Appendix 1. Difficulty level and discriminatory index for the answer tier (A), the reason tier (R) and the combined tiers (B) of the prototype FTDICK instrument

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Quest.** | **Difficulty Level (DL)** | | | **Discriminatory Index (DI)** | | |
| **A tier** | **R tier** | **B tier** | **A tier** | **R tier** | **B tier** |
| **1** | 0.18 | 0.11 | 0.01 | 0.33 | 0.04 | 0.04 |
| **2** | 0.55 | 0.61 | 0.46 | 0.38 | 0.36 | 0.59 |
| **3** | 0.26 | 0.07 | 0.04 | 0.04 | 0.16 | 0.08 |
| **4** | 0.51 | 0.44 | 0.32 | 0.58 | 0.45 | 0.66 |
| **5** | 0.56 | 0.46 | 0.35 | 0.53 | 0.44 | 0.74 |
| **6** | 0.16 | 0.20 | 0.06 | 0.22 | 0.04 | 0.15 |
| **7** | 0.48 | 0.51 | 0.26 | 0.47 | 0.34 | 0.47 |
| **8** | 0.32 | 0.36 | 0.20 | 0.40 | 0.48 | 0.38 |
| **9** | 0.51 | 0.19 | 0.07 | 0.19 | 0.07 | 0.14 |
| **10** | 0.42 | 0.39 | 0.17 | 0.18 | 0.26 | 0.05 |
| **11** | 0.39 | 0.07 | 0.03 | 0.45 | 0.08 | 0.11 |
| **12** | 0.44 | 0.30 | 0.17 | 0.41 | 0.30 | 0.30 |
| **13** | 0.08 | 0.16 | 0.01 | 0.03 | 0.12 | 0.03 |
| **14** | 0.25 | 0.30 | 0.06 | 0.16 | 0.40 | 0.12 |
| **15** | 0.32 | 0.37 | 0.14 | 0.27 | 0.41 | 0.23 |
| **16** | 0.37 | 0.28 | 0.13 | 0.40 | 0.33 | 0.26 |
| **17** | 0.28 | 0.27 | 0.16 | 0.47 | 0.52 | 0.38 |
| **18** | 0.28 | 0.27 | 0.12 | 0.40 | 0.42 | 0.30 |
| **19** | 0.32 | 0.19 | 0.08 | 0.25 | 0.08 | 0.08 |
| **20** | 0.17 | 0.06 | 0.03 | -0.03 | 0.08 | -0.01 |
| **Mean** | **0.33** | **0.28** | **0.14** | **0.30** | **0.27** | **0.25** |

Red = hard category yellow = good; teal = fair

Green = moderate category pink = poor; dark yellow = unsuitable

Appendix 2. Values of distractor effectiveness (%) of the Prototype FTDICK instrument

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Question** | **1** | | **2** | | **3** | | **4** | |
| **Option** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** |
| **A** | 26.94 | 25.09 | 4.80 | 16.24 | 34.69 | 11.44 | 9.23 | 19.93 |
| **B** | 10.33 | 22.88 | 18.08 | 61.25 | 33.95 | 35.06 | 50.55 | 21.03 |
| **C** | 39.85 | 10.70 | 54.61 | 7.01 | 25.83 | 20.66 | 24.35 | 44.28 |
| **D** | 18.08 | 18.08 | 5.17 |  | 2.95 | 13.65 | 11.81 | 7.01 |
| **E** |  |  |  |  |  | 7.38 |  |  |
| **F** |  |  |  |  |  | 1.48 |  |  |
|  |  |  |  |  |  |  |  |  |
| **Question** | **5** | | **6** | | **7** | | **8** | |
| **Option** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** |
| **A** | 4.80 | 46.13 | 28.04 | 34.69 | 47.97 | 22.51 | 10.70 | 6.64 |
| **B** | 18.82 | 9.23 | 15.87 | 17.71 | 8.49 | 50.55 | 19.56 | 24.72 |
| **C** | 55.72 | 23.25 | 16.24 | 19.93 | 11.81 | 10.70 | 25.46 | 35.79 |
| **D** | 15.13 | 11.44 | 25.09 | 14.76 | 23.25 |  | 32.10 | 14.39 |
|  |  |  |  |  |  |  |  |  |
| **Question** | **9** | | **10** | | **11** | | **12** | |
| **Option** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** |
| **A** | 26.20 | 12.18 | 18.45 | 11.07 | 19.93 | 12.18 | 19.19 | 21.77 |
| **B** | 50.55 | 8.12 | 13.28 | 39.11 | 13.28 | 15.13 | 19.56 | 19.93 |
| **C** | 6.27 | 18.82 | 41.70 | 9.23 | 18.82 | 29.15 | 43.91 | 11.07 |
| **D** | 10.33 | 14.02 | 19.19 | 12.18 | 39.48 | 15.13 | 5.90 | 29.89 |
| **E** |  | 25.83 |  | 7.38 |  | 6.64 |  |  |
| **F** |  | 4.80 |  | 2.21 |  | 1.48 |  |  |
| **G** |  |  |  | 5.17 |  | 4.43 |  |  |
| **H** |  |  |  | 0.74 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| **Question** | **13** | | **14** | | **15** | | **16** | |
| **Option** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** |
| **A** | 52.03 | 43.54 | 14.39 | 12.18 | 10.33 | 36.53 | 20.30 | 19.93 |
| **B** | 9.96 | 15.87 | 29.52 | 19.56 | 31.37 | 22.14 | 36.53 | 15.50 |
| **C** | 21.40 | 13.65 | 20.30 | 29.89 | 31.73 | 15.50 | 12.55 | 17.71 |
| **D** | 8.12 | 10.33 | 25.09 | 9.59 | 18.45 | 13.65 | 17.34 | 27.68 |
| **E** |  |  |  | 7.38 |  |  |  |  |
| **F** |  |  |  | 2.95 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| **Que** | **17** |  | **18** |  | **19** |  | **20** |  |
| **Option** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** | **A tier** | **R tier** |
| **A** | 19.19 | 27.31 | 24.35 | 27.31 | 6.27 | 25.09 | 36.90 | 7.38 |
| **B** | 28.41 | 18.82 | 19.19 | 19.19 | 39.85 | 31.37 | 18.82 | 18.82 |
| **C** | 16.97 | 30.63 | 12.92 | 21.03 | 31.73 | 19.19 | 16.61 | 19.56 |
| **D** | 21.40 | 4.43 | 28.04 | 11.07 | 4.80 |  | 11.81 | 18.82 |
| **E** |  |  |  |  |  |  |  | 8.12 |
| **F** |  |  |  |  |  |  |  | 5.90 |

Yellow font = distractor in the A tier selected by less than 5% students

Pink font = distractor in the R tier selected by less than 5% students

Appendix 3. the validity of each item/question of the prototype FTDICK instrument with a confidence level of 95%.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Question** | | **1** | **2** | **3** | **4** | **5** |
| **A tier** | ***rxy*** | 0.34 | 0.47 | 0.13 | 0.53 | 0.55 |
| **category** | Valid | Valid | Valid | Valid | Valid |
| **R tier** | ***rxy*** | **0.07** | 0.41 | 0.21 | 0.46 | 0.45 |
| **category** | **Invalid** | Valid | Valid | Valid | Valid |
| **B tier** | ***rxy*** | 0.24 | 0.48 | 0.21 | 0.60 | 0.58 |
| **category** | Valid | Valid | Valid | Valid | Valid |
|  |  |  |  |  |  |  |
| **Question** | | **6** | **7** | **8** | **9** | **10** |
| **A tier** | ***rxy*** | 0.28 | 0.39 | 0.38 | 0.33 | 0.23 |
| **category** | Valid | Valid | Valid | Valid | Valid |
| **R tier** | ***rxy*** | 0.09 | 0.41 | 0.47 | 0.18 | 0.30 |
| **category** | **Invalid** | Valid | Valid | Valid | Valid |
| **B tier** | ***rxy*** | 0.31 | 0.42 | 0.46 | 0.27 | 0.26 |
| **category** | Valid | Valid | Valid | Valid | Valid |
|  |  |  |  |  |  |  |
| **Question** | | **11** | **12** | **13** | **14** | **15** |
| **A tier** | ***rxy*** | 0.43 | 0.44 | 0.14 | 0.29 | 0.29 |
| **category** | Valid | Valid | Valid | Valid | Valid |
| **R tier** | ***rxy*** | 0.15 | 0.27 | 0.14 | 0.39 | 0.45 |
| **category** | Valid | Valid | Valid | Valid | Valid |
| **B tier** | ***rxy*** | 0.35 | 0.36 | 0.17 | 0.20 | 0.33 |
| **category** | Valid | Valid | Valid | Valid | Valid |
|  |  |  |  |  |  |  |
| **Question** | | **16** | **17** | **18** | **19** | **20** |
| **A tier** | ***rxy*** | 0.40 | 0.36 | 0.38 | 0.28 | **0.06** |
| **category** | Valid | Valid | Valid | Valid | **Invalid** |
| **R tier** | ***rxy*** | 0.39 | 0.47 | 0.50 | 0.17 | 0.19 |
| **category** | Valid | Valid | Valid | Valid | Valid |
| **B tier** | ***rxy*** | 0.39 | 0.50 | 0.48 | 0.24 | **0.01** |
| **category** | Valid | Valid | Valid | Valid | **Invalid** |

Appendix 4. Students’ confidence ratings of wrong answers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Question | **Popular wrong answer** | | | | | | | | |
| A tier | | | R tier | | | B tier | | |
| **Option** | **CR(TA)** | **%** | **Option** | **CR(TR)** | **%** | **Option** | **CR(TB)** | **%** |
| 1 | C | 3.34 | 39.9 | A | 2.79 | 25.1 | CA | 3.3 | 12.55 |
| 2 | **B** | **2.84** | **18.1** | **A** | **2.59** | **16.2** | BB | 3.3 | 9.60 |
| 3 | **A** | **3.5** | **34.7** | B | 2.83 | 35.1 | BB | 3.2 | 12.92 |
| 4 | C | 3.29 | 24.4 | **B** | **2.98** | **21.0** | **BA** | **3.9** | **7.38** |
| 5 | B | 2.45 | 18.8 | **C** | **2.79** | **23.2** | CC | 2.7 | 12.55 |
| 6 | A | 3.37 | 28 | **A** | **3.28** | **34.7** | AA | 3.3 | 16.97 |
| 7 | **D** | **3.38** | **23.2** | **A** | **2.9** | **22.5** | **AA** | **3.3** | **13.28** |
| 8 | **C** | **2.91** | **25.5** | **B** | **2.9** | **24.7** | **CB** | **3.1** | **11.44** |
| 9 | **A** | **3.3** | **26.2** | E | 3.24 | 25.8 | BE | 3.6 | 19.19 |
| 10 | **D** | **3.38** | **19.2** | D | 2.76 | 12.2 | AB | 3.3 | 9.23 |
| 11 | A | 3.09 | 19.9 | C | 2.82 | 29.2 | DC | 3.1 | 11.07 |
| 12 | **B** | **3.21** | **19.6** | **A** | **2.81** | **21.8** | CA | 2.8 | 9.23 |
| 13 | A | 3.43 | 52.03 | A | 2.87 | 43.54 | AA | 3.3 | 32.97 |
| 14 | B | 2.98 | 29.52 | B | 3.32 | 19.56 | BC | 3 | 12.92 |
| 15 | **B** | **3.18** | **31.37** | B | 2.83 | 22.14 | BA | 3.2 | 9.96 |
| 16 | A | 2.8 | 20.3 | A | 2.67 | 19.93 | BC | 2 | 8.12 |
| 17 | D | 3.07 | 21.4 | **C** | **2.76** | **30.63** | DC | 3.1 | 14.39 |
| 18 | **A** | **3.33** | **24.35** | B | 2.37 | 19.19 | **AA** | **3.5** | **8.49** |
| 19 | **B** | **2.67** | **39.85** | B | 2.38 | 31.37 | BB | 2.3 | 15.87 |
| 20 | **A** | **3.1** | **36.9** | C | 2.77 | 19.56 | AD | 2.8 | 11.81 |
|  |  |  |  |  |  |  |  |  |  |
| Qustion | **Wrong answer with highest CR** | | | | | | | | |
| A tier | | | R tier | | | B tier | | |
| **Option** | **CR(TA)** | **%** | **Option** | **CR(TR)** | **%** | **Option** | **CR(TB)** | **%** |
| 1 | B | 3.79 | 10.3 | C | 3.21 | 10.7 | BB | 3.9 | 1.48 |
| 2 | **B** | **2.84** | **18.1** | **A** | **2.59** | **16.2** | DB | 3.8 | 1.85 |
| 3 | **A** | **3.5** | **34.7** | F | 3.0 | 1.48 | AA | 3.5 | 3.69 |
| 4 | D | 3.5 | 11.8 | **B** | **2.98** | **21.0** | **BA** | **3.9** | **7.38** |
| 5 | A | 3.0 | 4.8 | **C** | **2.79** | **23.2** | DC | 3.5 | 1.85 |
| 6 | C | 3.5 | 16.2 | **A** | **3.28** | **34.7** | DA | 3.8 | 8.49 |
| 7 | **D** | **3.38** | **23.2** | **A** | **2.9** | **22.5** | **AA** | **3.3** | **13.28** |
| 8 | **C** | **2.91** | **25.5** | **B** | **2.9** | **24.7** | DB | 3.7 | 3.32 |
| 9 | **A** | **3.3** | **26.2** | F | 3.31 | 4.8 | DC | 3.9 | 2.95 |
| 10 | **D** | **3.38** | **19.2** | G | 3.21 | 5.17 | BD | 3.8 | 1.11 |
| 11 | **B** | **3.69** | **13.3** | G | 3.92 | 4.43 | BE | 4.9 | 2.21 |
| 12 | **B** | **3.21** | **19.6** | **A** | **2.81** | **21.8** | DC | 3.9 | 1.85 |
| 13 | **C** | **3.5** | **21.4** | D | 2.96 | 20.3 | DA | 4.5 | 0.74 |
| 14 | C | 3.16 | 20.3 | B | 3.32 | 19.56 | AE | 3.6 | 3.32 |
| 15 | **B** | **3.18** | **31.37** | C | 2.93 | 15.5 | BC | 3.4 | 4.06 |
| 16 | D | 3.17 | 17.34 | B | 2.69 | 15.5 | AD | 3.4 | 5.54 |
| 17 | C | 3.22 | 16.97 | **C** | **2.76** | **30.63** | CA | 3.7 | 4.06 |
| 18 | **A** | **3.33** | **24.35** | D | 2.9 | 11.07 | **AA** | **3.5** | **8.49** |
| 19 | **B** | **2.67** | **39.85** | A | 2.93 | 25.09 | DA | 3.3 | 1.11 |
| 20 | **A** | **3.1** | **36.9** | E | 3.18 | 8.12 | AF | 3.5 | 1.48 |

% = the percentages of all students who participate in this study;

CR = confidence rating

Appendix 5. The values of confidence variables per item of the prototype FTDICK instrument

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Question** | **A Tier** | | | | **R Tier** | | | | **B Tier** | | | |
| **CF** | **CFC** | **CFW** | **CDQ** | **CF** | **CFC** | **CFW** | **CDQ** | **CF** | **CFC** | **CFW** | **CDQ** |
| 1 | 3.32 | 3.69 | 3.24 | 0.37 | 2.60 | 2.70 | 2.59 | 0.11 | 2.96 | 3.4 | 2.95 | 0.33 |
| 2 | 2.74 | 3.55 | 1.76 | 1.29 | 2.87 | 3.66 | 1.62 | 1.59 | 2.81 | 3.7 | 2 | 1.04 |
| 3 | 3.33 | 3.59 | 3.24 | 0.32 | 2.59 | 3.30 | 2.53 | 0.72 | 3 | 3.8 | 2.9 | 0.7 |
| 4 | 3.43 | 3.79 | 3.06 | 0.67 | 2.96 | 3.27 | 2.72 | 0.48 | 3.19 | 3.6 | 2.99 | 0.52 |
| 5 | 2.88 | 3.33 | 2.31 | 0.90 | 2.70 | 3.27 | 2.22 | 0.90 | 2.79 | 3.6 | 2.35 | 0.96 |
| 6 | 3.04 | 3.35 | 2.98 | 0.32 | 2.73 | 3.07 | 2.64 | 0.37 | 2.88 | 3.6 | 2.84 | 0.51 |
| 7 | 3.09 | 3.55 | 2.67 | 0.78 | 2.65 | 3.20 | 2.10 | 0.90 | 2.87 | 3.7 | 2.59 | 0.76 |
| 8 | 2.92 | 4.17 | 2.32 | 1.47 | 2.61 | 3.67 | 2.01 | 1.32 | 2.76 | 4.3 | 2.36 | 1.27 |
| 9 | 3.09 | 3.40 | 2.78 | 0.60 | 2.46 | 2.84 | 2.37 | 0.41 | 2.78 | 3.1 | 2.75 | 0.27 |
| 10 | 3.07 | 3.43 | 2.80 | 0.60 | 2.61 | 3.24 | 2.20 | 0.95 | 2.8 | 3.7 | 2.7 | 0.8 |
| 11 | 3.04 | 3.36 | 2.84 | 0.52 | 2.58 | 3.83 | 2.49 | 1.34 | 2.81 | 4.1 | 2.77 | 0.98 |
| 12 | 2.78 | 3.08 | 2.55 | 0.47 | 2.37 | 2.90 | 2.14 | 0.69 | 2.57 | 3.1 | 2.47 | 0.47 |
| 13 | 3.12 | 3.59 | 3.08 | 0.47 | 2.37 | 2.53 | 2.34 | 0.19 | 2.74 | 3.5 | 2.73 | 0.57 |
| 14 | 2.93 | 3.96 | 2.58 | 1.27 | 2.43 | 2.94 | 2.22 | 0.68 | 2.69 | 3.9 | 2.61 | 0.92 |
| 15 | 2.94 | 3.56 | 2.66 | 0.76 | 2.68 | 3.29 | 2.33 | 0.79 | 2.82 | 3.7 | 2.67 | 0.76 |
| 16 | 2.50 | 2.92 | 2.26 | 0.58 | 2.28 | 3.12 | 1.96 | 1.03 | 2.39 | 3.5 | 2.23 | 0.85 |
| 17 | 2.63 | 3.09 | 2.45 | 0.58 | 2.32 | 3.14 | 2.01 | 1.08 | 2.48 | 3.4 | 2.31 | 0.74 |
| 18 | 2.66 | 3.43 | 2.36 | 0.95 | 2.25 | 3.24 | 1.88 | 1.33 | 2.46 | 3.7 | 2.29 | 0.97 |
| 19 | 2.22 | 2.87 | 1.91 | 0.83 | 2.13 | 2.83 | 1.97 | 0.76 | 2.18 | 3.1 | 2.1 | 0.74 |
| 20 | 2.47 | 2.73 | 2.42 | 0.27 | 2.20 | 3.13 | 2.14 | 0.89 | 2.34 | 3.2 | 2.31 | 0.63 |
| **Mean** | **2.91** | **3.42** | **2.61** | **0.70** | **2.52** | **3.26** | **2.22** | **0.83** | **2.72** | **3.59** | **2.55** | **0.74** |
| **SD** | **0.31** | **0.36** | **0.41** | **0.34** | **0.22** | **0.32** | **0.28** | **0.39** | **0.25** | **0.32** | **0.29** | **0.25** |