Let’s talk evidence – The case for combining inquiry-based and direct instruction

(Lugu teaduskommunikatsioonist)

Margus Pedaste

Paul A. Kirschner • 1st
Educational realist, Educational myth-buster, Emeritu...
5h •

In 2022, Lin Zhang, Bill Cobern, John Sweller and I published an article in Educational Psychology Review titled, 'There is an Evidence Crisis in Science Educational Policy.' We argued that the evidence cited by many science curriculum and standards documents is flawed as they rely on a particular class of what we call 'program-based studies which tend to vary more than one relevant factor at a time making it impossible to know what caused any differences found.
This prompted a critical response from Ton de Jong and twelve of his colleagues to reply with an article in Educational Research Review, 'Let's talk evidence – The case for combining inquiry-based and direct instruction'. There they argued that the case against inquiry had not been substantiated (they missed the point!).
Yes, the original authors - with reg AshmanAshman PhD added - decided we wanted to respond to this paper. That paper was accepted by Educational Research Review and published online today with the unimaginative title 'Response to De Jong et al.'s (2023) paper 'Let's talk evidence – The case for combining inquiry-based and direct instruction.'
Read Greg Ashman PhD's blog about the trilogy here:

Cool new paper in a long-running debate

2022. aastal avaldasid Lin Zhang, Bill Cobern, John Sweller ja Paul Kirschner ajakirjas *Educational Psychology Review* artikli pealkirjaga “Loodusteaduste hariduse poliitikas on tõendite kriis." Nad väitsid, et poliitikate kujundamisel sageli aluseks võetud tõendid on vigased.

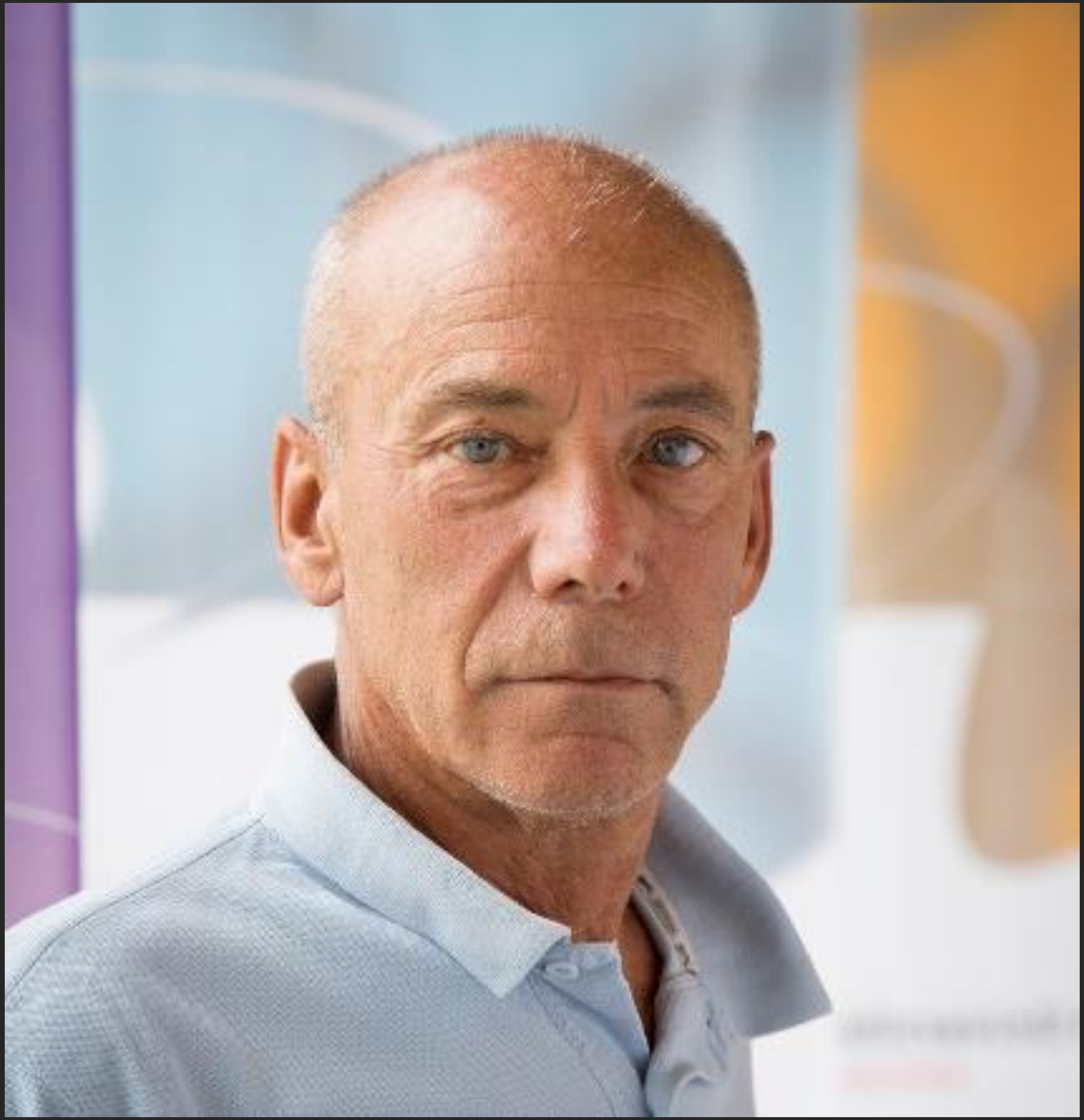
Keskseks kujunes see, kas otsene õpetamine on parem uurimuslikust lähenemisest. Tõendid on sageli kogutud väidetavalt uuringutes, kus muutujaid on rohkem kui üks.

See innustas Ton de Jongi kriitiliselt vastama, koondades enda ümber „raskekahurväe“ üle maailma. Avaldati ajakirjas *Educational Research Review* artikkel „Räägime tõenditest – uurimusliku lähenemise ja otsese õpetamise kombineerimine”. Nemad väitsid, et uurimusliku õppe vastu suunatud kriitika ei olnud põhjendatud.

Educational Research Review avaldas vastuartikli ja on avaldamas viimast vastulauset.

Austraalia, USA, Holland vs Holland, USA, Saksamaa, Küpros, Eesti

Erinevad blogipostitused ka muudel teemadel:
https://gregashman.wordpress.com/page/2/




Educational Psychology Review (2022) 34:1157–1176
https://doi.org/10.1007/s10648-021-09646-1

COMMENTARY

There is an Evidence Crisis in Science Educational Policy

Lin Zhang[1] · Paul A. Kirschner[2,3] · William W. Cobern[4] · John Sweller[5]

Accepted: 25 October 2021 / Published online: 6 November 2021

Abstract
There is a considerable gap between many of the findings from educational psychology research and educational practice. This gap is especially notable in the field of science education. In this article, the implications of three categories of research and their findings for science educational policy in the USA and other jurisdictions were reviewed. We indicate that a particular category of research that we call "Program-Based Studies," has dominated the formulation of educational standards while a large number of critical findings from randomized, controlled studies and correlational studies that overwhelmingly show minimal support for the suggested policy have been marked as irrelevant and excluded. The current blanket-emphasis on program-based studies at the expense of the other types of research is misplaced. Educational standards should represent a balanced view of the available data including findings from controlled and correlational studies. Finally, we indicate how these different forms of research might inform each other and provide coherent and consistent implications for educational procedures.

Keywords Methodology · Educational practice · Educational policy · Controlled studies · Correlational studies · Program-based studies · Science education

Educational standards should represent a balanced view of the available data including findings from controlled and correlational studies.

The exploration-based pedagogy, frequently called "inquiry," "discovery," "problem-based," or "investigations," has been prominently reflected in science education practice and policy for decades in the USA and internationally.

The emphasis on incorporating scientific investigation in science curricula has been a global phenomenon and is commonplace.

The best way to educate young "scientists" was to use the epistemology of the expert scientists. It has been resulted in understandings of science concepts, development of ownership of the knowledge, fostering positive attitudes toward science, and promoting practical skills in authentic settings.

We never should have reached the current point, as accumulated evidence from controlled studies, on which the field of educational psychology relies heavily, has found minimal support for teaching science through exploration-based investigations.

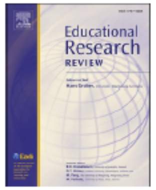
1. The development of students’ science conceptual knowledge is not best obtained by having students go through exploration-based investigation activities.
2. Although we hold that scientific procedures are an essential part of science education, we do not believe that investigative skills and methods in specific science fields emerge automatically as students engage in such investigation activities. Rather, they need to be explicitly and directly taught and then sufficiently practiced in guided or open situations. We are also aware that the current standards tend to emphasize the development of a generic set of inquiry/problem-solving skills covering several science subject fields. The expectation is that once students acquire these so-called general problem-solving skills in their early education they will be able to perform better in specific fields when they launch their careers in future. While the acquisition of such skills is debatable, there can be no doubt that for students to be able to successfully carry out scientific investigations, they need to acquire conceptual and procedural content.
3. The development of other related science learning goals during investigation activities, such as attitudes toward science, should not be at the cost of students’ learning of science concepts and procedures.

Educational Research Review 39 (2023) 100536

Contents lists available at ScienceDirect

Educational Research Review

journal homepage: www.elsevier.com/locate/edurev



Review

Let’s talk evidence – The case for combining inquiry-based and direct instruction

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ARTICLE INFO

Keywords:
Inquiry-based instruction
Direct instruction
Instructional design
Evidence-based instruction

ABSTRACT

Many studies investigating inquiry learning in science domains have appeared over the years. Throughout this period, inquiry learning has been regularly criticized by scholars who favor direct instruction over inquiry learning. In this vein, Zhang, Kirschner, Cobern, and Sweller (2022) recently asserted that direct instruction is overall superior to inquiry-based instruction and reproached policy makers for ignoring this fact. In the current article we reply to this assertion and the premises on which it is based. We review the evidence and argue that a more complete and correct interpretation of the literature demonstrates that inquiry-based instruction produces better overall results for acquiring conceptual knowledge than does direct instruction. We show that this conclusion holds for controlled, correlational, and program-based studies. We subsequently argue that inquiry-based and direct instruction each have their specific virtues and disadvantages and that the effectiveness of each approach depends on moderating factors such as the learning goal, the domain involved, and students’ prior knowledge and other student characteristics. Furthermore, inquiry-based instruction is most effective when supplemented with guidance that can be personalized based on these moderating factors and can even involve providing direct instruction. Therefore, we posit that a combination of inquiry and direct instruction may often be the best approach to support student learning. We conclude that policy makers rightfully advocate inquiry-based instruction, particularly when students’ investigations are supplemented with direct instruction at appropriate junctures.

Uurimuslik lähenemine on siiski otsesest õpetamisest parem kontseptuaalsete arusaamade kujundamisel loodusteadustes.

Järeldus kehtib 1) kontrollitud, 2) korrelatsiooniliste ja 3) programmipõhiste uuringute korral.

Mõlemal on oma spetsiifilised eelised ja puudused ning nende tõhusus sõltub moderaatoritest, nagu õppe-eesmärgid, õpitav valdkond, eelteadmised, õpilase omadused.

Uurimuslik lähenemine on kõige tulemuslikum, kui see on toetatud personaliseeritud juhistega, mille pakkumisel on arvestatud eelnevalt välja toodud tegureid. Seejuures on omal kohal ka otsene õpetamine.

Seetõttu: kombinatsioon võib sageli olla parim lähenemisviis õpilaste õppimise toetamiseks.

Me järeldame, et poliitikakujundajad toetavad õigustatult uurimuslikku lähenemist, eriti kui seda täiendatakse asjakohastel etappidel otsese juhendamisega.

Uurimusliku õppe raamistik

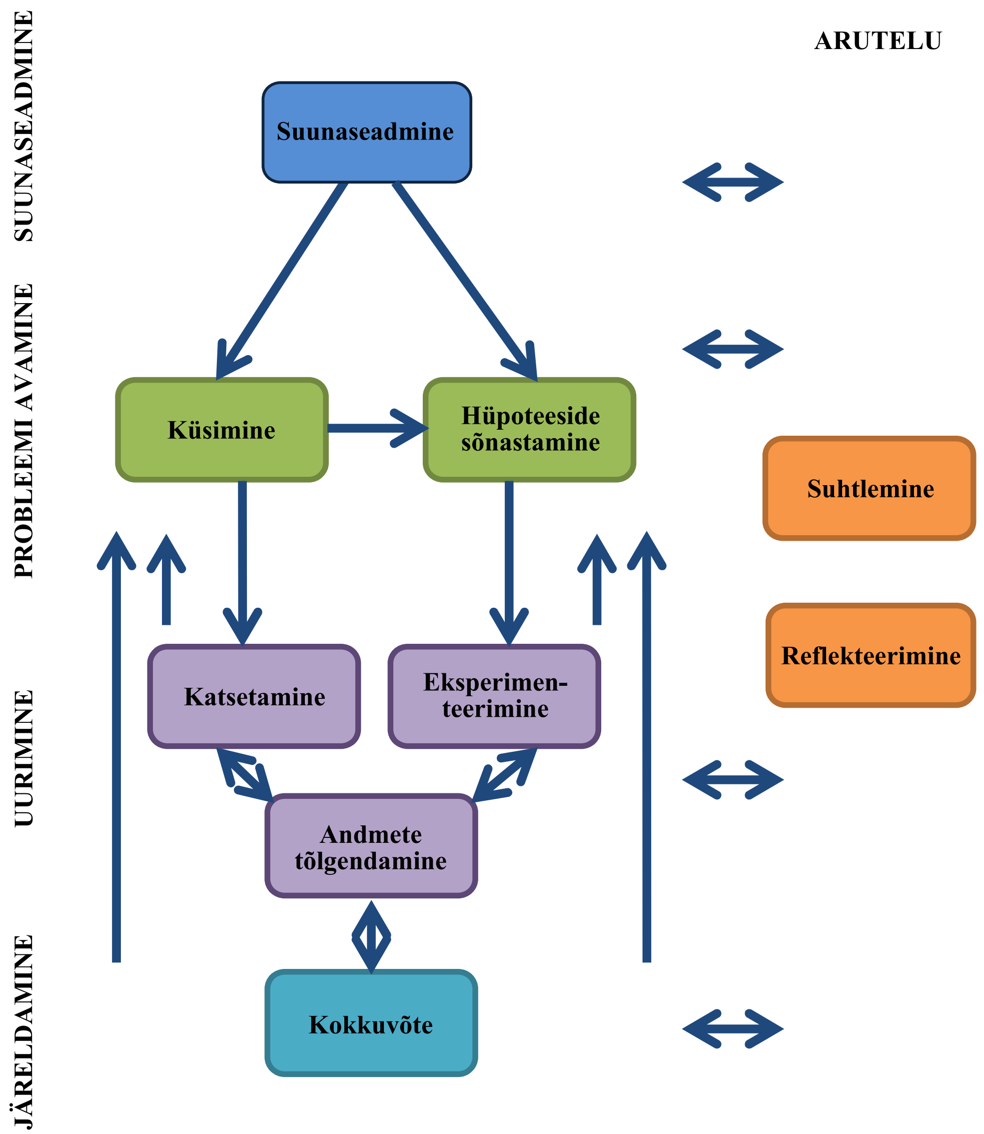
Suunaseadmine: tekitatakse huvi teema vastu ja defineeritakse probleem

Probleemi avamine: sõnastatakse uuritavad küsimused ja teooriale tuginevad hüpoteesid

Uurimine: planeeritakse andmekogumine, kogutakse andmed, analüüsitakse ja tõlgendatakse need

Järeldamine: kokkuvõtte tegemine

Arutelu: tulemuste esitamine teistele ja kogemusest õppimine



Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47-61.

Evidence from controlled studies:
The claim was based on a limited number of primary studies from a selected set of authors, thereby bypassing a massive number of controlled studies that have shown the benefits of inquiry-based instruction in comparison with direct instruction. We have chosen to rely on meta-analyses and systematic review studies that have summarized this work, covering relatively recent as well as older primary studies.

Minner, Levy, and Century (2010) analysed the findings of 138 studies that included some level of inquiry and found that 51% of the studies indicated a positive effect of inquiry-based instruction on the acquisition of conceptual knowledge. Only 2% of the studies showed a negative impact, while the remaining studies showed mixed results or found no difference.

In a meta-analysis comparing inquiry-based instruction and direct instruction on the basis of 164 primary studies, Alfieri, Brooks, Aldrich, and Tenenbaum (2011) concluded that unassisted (or unguided) discovery is less effective than explicit instruction, but that assisted inquiry is more effective than explicit instruction involving "explicit teaching of strategies, procedures, concepts, or rules in the form of formal lectures, models, demonstrations, and so forth and/or structured problem solving" (p. 5).

Furtak, Seidel, Iverson, and Briggs (2012) analysed 37 (quasi-)experimental studies comparing inquiry-based instruction with direct instruction (labelled as textbook approach, traditional instruction, individual mastery learning, etc.) and reported an overall positive effect of inquiry-based instruction, with an additional positive effect of approaches in which there was teacher guidance.

Evidence from correlational studies:

One concern with the PISA 2015 data is that the information collected on inquiry practices was based on self-reports: Students had to answer questions that addressed the occurrence of these activities in their classes. As already indicated in much other work (e.g., Aditomo & Köhler, 2020), students' reporting can be inaccurate (e.g., it could include cookbook-based laboratory experiences), and the PISA 2015 data did not report on the quality of the inquiry lessons offered.

The relation between the frequency of inquiry learning activities and science achievement scores is not linear but curvilinear, meaning that inquiry activities do have a positive relation with science performance up to a certain level (Chen, Dorn, Krawitz, Lim, & Mourshed, 2017; Oliver et al., 2021).

Aditomo and Klieme (2020) analyzed the data from the 10 highest and 10 lowest performing regions in PISA 2015 (>150,000 students from >5000 schools), examining independent inquiry, in which students performed their inquiry activities without support by the teacher, and guided inquiry, in which teacher guidance was present. The results showed that guided inquiry was positively associated with science achievement in all 16 regions where this form of instruction was applied.

Cairns (2019) found that some inquiry activities had a positive relation with science achievement whereas others showed a negative relation; still others (most particularly, explaining ideas and doing experiments) had a curvilinear relation with achievement. This analysis also confirmed that open inquiry without teacher guidance is negatively associated with science achievement.

Evidence from program-based studies:
Combining elements seems unavoidable when designing realistic, comprehensive real-classroom intervention.

It is still interesting and significant to find that the approaches characterized as inquiry-oriented at their core turned out to be more effective than approaches that had direct instruction as their core.

This brief sample of what can be called program-based studies shows that these studies can be conducted in a relatively controlled way. The evidence from these studies certainly does not show overall superiority of the direct instruction approach.

Moderating factors:
Combining elements seems unavoidable when designing realistic, comprehensive real-classroom intervention.

In a recent paper, Hirsh, Nilholm, Roman, Forsberg, and Sundberg (2022) analyzed the 75 most cited review studies on teaching methods from 1980 to 2017 and identified moderating factors that influence the outcomes of instructional approaches. They summarized four categories of factors:

a) differences in students (e.g., achievement level, cognitive level, level of previous familiarity with method),
b) differences in teachers (e.g., professional experience, subject-specific knowledge, knowledge of the method used),
c) differences in context (size or composition of student group, physical classroom context), and
d) differences in content (school subject and quality of the teaching program).

When the subject matter is ill-structured, open to multiple interpretations, or susceptible to misconceptions (e.g., how does water's boiling point change with altitude, Desilver, 2015), inquiry learning can foster deep conceptual understanding (e.g., de Jong, 2019) and transfer of learned material to different tasks and settings (e.g., Gobert, Sao Pedro, Li, & Lott, 2023; Li, Gobert, & Dickler, 2019).

Frey et al. (2017) showed that different strategies are needed for developing surface, deep, and transferable knowledge. Inquiry-based methods were used effectively in lessons beyond the surface learning phase (see also Hattie & Donoghue, 2016).

Educational Research Review 42 (2024) 100584

Contents lists available at ScienceDirect

Educational Research Review

journal homepage: www.elsevier.com/locate/edurev

Review

Response to De Jong et al.'s (2023) paper "Let's talk evidence – The case for combining inquiry-based and direct instruction"

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A R T I C L E I N F O

Keywords:
Inquiry learning
Explicit instruction
Randomised
Controlled trials
Cognitive load theory

A B S T R A C T

De Jong et al. (2023) objected to the evidence presented by Zhang et al. (2022) to support their concerns about the unreserved acceptance and promotion of inquiry-based learning and problem solving in current policy documents related to the teaching of science. In their response, De Jong et al. (2023) reiterated their advocacy for inquiry approaches, arguing that an emphasis on a mixture of inquiry learning and explicit instruction is needed. The present article rebuts De Jong et al. (2023), in which we: 1) challenge their view of and approach to scientific methods in establishing the efficacy of different instructional approaches; 2) indicate that an underpinning theory to explain the cognitive machinery that drives inquiry-based instructional approaches is missing from their argument; and 3) address the empirical issues arising in their argument. We also highlight potential agreement with De Jong et al. (2023) on the essential role of explicit instruction and thus raise a call to the field to revise current science educational policies and standards to reflect such a role. Our agreements and disagreements advance the debate to a new focus concerning when and how inquiry-based learning and explicit instruction should be used and combined. While De Jong et al. (2023), in their theory-free paper, provided no answer to how explicit instruction and inquiry learning should be combined, we offer our suggestions based on evolutionary psychology and the expertise reversal effect from cognitive load theory.

1) vaidlustame vaate ja lähenemise teaduslikele meetoditele erinevate õpetamisviiside tõhususe kindlakstegemisel;
2) näitame, et argumentidel puudub alusteooria, mis selgitaks kognitiivset masinavärki, mis juhib uurimusliku õpet;
3) käsitleme argumenteerimisel esilekerkivaid empiirilisi probleeme.

Võimalik, et oleme ühel meelel, et otsesel õppel on oma roll. Sellest tulenevalt kutsume üles vaatama üle vaatama loodusteaduslikku haridust kujundavaid poliitikaid ja standardeid, et seda rolli kajastada.

Kuigi De Jong et al. (2023) oma teooriavabas artiklis ei andnud vastust selle kohta, kuidas tuleks otsest õpetamise ja uurimuslikku õpet kombineerida, pakume oma ettepanekuid, mis põhinevad evolutsioonilisel psühholoogial ja ekspertiisi ümberpööramise efektil, mis tuleneb kognitiivse koormuse teooriast.

Kus on tõendid?

Või kuidas neid tõlgendada, ümber hinnata ja edasi liikuda

(küsimused ja mõtted)