Supplementary Material

Learning from Physical and Virtual Investigation: A Meta-Analysis of Conceptual Knowledge Acquisition

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Table S1. Included Studies and Their Characteristics

| Study | *N* | *g* | STEM-domain | Assessment type | Tactile feedback | Student age | Research setting |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Abdel-Maksoud (2018) | 116 | −1.20 | Technology | Performance based | Irrelevant | Adults | Classroom |
| Ajredini et al. (2013) | 167 | −0.02 | Science (physics) | Constructed response | Relevant | Adolescents | Classroom |
| Baki et al. (2011) | 66 | −0.29 | Mathematics | Multiple choice | Irrelevant | Adolescents | Classroom |
| Barrett et al. (2018) | 8 | −0.18 | Science (chemistry) | Constructed response | Irrelevant | Adults | Research lab |
| Brown (2007) | 46 | 0.20 | Mathematics | Constructed response | Irrelevant | Children | Classroom |
| Chang et al. (2013) | 59 | −0.23 | Mathematics | Constructed response | Irrelevant | Children | Classroom |
| Chen et al. (2014) | 68 | −0.02 | Science (chemistry) | Constructed response | Irrelevant | Adolescents | Classroom |
| Chien et al. (2015) | 43 | −0.14 | Science (physics) | Constructed response | Irrelevant | Adolescents | Classroom |
| Chini et al. (2012) | 121 | −0.62 | Science (physics) | Multiple choice | Relevant | Adults | Classroom |
| Darrah et al. (2014, Exp.1) | 49 | −0.06 | Science (physics) | Multiple choice | Relevant | Adults | Classroom |
| Darrah et al. (2014, Exp.2) | 51 | 0.07 | Science (physics) | Multiple choice | Relevant | Adults | Classroom |
| Ekmekci & Gulacar (2015) | 36 | −0.12 | Science (physics) | Multiple choice | Irrelevant | Adults | Classroom |
| Gecu-Parmaksiz & Delialioğlu (2019) | 72 | −0.90 | Mathematics | Multiple choice | Relevant | Children | Classroom |
| Gibbard & Salajan (2009) | 162 | −0.51 | Science (physics) | Performance based | Relevant | Adults | Classroom |
| Hannel & Cuevas (2018) | 176 | 0.30 | Science (physics) | Multiple choice | Relevant | Children | Classroom |
| Hawkins & Phelps (2013) | 169 | −0.09 | Science (chemistry) | Combined | Irrelevant | Adults | Classroom |
| Hensen et al. (2020) | 390 | 0.20 | Science (chemistry) | Performance based | Irrelevant | Adults | Classroom |
| Husnaini & Chen (2019) | 68 | −0.20 | Science (physics) | Multiple choice | Relevant | Adolescents | Classroom |
| Jaakkola & Nurmi (2008) | 42 | −0.37 | Science (physics) | Constructed response | Irrelevant | Children | Classroom |
| Kapici et al. (2019) | 67 | 0.26 | Science (physics) | Combined | Irrelevant | Adolescents | Classroom |
| Lazonder & Ehrenhard (2014) | 40 | 1.23 | Science (physics) | Constructed response | Relevant | Children | Research lab |
| Martinez et al. (2011) | 123 | −0.45 | Science (physics) | Multiple choice | Irrelevant | Adults | Classroom |
| Merkouris et al. (2019) | 56 | 0.52 | Science (physics) | Multiple choice | Relevant | Children | Classroom |
| Olympiou & Zacharia (2012) | 46 | −0.26 | Science (physics) | Constructed response | Irrelevant | Adults | Classroom |
| Pyatt & Sims (2012) | 184 | −0.25 | Science (physics) | Performance based | Irrelevant | Adults | Classroom |
| Sullivan et al. (2017) | 100 | −0.17 | Science (physics) | Combined | Relevant | Adolescents | Classroom |
| Tarng et al. (2018) | 109 | −0.68 | Science (chemistry) | Constructed response | Irrelevant | Adults | Classroom |
| Triona & Klahr (2003) | 92 | 0.27 | Science (physics) | Constructed response | Relevant | Children | Research lab |
| Wang & Tseng (2018) | 138 | −0.33 | Science (physics) | Multiple choice | Irrelevant | Children | Classroom |
| Winn et al. (2006) | 60 | 0.25 | Science (biology) | Multiple choice | Relevant | Adults | Classroom |
| Yuan et al. (2010) | 68 | −0.33 | Mathematics | Constructed response | Relevant | Adolescents | Classroom |
| Zacharia & Constantinou (2008) | 76 | −1.51 | Science (physics) | Constructed response | Irrelevant | Adults | Classroom |
| Zacharia & De Jong (2014) | 115 | −0.16 | Science (physics) | Constructed response | Irrelevant | Adults | Classroom |
| Zacharia & Olympiou (2011) | 80 | 1.63 | Science (physics) | Constructed response | Irrelevant | Adults | Classroom |
| Zacharia et al. (2012) | 40 | −0.22 | Science (physics) | Constructed response | Relevant | Children | Research lab |

*Note.* *N* = total sample size. *g* = effect size; a positive value indicates that students learned more from physical investigation, whereas a negative effect size denotes higher learning from virtual investigation.