Supplementary Material

# Supplementary Data

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| **Author (Year)** | **Sample size** | **Academic level** | **Subjects** | **Experimental period** | **Teaching method** | **Experimental results** |
| Asrizal et al. (2023) | E20, C20 | Primary Schools | Technology | <1 weeks | Project-orientated | Positive impact |
| Ha et al. (2023) | E31, C36 | High Schools | Engineering | <1 weeks | Problem-orientated | Positive impact |
| Khalil et al. (2023) | E48, C46 | High Schools | Technology | 1–5 weeks | Inquiry -orientated | Positive impact |
| Abdurrahman et al. (2023) | E31, C36 | High Schools | Engineering | <1 weeks | Problem-orientated | Positive impact |
| Awad (2023) | E120, C120 | High Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Chang and Chen (2022) | E42, C42 | High Schools | Science | 1–5 weeks | Project-orientated | Positive impact |
| Minarti et al. (2022) | E36, C36 | Primary Schools | Technology | <1 weeks | Project-orientated | No significant difference |
| Sirajudin and Suratno (2021) | E12, C12 | Universities | Science | <1 weeks | Project-orientated | Positive impact |
| Micari and Pazos (2021) | E604, C676 | Universities | Technology | 5–10 weeks | Problem-orientated | Positive impact |
| Kencana and Syukri (2020) | E101, C102 | High Schools | Technology | >10 weeks | Inquiry -orientated | Positive impact |
| Kurt and Benzer (2020) | E13, C13 | Primary Schools | Science | 5–10 weeks | Problem-orientated | Positive impact |
| Oren et al. (2020) | E9, C27 | High Schools | Science | >10 weeks | Project-orientated | No significant difference |
| Oren et al. (2020) | E18, C52 | High Schools | Mathematics | >10 weeks | Project-orientated | Positive impact |
| Lin et al. (2019) | E78, C71 | High Schools | Engineering | >10 weeks | Project-orientated | Positive impact |
| Özcan and Koca (2019) | E20, C13 | High Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Yaki et al. (2019) | E51, C49 | High Schools | Science | 5–10 weeks | Project-orientated | No significant difference |
| Gülen and Yaman (2019) | E20, C20 | High Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Gülen (2019) | E20, C18 | High Schools | Engineering | 1–5 weeks | Project-orientated | No significant difference |
| Gülhan and Şahin (2018) | E30, C33 | High Schools | Science | 1–5 weeks | Project-orientated | Positive impact |
| Proudfoot et al. (2018) | E17, C428 | Primary Schools | Mathematics | >10 weeks | Problem-orientated | No significant difference |
| Ojaleye and Awofala (2018) | E96, C116 | High Schools | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Yıldırım and Sidekli (2018) | E29, C29 | Universities | Mathematics | >10 weeks | Project-orientated | Positive impact |
| Sarican and Akgunduz (2018) | E22, C22 | Primary Schools | Science | >10 weeks | Project-orientated | No significant difference |
| Toma and Greca (2018) | E55, C41 | Primary Schools | Engineering | >10 weeks | Project-orientated | Positive impact |
| Acara et al. (2018) | E25, C25 | Primary Schools | Mathematics | 5–10 weeks | Inquiry -orientated | Positive impact |
| Yildirim and Selvi (2017) | E26, C22 | High Schools | Science | 5–10 weeks | Inquiry -orientated | Positive impact |
| Lou et al. (2017) | E60, C60 | High Schools | Science | 5–10 weeks | Project-orientated | Positive impact |
| Arsad et al. (2017) | E56, C58 | Primary Schools | Engineering | 1–5 weeks | Inquiry -orientated | No significant difference |
| Fan and Yu (2017) | E171, C161 | High Schools | Engineering | >10 weeks | Project-orientated | Positive impact |
| Tati et al. (2017) | E36, C36 | High Schools | Science | <1 weeks | Project-orientated | Positive impact |
| Sunyoung et al. (2016) | E661, C526 | Universities | Mathematics | >10 weeks | Project-orientated | Positive impact |
| Rasul et al. (2016) | E125, C125 | High Schools | Technology | <1 weeks | Project-orientated | Positive impact |
| ONER et al. (2016) | E1481, C1481 | High Schools | Mathematics | >10 weeks | Project-orientated | No significant difference |
| Corlu and Aydin (2016) | E125, C125 | Universities | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Açışlı (2016) | E20, C20 | High Schools | Science | <1 weeks | Inquiry -orientated | Positive impact |
| Tolliver (2016) | E64, C53 | Primary Schools | Mathematics | 1–5 weeks | Problem-orientated | No significant difference |
| Townes (2016) | E27, C27 | High Schools | Technology | >10 weeks | Project-orientated | No significant difference |
| Wade-Shepherd (2016) | E916, C916 | High Schools | Mathematics | >10 weeks | Project-orientated | Positive impact |
| Robinson (2016) | E54, C54 | High Schools | Technology | 1–5 weeks | Problem-orientated | Positive impact |
| Yildirim and Selvi (2016) | E76, C76 | Primary Schools | Technology | >10 weeks | Project-orientated | Positive impact |
| Erdoğan and Stuessy (2015) | E9004, C19155 | High Schools | Mathematics | >10 weeks | Inquiry -orientated | No significant difference |
| Erdoğan and Stuessy (2015) | E9004, C19155 | High Schools | Science | >10 weeks | Inquiry -orientated | No significant difference |
| Harris et al. (2015) | E46, C26 | Primary Schools | Science | >10 weeks | Project-orientated | No significant difference |
| Maxwell et al. (2015) | E22, C20 | Primary Schools | Science | 5–10 weeks | Inquiry -orientated | Positive impact |
| Bicer et al. (2015) | E1506, C1520 | High Schools | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Parker et al. (2015) | E35, C24 | Universities | Science | >10 weeks | Inquiry -orientated | Positive impact |
| Karahan et al. (2015) | E21, C21 | High Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Abdullah et al. (2014) | E96, C97 | Primary Schools | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Robinson et al. (2014) | E38, C38 | Primary Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Judson (2014) | E53, C3681 | High Schools | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Kong and Huo (2014) | E25, C25 | Primary Schools | Technology | 1–5 weeks | Project-orientated | Positive impact |
| Cotabish et al. (2013) | E42, C54 | Primary Schools | Mathematics | >10 weeks | Problem-orientated | Positive impact |
| Cotabish et al. (2013) | E818, C932 | Primary Schools | Science | 1–5 weeks | Inquiry-orientated | Positive impact |
| Cotabish et al. (2013) | E139, C139 | Primary Schools | Science | >10 weeks | Inquiry -orientated | Positive impact |
| Park and Yoo (2013) | E26, C26 | Primary Schools | Technology | 5–10 weeks | Inquiry -orientated | No significant difference |
| Kim et al. (2012) | E88, C106 | Primary Schools | Science | >10 weeks | Inquiry -orientated | Positive impact |
| Cervetti et al. (2012) | E976, C937 | Primary Schools | Technology | 1–5 weeks | Project-orientated | No significant difference |
| Kim and Choi (2012) | E18, C20 | Primary Schools | Science | 5–10 weeks | Inquiry -orientated | No significant difference |
| Ruiz-Primo et al. (2011) | E166, C166 | Universities | Science | >10 weeks | Project-orientated | No significant difference |
| Nugent et al. (2010) | E124, C124 | High Schools | Science | <1 weeks | Inquiry -orientated | No significant difference |
| Riskowski et al. (2009) | E126, C126 | High Schools | Science | 1–5 weeks | Project-orientated | Positive impact |
| Apedoe et al. (2008) | E271, C271 | High Schools | Science | 5–10 weeks | Problem-orientated | Positive impact |
| Lam et al. (2008) | E21, C21 | High Schools | Technology | >10 weeks | Project-orientated | Positive impact |
| Mehalik et al. (2008) | E587, C466 | High Schools | Science | >10 weeks | Problem-orientated | Positive impact |
| Sullivan (2008) | E26, C26 | High Schools | Science | >10 weeks | Project-orientated | Positive impact |
| Cole and Espinoza (2008) | E146, C146 | Universities | Technology | 1–5 weeks | Problem-orientated | Positive impact |

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| **Author (Year)** | **E** | **M** | **SD** | **C** | **M** | **SD** |
| Asrizal et al. (2023) | 20 | 82.60 | 10.53 | 20 | 73.80 | 13.13 |
| Ha et al. (2023) | 31 | 82.42 | 5.60 | 36 | 75.28 | 7.74 |
| Khalil et al. (2023) | 48 | 1.20 | 1.00 | 46 | 0.86 | 1.02 |
| Abdurrahman et al. (2023) | 31 | 82.42 | 5.60 | 36 | 75.28 | 7.74 |
| Awad (2023) | 120 | 81.96 | 12.70 | 120 | 66.40 | 19.20 |
| Chang and Chen (2022) | 42 | 4.03 | 1.03 | 42 | 3.77 | 1.01 |
| Minarti et al. (2022) | 36 | 11.08 | 2.45 | 36 | 11.00 | 1.83 |
| Sirajudin and Suratno (2021) | 12 | 22.50 | 1.73 | 12 | 17.92 | 4.98 |
| Micari and Pazos (2021) | 604 | 4.00 | 1.11 | 676 | 3.78 | 1.14 |
| Kencana and Syukri (2020) | 101 | 79.90 | 11.31 | 102 | 63.00 | 10.06 |
| Kurt and Benzer (2020) | 13 | 3.74 | 0.56 | 13 | 2.76 | 0.55 |
| Oren et al. (2020) | 9 | 0.94 | 0.08 | 27 | 0.93 | 0.06 |
| Oren et al. (2020) | 18 | 0.94 | 0.06 | 52 | 0.91 | 0.11 |
| Lin et al. (2019) | 78 | 76.62 | 17.61 | 71 | 69.83 | 17.66 |
| Özcan and Koca (2019) | 20 | 148.60 | 12.75 | 13 | 142.30 | 24.61 |
| Yaki et al. (2019) | 51 | 40.35 | 6.89 | 49 | 39.49 | 6.32 |
| Gülen and Yaman (2019) | 20 | 24.50 | 4.90 | 20 | 16.50 | 3.30 |
| GÜLEN (2019) | 20 | 21.35 | 1.3 | 18 | 17.44 | 1.2 |
| Gülhan and Şahin (2018) | 30 | 14.53 | 4.96 | 33 | 11.06 | 4.35 |
| Proudfoot et al. (2018) | 17 | 47.50 | 1.84 | 428 | 44.00 | 2.87 |
| Ojaleye and Awofala (2018) | 96 | 24.25 | 9.34 | 116 | 17.47 | 5.10 |
| Yıldırım and Sidekli (2018) | 29 | 16.93 | 2.75 | 29 | 17.03 | 2.64 |
| Sarican and Akgunduz (2018) | 22 | 11.00 | 2.94 | 22 | 10.45 | 1.81 |
| Toma and Greca (2018) | 55 | 10 | 3.69 | 41 | 9.9 | 3.63 |
| Acara et al. (2018) | 25 | 15.92 | 2.85 | 25 | 13.36 | 2.01 |
| Yildirim and Selvi (2017) | 26 | 7.57 | 3.47 | 22 | 6.64 | 1.76 |
| Lou et al. (2017) | 60 | 28.28 | 5.15 | 60 | 26.68 | 4.47 |
| Arsad et al. (2017) | 56 | 4.19 | 1.03 | 58 | 4.20 | 0.72 |
| Fan and Yu (2017) | 171 | 55.35 | 15.22 | 161 | 42.27 | 9.07 |
| Tati et al. (2017) | 36 | 1.67 | 0.56 | 36 | 1.19 | 0.57 |
| Sunyoung et al. (2016) | 661 | 34.84 | 10.50 | 526 | 32.56 | 10.80 |
| Rasul et al. (2016) | 125 | 4.14 | 0.45 | 125 | 4.05 | 0.33 |
| ONER et al. (2016) | 1481 | 2365.31 | 172.02 | 1481 | 2361.48 | 236.20 |
| Corlu and Aydin (2016) | 125 | 12.49 | 2.69 | 125 | 10.17 | 2.30 |
| Açışlı (2016) | 20 | 17.25 | 2.26 | 20 | 13.20 | 2.44 |
| Tolliver (2016) | 64 | 60.57 | 16.13 | 53 | 57.70 | 10.97 |
| Townes (2016) | 27 | 25.67 | 9.43 | 27 | 23.46 | 6.65 |
| Wade-Shepherd (2016) | 916 | 62.77 | 17.37 | 916 | 57.65 | 19.83 |
| Robinson (2016) | 54 | 3926 | 1358 | 54 | 3204 | 1294 |
| Yildirim and Selvi (2016) | 76 | 51.4 | 10.75 | 76 | 43.37 | 14.40 |
| Erdoğan and Stuessy (2015) | 9004 | 2253 | 246 | 19155 | 2228 | 236 |
| Erdoğan and Stuessy (2015) | 9004 | 2249 | 208 | 19155 | 2239 | 204 |
| Harris et al. (2015) | 46 | 77.42 | 12.93 | 26 | 79.17 | 13.63 |
| Maxwell et al. (2015) | 22 | 78.82 | 15.73 | 20 | 51.14 | 14.02 |
| Bicer et al. (2015) | 1506 | 10.27 | 1.64 | 1520 | 9.65 | 1.27 |
| Parker et al. (2015) | 35 | 10.50 | 2.5 | 24 | 9.33 | 2.34 |
| Karahan et al. (2015) | 21 | 30.90 | 2.14 | 21 | 27.09 | 5.84 |
| Abdullah et al. (2014) | 96 | 75.75 | 11.45 | 97 | 60.32 | 16.02 |
| Robinson et al. (2014) | 38 | 9.11 | 1.94 | 38 | 8.53 | 1.61 |
| Judson (2014) | 53 | 5.98 | 2.10 | 3681 | 5.53 | 1.90 |
| Kong and Huo (2014) | 25 | 23.25 | 6.53 | 25 | 19.40 | 5.48 |
| Cotabish et al. (2013) | 42 | 43.79 | 14.46 | 54 | 34.96 | 9.62 |
| Cotabish et al. (2013) | 818 | 6.44 | 3.18 | 932 | 5.33 | 3.07 |
| Cotabish et al. (2013) | 139 | 9.27 | 3.55 | 139 | 8.45 | 3.40 |
| Park and Yoo (2013) | 26 | 13.73 | 1.88 | 26 | 13.69 | 1.33 |
| Kim et al. (2012) | 88 | 16.70 | 5.60 | 106 | 14.30 | 6.10 |
| Cervetti et al. (2012) | 976 | 15.41 | 3.45 | 937 | 14.05 | 2.58 |
| Kim and Choi (2012) | 18 | 23.54 | 3.45 | 20 | 43.56 | 4.57 |
| Ruiz-Primo et al. (2011) | 166 | 0.47 | 0.54 | 166 | 0.43 | 0.49 |
| Nugent et al. (2010) | 124 | 4.23 | 0.53 | 124 | 4.12 | 0.46 |
| Riskowski et al. (2009) | 126 | 4.32 | 0.51 | 126 | 3.94 | 0.47 |
| Apedoe et al. (2008) | 271 | 27.65 | 4.25 | 271 | 25.56 | 3.08 |
| Lam et al. (2008) | 21 | 9.71 | 1.57 | 21 | 8.39 | 1.46 |
| Mehalik et al. (2008) | 587 | 21.39 | 3.16 | 466 | 20.63 | 2.97 |
| Sullivan (2008) | 26 | 25.82 | 4.04 | 26 | 23.09 | 4.14 |
| Cole and Espinoza (2008) | 146 | 11.46 | 2.38 | 146 | 9.76 | 1.75 |

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