik: Band 44. Perspektiven angewandter Hochschuldidaktik: Studien und Erfahrungsberichte* (S. 81–112). Shaker Verlag.

Kautz, C. (2016). *Wissenskonstruktion : durch aktivierende Lehre nachhaltiges Verständnis in MINT-Fächern fördern: Durch aktivierende Lehre nachhaltiges Verständnis in MINT-Fächern fördern (2. überarbeitete Auflage)*. Schriften zur Didaktik der Ingenieurwissenschaften: Bd. 4. TUHH Universitätsbibliothek.
<https://doi.org/10.15480/882.1388>

Kautz, C. H., Brose, A. & Hoffmann, N. (2018). *Tutorien zur Technischen Mechanik: Arbeitsmaterialien für das Lehren und Lernen in den Ingenieurwissenschaften*. Springer.
<https://doi.org/10.1007/978-3-662-56758-6>

Kortz, K. M. & Smay, J. J. (2024, 30. Januar). Lecture tutorials. SERC Pedagogic Service.
https://serc.carleton.edu/sp/library/lecture_tutorials/index.html

Krüger, D., Parchmann, I. & Schecker, H. (Hrsg.). (2018). *Lehrbuch. Theorien in der naturwissenschaftsdidaktischen Forschung*. Springer.

Kryjevskaja, M., Boudreaux, A. & Heins, D. (2014). Assessing the flexibility of research-based instructional strategies: Implementing tutorials in introductory physics in the lecture environment. *American Journal of Physics*, 82(3), 238–250.
<https://doi.org/10.1119/1.4863160>

Kubrak, H. (2023). BLS "Interactive Lecturing": Module 5: Active Learning Methods. QUADIS. <https://oer.vhb.org/edu-sharing/components/render/4da16074-3170-43f4-9361-1090c4d3eaeed>

Kuo, E. & Wieman, C. E. (2016). Toward instructional design principles: Inducing Faraday's law with contrasting cases. *Physical Review Physics Education Research*, 12(1). <https://doi.org/10.1103/PhysRevPhysEducRes.12.010128>

Lasry, N., Mazur, E. & Watkins, J. (2008). Peer instruction: From Harvard to the two-year college. *American Journal of Physics*, 76(11), 1066–1069. <https://doi.org/10.1119/1.2978182>

Leinonen, R., Kesonen, M. H. P., Asikainen, M. A. & Hirvonen, P. E. (2017). Opiskelijoiden kokemukset tutoriaaleista fysiikan yliopisto-opetuksessa. *FMSERA Journal*, 1(1), 12–21. <https://journal.fi/fmsera/article/view/60891>

Lukes, L. A. (2015). Scope of geoscience education research (GER) and how it can be used: Community perspectives. George Mason University. https://cdn.serc.carleton.edu/files/earth_rendezvous/2015/morning_workshops/w3/eer15_ger_workshop_scope.pptx

Maier, M. H. & Simkins, S. P. (2010). Just-in-Time Teaching in combination with other pedagogical innovations. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), *Just-in-Time Teaching: Across the disciplines, and across the academy*. Stylus Publishing.

Maloney, D. P., O'Kuma, T. L., Hieggelke, C. J. & van Heuvelen, A. (2001). Surveying students' conceptual knowledge of electricity and magnetism. *American Journal of Physics*, 69(S1), S12–S23. <https://doi.org/10.1119/1.1371296>

Marrs, K. A., Blake, R. E. & Gavrin, A. D. (2003). Web-based Warm Up exercises in Just-in-Time Teaching: Determining students' prior knowledge and misconceptions in biology, chemistry, and physics. *Journal of College Science Teaching*, 33(1), 42–47. <http://www.jstor.org/stable/45048285>

Marrs, K. A. (2010). Using Just-in-Time Teaching in the biological sciences. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), *Just-in-Time Teaching: Across the disciplines, and across the academy*. Stylus Publishing.

Marrs, K. A. & Novak, G. (2004). Just-in-Time Teaching in biology: Creating an active learner classroom using the Internet. *Cell biology education*, 3(1), 49–61. <https://doi.org/10.1187/cbe.03-11-0022>

Mastascusa, E. J., Snyder, W. J., Hoyt, B. S. & Weimer, M. (2011). *Effective instruction for STEM disciplines: From learning theory to college teaching*. Jossey-Bass.

Mayer, R. E. & Fiorella, L. (Hrsg.). (2022). *Cambridge handbooks in psychology. The Cambridge handbook of multimedia learning* (Third edition). Cambridge University Press. <https://doi.org/10.1017/9781108894333>

Mazur, E. (2013). *Peer Instruction: A user's manual*. Pearson.

Mazur, E. (2017). *Peer Instruction: Interaktive Lehre praktisch umgesetzt* (G. Kurz & U. Harten, Hg.). Springer Spektrum. <https://doi.org/10.1007/978-3-662-54377-1>

McCauley, V. (2003, 17. Dezember). Interactive learning toolkit: Tools for the interactive classroom.

https://mazur.harvard.edu/sites/projects.iq.harvard.edu/files/mazur/files/talk_508.pdf

McConnell, D. (2023a, 30. November). Conceptest: Equator tilt change. SERC Pedagogic Service.

https://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/examples/conceptest_equator_tilt.html

McConnell, D. (2023b, 30. November). Conceptest: Ozone umbrella analogy. SERC Pedagogic Service.

https://serc.carleton.edu/sp/library/conceptests/examples/conceptest_ozone_umbrella_analogy.html

McConnell, D. (2023c, 30. November). What are ConcepTests? SERC Pedagogic Service.

<https://serc.carleton.edu/sp/library/conceptests/what.html>

McConnell, D. (2024, 30. Januar). ConcepTests. SERC Pedagogic Service.

<https://serc.carleton.edu/sp/library/conceptests/index.html>

McConnell, D., Steer, D., Borowski, W., Dick, J., Foos, A., Knott, J., Konigsberg, Alvin, Malone, M., McGrew, H., Owens, K. & van Horn, S. (2023a, 23. Dezember). ConcepTest: Continental Earthquakes. SERC Pedagogic Service.

<https://serc.carleton.edu/sp/library/conceptests/examples/rotation.html>

McConnell, D., Steer, D., Borowski, W., Dick, J., Foos, A., Knott, J., Konigsberg, Alvin, Malone, M., McGrew, H., Owens, K. & van Horn, S. (2023b, 23. Dezember). ConcepTest: Rotation. SERC Pedagogic Service.

<https://serc.carleton.edu/sp/library/conceptests/examples/rotation.html>

McConnell, D. A., Chapman, L., Czajka, C. D., Jones, J. P., Ryker, K. D. & Wiggan, J. (2017). Instructional utility and learning efficacy of common active learning strategies. *Journal of Geoscience Education*, 65(4), 604–625. <https://doi.org/10.5408/17-249.1>

McDermott, L. C., Heron, P. R. L., Shaffer, P. S. & P.E.G., U. W. (2015). Homework: time dependence in quantum mechanics [Preliminary First Edition].

https://journals.aps.org/prper/supplemental/10.1103/PhysRevPhysEducRes.14.020128/Supplement1_Homeworks.pdf

McDermott, L. C. & Shaffer, P. S. (1992). Research as a guide for curriculum development: An example from introductory electricity. Part I: Investigation of student understanding. *American Journal of Physics*, 60(11), 994–1003. <https://doi.org/10.1119/1.17003>

McDermott, L. C. & Shaffer, P. S. (1998). *Tutorials in introductory physics: With accompanying homework* (2. Aufl.). Prentice Hall.

McDermott, L. C. & Shaffer, P. S. (2009). *Tutorien zur Physik*. Pearson Studium.

McDermott, L. C., Shaffer, Peter, P.E.G. U. Wash. (2003). *Tutorials in Introductory Physics: Handouts*. Prentice Hall.

McDermott, L. C. (1991). Millikan Lecture 1990: What we teach and what is learned—Closing the gap. *American Journal of Physics*, 59(4), 301–315. <https://doi.org/10.1119/1.16539>

McDermott, L. C. (2001). Oersted Medal Lecture 2001: "Physics Education Research - the key to student learning". American Journal of Physics, 69(11), 1127–1137.

<https://doi.org/10.1119/1.1389280>

McGlynn, T. (2020). The Chicago guide to college science teaching. Chicago guides to academic life. The University of Chicago Press.

<https://press.uchicago.edu/ucp/books/book/chicago/C/bo27808232.html>

McKeachie, W. J. (1992). Recent research on university learning and teaching: Implications for practice and future research. Academic Medicine, 67(10).

https://journals.lww.com/academicmedicine/abstract/1992/10000/recent_research_on_university_learning_and.46.aspx

McKeachie, W. J. (1999). Teaching tips: Strategies, research, and theory for college and university teachers (10. Aufl.). Houghton Mifflin Co.

Meltzer, D. E. & Manivannan, K. (2002). Transforming the lecture-hall environment: The fully interactive physics lecture. American Journal of Physics, 70(6), 639–654.

<https://doi.org/10.1119/1.1463739>

Mglessmer, M. S. (2014). All learning is relearning. Adventures in Oceanography and Teaching. <https://mirjamglessmer.com/2014/10/15/all-learning-is-relearning/>

Michael, J. (2006). Where's the evidence that active learning works? Advances in physiology education, 30(4), 159–167. <https://doi.org/10.1152/advan.00053.2006>

Miller, R. L., Santana-Vega, E. & Terrell, M. S. (2006). Can good questions and peer discussion improve calculus instruction? PRIMUS, 16(3), 193–203.

<https://doi.org/10.1080/10511970608984146>

Mintzes, J. J. & Walter, E. M. (Hrsg.). (2020). Active learning in college science: The case for evidence-based practice. Springer. <https://doi.org/10.1007/978-3-030-33600-4>

Mohd Zaid, N., Yaacob, F. S., A Shukor, N., Mohd Said, M. N. H., Musta'amal, A. H. & Rahmatina, D. (2018). Integration of Peer Instruction in online social network to enhance higher order thinking skills. International Journal of Interactive Mobile Technologies (IJIM), 12(8), 30. <https://doi.org/10.3991/ijim.v12i8.9672>

Morel, E. (2021). Der Sokratische Dialog im Unterricht. BACKWINKEL Blog.

<https://www.backwinkel.de/blog/der-sokratische-dialog-im-unterricht/>

Muller, D. A., Bewes, J., Sharma, M. D. & Reimann, P. (2008). Saying the wrong thing: Improving learning with multimedia by including misconceptions. Journal of Computer Assisted Learning, 24(2), 144–155. <https://doi.org/10.1111/j.1365-2729.2007.00248.x>

National Academies of Sciences, Engineering, and Medicine (Hrsg.). (2018). How people learn II: Learners, contexts, and cultures. The National Academies Press.

<https://nap.nationalacademies.org/catalog/24783/how-people-learn-ii-learners-contexts-and-cultures>

National Research Council. (2003). Improving undergraduate instruction in science, technology, engineering, and mathematics: Report of a workshop. The National Academies Press. <https://doi.org/10.17226/10711>

National Research Council (Hrsg.). (2012). Discipline-based education research: Understanding and improving learning in undergraduate science and engineering. National Academies Press. <https://doi.org/10.17226/13362>

Nationales MINT-Forum. (2019). Hochschulen als MINT-Bildungsstätte und -Innovationsmotor stärken. Empfehlungen des Nationalen MINT-Forums: (Nr. 8). utzverlag GmbH.

Neugebauer, M., Daniel, H.D. & Wolter, A. (Hrsg.). (2021). Studienerfolg und Studienabbruch. Springer Fachmedien Wiesbaden GmbH.

Newbury, P. (2016, 2. Januar). Getting the most out of peer instruction. Science Edventures Reflections on teaching and learning. <https://peternewbury.org/2016/01/02/getting-the-most-out-of-peer-instruction/>

Newbury, P. & Heiner, C. (2011, 5. Dezember). Effective Peer Instruction using clickers. Carl Wieman Science Education Initiative. https://cwsei.ubc.ca/sites/default/files/cwsei/resources/workshops/PeerInstructionWorkshop_NewburyHeiner_pdf.pdf

Newbury, P. & Heiner, C. (2012). Ready, set, react! Getting the most out of peer instruction using clickers. Carl Wieman Science Education Initiative. https://cwsei.ubc.ca/sites/default/files/cwsei/resources/workshops/ReadySetReact_3fold.pdf

Nissler, A. (2016, 31. März). Peer Instruction. HD MINT open. <https://open.hd-mint.de/node/286>

Nissler, A. (2016, 20. April). Just-in-Time Teaching (JiTT). HD MINT open. <https://open.hd-mint.de/node/386>

Nissler, A., Brunnhuber, M., Hank, B., Hoechstetter, K., Kämper, A. & Wolf, K. (o. D.). Beratung und Unterstützung für Hochschullehrende im HD-MINT-Projekt. HD MINT.

Novak, G. & Patterson, E. (2010). An Introduction to Just-in-Time Teaching (JiTT). In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), Just-in-Time Teaching: Across the disciplines, and across the academy. Stylus Publishing.

Novak, G. M. (2011). Just-in-time Teaching. New Directions for Teaching and Learning, 2011(128), 63–73. <https://doi.org/10.1002/tl.469>

Novak, G. M., Patterson, E. T., Gavrín, A. D. & Christian, W. (1999). Just-in-Time Teaching: Blending active learning with web technology. Prentice Hall.

Özmen, H. (2004). Some Student Misconceptions in Chemistry: A Literature Review of Chemical Bonding. Journal of Science Education and Technology, 13(2), 147–159.

Paas, F. & Sweller, J. (2022). Implications of Cognitive Load Theory for Multimedia Learning. In R. E. Mayer & L. Fiorella (Hrsg.), Cambridge handbooks in psychology. The Cambridge handbook of multimedia learning (Third edition, S. 73–81). Cambridge University Press.

Patterson, E. T. (2004). Just-in-Time Teaching: Technology transforming learning: A status report. In American Association for the Advancement of Science (Hrsg.), Invention and

impact: Building excellence in undergraduate science, technology, engineering and mathematics (STEM) education. American Association for the Advancement of Science. https://www.aaas.org/sites/default/files/03_Suc_Peds_Patterson.pdf

Perez, K. E., Strauss, E. A., Downey, N., Galbraith, A., Jeanne, R. & Cooper, S. (2010). Does displaying the class results affect student discussion during peer instruction? *CBE Life Sciences Education*, 9(2), 133–140. <https://doi.org/10.1187/cbe.09-11-0080>

Physics Education Research Group. (2009). 121-122 Facilitating in Tutorial. <http://umdperg.pbworks.com/w/page/10511167/121-122%20Facilitating%20in%20Tutorial>

PhysPort. (2015, 24. März). Tutorials in introductory physics at the University of Colorado. YouTube. <https://www.youtube.com/watch?v=VSftkElrEMc>

PhysPort. (2016, 26. Februar). Running Weekly Tutorial Preparation Sessions. YouTube. <https://www.youtube.com/watch?v=gFVk1oksSv4>

PhysPort. (2016, 26. Februar). Using Tutorials: Facilitation tips. YouTube. <https://www.youtube.com/watch?v=0aZ3PvxHpkc>

Porter, L., Lee, C. B., Simon, B., & Zingaro, D. (2011). Peer instruction: Do students really learn from peer discussion in computing? *Proceedings of the Seventh International Workshop on Computing Education*, pp. 45-52. <https://dl.acm.org/doi/10.1145/2016911.2016923>

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93(3), 223–231. <https://doi.org/10.1002/j.2168-9830.2004.tb00809.x>

Prince, M. & Felder, R. (2007). The many faces of inductive teaching and learning. *Journal of College Science Teaching*, 36(5). https://www.researchgate.net/publication/239773785_The_Many_Faces_of_Inductive_Teaching_and_Learning

Prince, M. J. & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education*, 95(2), 123–138. <https://doi.org/10.1002/j.2168-9830.2006.tb00884.x>

Prud'homme-Généreux, A. (2022). Learning through examples: Inductive learning. *Faculty Focus*. <https://www.facultyfocus.com/articles/course-design-ideas/learning-through-examples-inductive-learning/>

Rehehäuser, T. (2018). Was ist ein Sokratisches Gespräch / ein Sokratischer Dialog? prinzip wirksamkeit. <https://www.prinzip-wirksamkeit.de/sokratisches-gespraech-sokratischer-dialog/>

Reich, I. (o. D.). Organic Reactions: Electrophilic Aromatic Substitution. University of Wisconsin-Madison. <https://www.chemedx.org/JCEDLib/QBank/collection/ConcepTests/rxneasub.html>

Reichersdorfer, E., Ufer, S., Lindmeier, A. & Reiss, K. (2014). Der Übergang von der Schule zur Universität: Theoretische Fundierung und praktische Umsetzung einer Unterstützungmaßnahme am Beginn des Mathematikstudiums. In I. Bausch, R. Biehler, R.

Bruder, P. R. Fischer, R. Hochmuth, W. Koepf, S. Schreiber, T. Wassong & P. R. Fischer (Hrsg.), Konzepte und Studien zur Hochschuldidaktik und Lehrerbildung Mathematik. Mathematische Vor- und Brückenkurse: Konzepte, Probleme und Perspektiven (S. 37–53). Springer Spektrum.

Riegler, P. (2014). Schwellenkonzepte, Konzeptwandel und die Krise der Mathematikausbildung. Zeitschrift für Hochschulentwicklung, 9(4), 241–257.

Riegler, P. (2018). 5.2 Peter Riegler: JiTT – Just in Time Teaching. In B. Tobina & K. Ilg (Hrsg.), Lehre und Digitalisierung: Lehre und Digitalisierung 5. Forum Hochschullehre und E-Learning-Konferenz - 25.10.2016. UVW UniversitätsVerlagWebler.

Riegler, P. (2019). Decoding the Disciplines - vom Laien zum Experten und noch einmal zu den Anfängen zurück. Didaktiknachrichten, 3–7. https://diz-bayern.de/DiNa/11_2019

Riegler, P. (2019). Peer Instruction in der Mathematik: Didaktische, organisatorische und technische Grundlagen praxisnah erläutert. Springer Spektrum.
<https://doi.org/10.1007/978-3-662-60510-3>

Riegler, P. (2020). Einflüsse von Decoding the Disciplines auf die Gestaltung von Lehr- und Lernprozessen. die hochschullehre, 6(23), 356–366. <https://doi.org/10.3278/HSL2023W>

Riegler, P., Simon, A., Prochaska, M., Kautz, C., Bierwirth, R., Hagendorf, S. & Kortemeyer, G. (2016). Using Tutorials in Introductory Physics on circuits in a German university course: Observations and experiences. Physics Education, 51(6), 65014.
<https://doi.org/10.1088/0031-9120/51/6/065014>

Roehr, B. (2012, 8. Juni). Nobel Laureate Carl Wieman: Effective teaching should create students who think like scientists. American Association for the Advancement of Science (AAAS). <https://www.aaas.org/news/nobel-laureate-carl-wieman-effective-teaching-should-create-students-who-think-scientists>

Rolf, J. (o. D.). Just in Time Teaching. Derek Bok Center for Teaching and Learning at Harvard University. <https://ablconnect.harvard.edu/just-time-teaching-research>

Roschelle, J. Learning in interactive environments: Prior knowledge and new experience. In J. H. Falk & L. D. Dierking (Hrsg.), Public institutions for personal learning: Establishing a research agenda (S. 37–51).

Rosenblatt, R., Heckler, A. F. & Flores, K. (2011). Group-work Tutorials for an introductory materials engineering course. In 2011 Frontiers in Education Conference (FIE). IEEE.

Rutledge, J. (2023, 19. November). Effect of proportionality constant on exponential graph ($k < 0$). Merlot & SERC Pedagogic Service.
<https://serc.carleton.edu/sp/library/interactive/examples/48751.html>

Sands, D., Parker, M., Hedgeland, H., Jordan, S. & Galloway, R. (2018). Using concept inventories to measure understanding. Higher Education Pedagogies, 3(1), 173–182.
<https://doi.org/10.1080/23752696.2018.1433546>

Sayer, R., Marshman, E. & Singh, C. (2016). Case study evaluating just-in-time teaching and peer instruction using clickers in a quantum mechanics course. Physical Review Physics Education Research, 12(2). <https://doi.org/10.1103/PhysRevPhysEducRes.12.020133>

- Schaar, J. (2022). Aufgabenkatalog für Übergang Schule zu MINT Studium [Audio]. <https://www.deutschlandfunk.de/aufgabenkatalog-fuer-uebergang-schule-zu-mint-studium-dlf-d5d8c1d6-100.html>
- Schaffhauser, D. (2014, 13. August). 2 great techniques for the flipped classroom. Campus Technology. <https://campustechnology.com/articles/2014/08/13/2-great-techniques-for-the-flipped-classroom.aspx>
- Schoenfeld, A. H. (Hrsg.). (1990). A source book for college mathematics teaching: A report from the MAA Committee on the Teaching of Undergraduate Mathematics. Mathematical Association of America.
- Sell, R., Rüttemann, T. & Seiler, S. (2014). Inductive teaching and learning in engineering pedagogy on the example of remote labs. International Journal of Engineering Pedagogy (ijEP), 4(4), 12. <https://doi.org/10.3991/ijep.v4i4.3828>
- Serious Science. (2014, 18. Juni). Peer Instruction for Active Learning - Eric Mazur. YouTube. <https://www.youtube.com/watch?v=Z9orbxoRofI>
- Shaffer, P. S. & McDermott, L. C. (2005). A research-based approach to improving student understanding of the vector nature of kinematical concepts. American Journal of Physics, 73(10), 921–931. <https://doi.org/10.1119/1.2000976>
- Shemwell, J. T., Chase, C. C. & Schwartz, D. L. (2015). Seeking the general explanation: A test of inductive activities for learning and transfer. Journal of Research in Science Teaching, 52(1), 58–83. <https://doi.org/10.1002/tea.21185>
- Simkins, S. P., Maier, M. & Rhem, J. (Hrsg.). (2010). Just-in-Time Teaching: Across the disciplines, and across the academy. Stylus Publishing.
- Slezak, C., Koenig, K. M., Endorf, R. J. & Braun, G. A. (2011). Investigating the effectiveness of the tutorials in introductory physics in multiple instructional settings. Physical Review Special Topics - Physics Education Research, 7(2). <https://doi.org/10.1103/PhysRevSTPER.7.020116>
- Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N. & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. Science, 323(5910), 122–124. <https://doi.org/10.1126/science.1165919>
- Smith, T. I. & Wittmann, M. C. (2007). Comparing three methods for teaching Newton's third law. Physical Review Special Topics - Physics Education Research, 3(2). <https://doi.org/10.1103/PhysRevSTPER.3.020105>
- Stanford. (2015, 3. November). Finding New Ways to Learn Science - Carl Wieman. YouTube. <https://www.youtube.com/watch?v=olpcZbAmDOY>
- Stanzel, S. (2023). Analyse studentischer Fehlvorstellungen mittels des Force Concept Inventory: Item Response Curves im internationalen Vergleich. PhyDid B - Didaktik Der Physik - Beiträge Zur DPG-Frühjahrstagung, 1(1). <https://ojs.dpg-physik.de/index.php/phydid-b/article/view/1339>

- Steinberg, R. N., Wittmann, M. C. & Redish, E. F. (1997). Mathematical tutorials in introductory physics. In AIP Conference Proceedings (S. 1075–1092). AIP.
<https://doi.org/10.1063/1.53110>
- Stone, K. (2019, 20. Januar). Just-In-Time Teaching (JiTT).
<https://prezi.com/p/7qt1plyqplmi/just-in-time-teaching-jitt/>
- Tanevala. (22. Dezember 2023). Vertaisohjaus (Peer Instruction). Wikimedia Commons.
[https://commons.wikimedia.org/wiki/File:Vertaisohjaus_\(Peer_Instruction\).png](https://commons.wikimedia.org/wiki/File:Vertaisohjaus_(Peer_Instruction).png)
- Thornton, R. K. & Sokoloff, D. R. (1998). Assessing student learning of Newton's laws: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula. American Journal of Physics, 66(4), 338–352.
<https://doi.org/10.1119/1.18863>
- Tieben, N. (2019). Brückenkursteilnahme und Studienabbruch in Ingenieurwissenschaftlichen Studiengängen. Zeitschrift für Erziehungswissenschaft, 22(5), 1175–1202. <https://doi.org/10.1007/s11618-019-00906-z>
- Tullis, J. G. & Goldstone, R. L. (2020). Why does peer instruction benefit student learning? Cognitive research: principles and implications, 5(1), 15. <https://doi.org/10.1186/s41235-020-00218-5>
- Vickrey, T., Rosploch, K., Rahmanian, R., Pilarz, M. & Stains, M. (2015). Research-based implementation of peer instruction: A literature review. CBE Life Sciences Education, 14(1), es3. <https://doi.org/10.1187/cbe.14-11-0198>
- Waldherr, F., Walter, C., Harlander, S. & Dingeldey, C. (Hrsg.). (2016). DiNa Sonderausgabe 12/2016. Wege zum Verständnis bauen: Das Projekt HD MINT.
- Watkins, J. & Mazur, E. (2010). Just-in-Time Teaching and Peer Instruction. In S. P. Simkins, M. Maier & J. Rhem (Hrsg.), Just-in-Time Teaching: Across the disciplines, and across the academy. Stylus Publishing.
- WebScience at IUPUI. (o. D.-b). Chemistry 105 Puzzle: "Silly Units Scavenger Hunt".
http://webphysics.iupui.edu/webscience/chem_archive/sillyunitspuzzle.html
- WebScience at IUPUI. (o. D.). Math 164 Chapter 10.3 Puzzle.
http://webphysics.iupui.edu/webscience/mathematics_archive/puzzles/math164pz04.html
- Wieman, C. (2012). Applying new research to improve science education. Issues in Science and Technology, 29(1). <https://issues.org/carl/>
- Wieman, C. & Gilbert, S. (2014). The teaching practices inventory: A new tool for characterizing college and university teaching in mathematics and science. CBE Life Sciences Education, 13(3), 552–569. <https://doi.org/10.1187/cbe.14-02-0023>
- Wieman, C. E. (2014). Large-scale comparison of science teaching methods sends clear message. Proceedings of the National Academy of Sciences of the United States of America, 111(23), 8319–8320. <https://doi.org/10.1073/pnas.1407304111>

Wieman, C. E. (2017). Improving how universities teach science: Lessons from the Science Education Initiative. Harvard University Press.

<https://www.hup.harvard.edu/books/9780674972070>

Wikipedia. (2023, 13. April). Just-in-time teaching. https://en.wikipedia.org/wiki/Just-in-time_teaching

Wikipedia. (2023, 24. Juni). Discipline-Based Educational Research.

https://de.wikipedia.org/wiki/Discipline-Based_Educational_Research

Wikipedia. (2023, 9. August). Konzeptfrage. <https://de.wikipedia.org/wiki/Konzeptfrage>

Wikipedia. (2023, 13. November). Blooms Taxonomie.

https://de.wikipedia.org/wiki/Blooms_Taxonomie

Wolf, K. Eich-Soellner, E. & Fischer., R. (o. D.). Projekt HD MINT: Wege zu einer interaktiven und verständnisorientierten Lehre - Ein Beispiel aus der Mathematik. Hochschule München.

https://www.hd-mint.de/wp-content/uploads/2014/08/2014_Poster_Wolf_Projekt-HD-MINT-Wege-zu-einer-interaktiven-und-verst%C3%A4ndnisorientierten-Lehre.pdf

Wood, A. K., Galloway, R. K., Hardy, J. & Sinclair, C. M. (2014). Analyzing learning during Peer Instruction dialogues: A resource activation framework. Physical Review Special Topics - Physics Education Research, 10(2). <https://doi.org/10.1103/PhysRevSTPER.10.020107>

Zentrum für Lehre und Lernen. (2019). Wissenskonstruktion: Durch aktivierende Lehre nachhaltiges Verständnis in MINT-Fächern fördern. Technische Universität Hamburg (TUHH).

Zollman, D. (1996). Millikan Lecture 1995: Do they just sit there? Reflections on helping students learn physics. American Journal of Physics, 64(2), 114–119.

<https://doi.org/10.1119/1.18129>