

**PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP
PENGUBAHAN KONSEPSI PADA GELOMBANG DAN
PENGUNGKAPAN PROFIL *ATTITUDE TOWARDS PHYSICS*
SISWA SMA**

TESIS

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Magister
Pendidikan Fisika



oleh

Fatah Kurniawan
NIM 2105539

**PROGRAM STUDI
MAGISTER PENDIDIKAN FISIKA
FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA**

2023

*PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN
KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE
TOWARDS PHYSICS SISWA SMA*

LEMBAR HAK CIPTA

Oleh

Fatah Kurniawan

Sebuah tesis yang diajukan untuk memenuhi salah satu syarat memperoleh gelar
Magister Pendidikan Fisika

© Fatah Kurniawan 2023
Universitas Pendidikan Indonesia
Agustus 2023

Hak Cipta dilindungi undang-undang.
Tesis ini tidak boleh diperbanyak seluruhnya atau sebagian
dengan dicetak ulang, difotokopi, atau cara lainnya tanpa izin dari penulis.

FATAH KURNIAWAN

2105539

**PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP
PENGUBAHAN KONSEPSI PADA GELOMBANG DAN
PENGUNGKAPAN PROFIL *ATTITUDE TOWARDS PHYSICS* SISWA SMA**

disetujui dan disahkan oleh:

Pembimbing I



Dr. Achmad Samsudin, S.Pd., M.Pd.
NIP. 198310072008121004

Pembimbing II



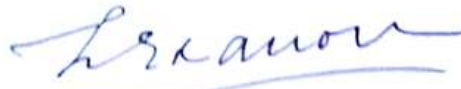
Dr. Didi Teguh Chandra, M.Si.
NIP. 195910131984031001

Penguji



Prof. Dr. Endi Suhendi, M.Si.
NIP. 197905012003121001

Penguji



Dra. Hera Novia, M.T.
NIP. 196811042001122001

Mengetahui,

Ketua Program Studi Sarjana dan Magister Pendidikan Fisika




Dr. Achmad Samsudin, S.Pd., M.Pd.
NIP. 198310072008121004

PERNYATAAN

Dengan ini saya menyatakan bahwa tesis dengan judul “Penerapan VirtumFi Berbasis Android terhadap Perubahan Konsepsi pada Gelombang dan Pengungkapan Profil *Attitude Towards Physics* Siswa SMA” ini beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung resiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, 21 Agustus 2023

Yang menyatakan,



Fatah Kurniawan
NIM. 2105539

**PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN
KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL *ATTITUDE
TOWARDS PHYSICS* SISWA SMA**

Fatah Kurniawan
2105539

Pembimbing I: Dr. Achmad Samsudin, M.Pd.
Pembimbing II: Dr. Didi Teguh Chandra, M.Si.
Prodi Magister Pendidikan Fisika FPMIPA UPI

ABSTRAK

Gelombang berjalan dan stasioner (GBS) merupakan topik pentingnya yang erat kaitannya dengan kemajuan teknologi saat ini. Namun, pentingnya topik ini belum selaras dengan tingginya pemahaman konseptual siswa SMA terhadap topik terkait. Keadaan ini didukung oleh fakta bahwa beberapa siswa SMA masih memiliki *attitude toward physics* (ATP) yang cenderung negatif. Usaha penanganan telah dilakukan, tetapi masih terdapat beberapa kekurangan dan saran dari penelitian terdahulu. Maka dari itu, penelitian ini bertujuan untuk menganalisis perubahan konsepsi gelombang dan ATP siswa SMA sebagai penerapan VirtumFi berbasis Android. Metode yang akan digunakan dalam penelitian ini adalah metode penelitian campuran (*mixed-methods*). Desain penelitian ini menggunakan *embedded experimental* model dengan *pre-test-post-test control group design*. Sampel penelitian ini merupakan siswa kelas XI dari salah satu SMA di Kota Malang. Sampel terdiri atas siswa kelas kontrol dan eksperimen yang berjumlah 32 siswa dan 34 siswa dengan rentang usia 16-19 tahun. Penelitian ini menggunakan instrumen utama berupa *four-tier test* GBS dan angket ATP berskala Likert 4 poin. Analisis perubahan konsepsi dilakukan dengan perhitungan *N-Change* dari skor konsepsi, perubahan konsepsi dilakukan dengan melakukan kodifikasi dan simbolisasi proses perubahan tingkat konsepsi setiap siswa di setiap konsep, efektivitas perubahan konsepsi dilakukan dengan uji beda melalui hipotesis, dan pengungkapan ATP dilakukan dengan analisis Rasch *Wright Map*. Hasil penelitian ini menunjukkan bahwa media VirtumFi terbukti valid secara konten dan konstruk oleh para ahli serta praktis oleh para responden siswa. Perubahan konsepsi yang terjadi siswa memiliki rentang nilai *N-Change* sebesar 0,06 – 0,66 untuk kelas kontrol dan 0,25 – 0,51 untuk kelas eksperimen. Proses perubahan konsepsi menunjukkan bahwa siswa kelas kontrol dan eksperimen sama-sama memiliki kecenderungan untuk mengalami proses perubahan dengan kategori *Acceptable Change*. Apabila dibandingkan, pembelajaran media VirtumFi melalui ECIRR (kelas eksperimen) lebih mampu meningkatkan pemahaman konsep siswa pada gelombang berjalan dan stasioner daripada pembelajaran model ECIRR saja (kelas kontrol). Maka dari itu, media VirtumFi dapat dikatakan efektif untuk pembelajaran fisika pada topik gelombang berjalan dan stasioner. Selain itu, siswa kelas kontrol dan eksperimen cenderung memiliki ATP yang bernilai positif. Dengan demikian, pembelajaran gelombang berjalan dan stasioner yang dilakukan dapat mendorong siswa untuk memiliki ATP positif.

Kata kunci: Laboratorium virtual, perubahan konsepsi, perubahan konsepsi, *Attitude Toward Physics* (ATP), gelombang berjalan dan stasioner, *embedded mixed methods*.

IMPLEMENTATION OF ANDROID-BASED VIRTUMFI TO CHANGING CONCEPTION ON WAVES AND DISCLOSURE OF ATTITUDE TOWARDS PHYSICS PROFILES FOR HIGH SCHOOL STUDENTS

Fatah Kurniawan
2105539

1st Supervisor: Dr. Achmad Samsudin, M.Pd.

2nd Supervisor: Dr. Didi Teguh Chandra, M.Si.

Magister of Physics Education Study Program FPMIPA UPI

ABSTRACT

Transverse and stationary waves (GBS) are important topics that are closely related to current technological advances. However, the importance of this topic is not in line with the high conceptual understanding of high school students towards related topics. This situation is supported by the fact that some high school students still have a negative attitude toward physics (ATP). Handling efforts have been made, but there are still some deficiencies and suggestions from previous studies. Therefore, this study aims to analyze the conceptual change of high school students in waves and to disclose their ATP through the application of Android-based VirtumFi. The method used in this research is mixed-methods research. The research design used is an embedded experimental model with a pre-test-post-test control group design. The sample for this research is a class XI student from a high school in Malang City. The sample consisted of control and experimental class students, totaling 32 and 34 students, with an age range of 16–19 years. This study used the main instrument in the form of a four-tier GBS test and a 4-point Likert scale ATP questionnaire. The analysis of the quantity of conceptual change was carried out by calculating the N-Change of the conception score; the quality of conceptual change was carried out by codifying and symbolizing the process of changing the level of conception of each student in each concept; the effectiveness of the conceptual change was carried out through different tests through hypotheses; and the disclosure of ATP was carried out by analysis of the Rasch-Wright Map. The results of this study indicate that VirtumFi media is proven to be valid in terms of content and construct by experts and practically by student respondents. The quantity of conceptual change that occurs in students has a range of N-Change values of 0.06–0.66 for the control class and 0.25–0.51 for the experimental class. The quality of conceptual change shows that control and experimental class students both tend to experience a change process in the Acceptable Change category. When compared, learning VirtumFi media through ECIRR (experimental class) is more able to improve students' understanding of concepts in running and stationary waves than learning the ECIRR model alone (control class). Therefore, VirtumFi media can be said to be effective for learning physics on the topic of transverse and stationary waves. In addition, control and experimental class students tend to have positive ATP values. Thus, the learning of transverse and stationary waves that are carried out can encourage students to have positive ATP.

Keywords: Virtual laboratory, quantity of conceptual change, quality of conceptual change, Attitude Toward Physics (ATP), transverse and stationary waves, embedded mixed methods.

DAFTAR ISI

PERNYATAAN.....	iii
ABSTRAK.....	iv
ABSTRACT.....	v
DAFTAR ISI.....	vi
DAFTAR TABEL.....	ix
DAFTAR GAMBAR.....	xii
BAB I PENDAHULUAN.....	1
1.1 Latar Belakang Penelitian.....	1
1.2 Rumusan Masalah Penelitian.....	12
1.3 Tujuan Penelitian.....	13
1.4 Hipotesis Penelitian.....	13
1.5 Manfaat Penelitian.....	13
1.5.1 Manfaat Praktis.....	13
1.5.2 Manfaat Teoretis.....	13
1.6 Definisi Operasional.....	14
1.6.1 Kelayakan VirtumFi: Gelombang Berjalan dan Stasioner sebagai Media Laboratorium.....	14
1.6.2 Kuantitas Perubahan Konsepsi (termasuk Four-Tier Test).....	15
1.6.3 Proses Pengubahan Konsepsi.....	16
1.6.4 Efektivitas Perubahan Konsepsi.....	16
1.6.5 Pengungkapan Profil Attitude Towards Physics.....	17
1.7 Struktur Organisasi Tesis.....	18
BAB II KAJIAN PUSTAKA.....	19
2.1 Media Pembelajaran VirtumFi melalui Model ECIRR.....	19
2.1.1 Media Pembelajaran VirtumFi.....	19
2.1.2 Android.....	22
2.1.3 Model ECIRR.....	24
2.1.4 Penerapan VirtumFi dipadukan dengan Model ECIRR.....	27
2.1.5 Kriteria Kelayakan VirtumFi.....	28
2.2 Perubahan Konsepsi.....	31
2.2.1 Konsep, Konsepsi, Miskonsepsi.....	31
2.2.2 Tes Diagnostik.....	33
2.2.3 Karakteristik Pengubahan Konsepsi.....	35

2.3 Profil Attitude Towards Physics (ATP).....	37
2.3.1 Sikap Sains	37
2.3.2 <i>Attitude Towards Physics</i> (ATP).....	38
2.3.3 Karakter Profil ATP	39
2.4 Konsep Gelombang Berjalan dan Stasioner	40
2.4.1 Analisis Kurikulum topik Gelombang Berjalan dan Stasioner	40
2.4.2 Miskonsepsi pada Gelombang Berjalan dan Stasioner	41
2.4.3 Konsep Esensial Gelombang Berjalan dan Stasioner.....	42
2.5 Hubungan VirtumFi melalui Model ECIRR terhadap Perubahan Konsepsi dan Pengungkapan Profil ATP	54
2.6 Penelitian yang Relevan	57
2.7 Kerangka Pikir Penelitian.....	59
2.7.1 Laboratorium Virtual	60
2.7.2 Laboratorium Virtual dan Pemahaman Siswa	61
2.7.3 Laboratorium Virtual dan Sikap Sains Siswa	64
BAB III METODE PENELITIAN.....	66
3.1 Desain Penelitian	66
3.2 Populasi dan Sampel.....	67
3.3 Instrumen Penelitian	68
3.3.1 Instrumen Four-Tier Test Gelombang Berjalan dan Stasioner	69
3.3.2 Instrumen Angket IMPAS.....	83
3.3.3 Lembar Observasi Keterlaksanaan Pembelajaran	95
3.3.4 Lembar Petunjuk Wawancara tentang ATP Siswa.....	95
3.4 Prosedur Penelitian	96
3.4.1 Pra-Penelitian Inti.....	96
3.4.2 Penelitian Inti.....	99
3.4.3 Pasca-Penelitian Inti	99
3.5 Analisis Data.....	100
3.5.1 Analisis Kelayakan VirtumFi	100
3.5.2 Analisis Kuantitas Perubahan Konsepsi GBS	101
3.5.3 Analisis Proses Perubahan Konsepsi GBS	104
3.5.4 Analisis Efektivitas Perubahan Konsepsi GBS	105
3.5.5 Analisis Pengungkapan ATP.....	111
BAB IV TEMUAN DAN PEMBAHASAN	113
4.1 Kelayakan VirtumFi.....	113

4.1.1 Define	113
4.1.2 Design.....	114
4.1.3 Develop.....	120
4.1.4 Disseminate	148
4.2 Kuantitas Perubahan Konsepsi GBS	154
4.2.1 Sub-topik Gelombang Transversal dan Longitudinal (GTL)	155
4.2.2 Sub-topik Hubungan Frekuensi, Cepat rambat, dan Panjang Gelombang (FCP).....	164
4.2.3 Sub-topik Pemantulan dan Superposisi Gelombang (PSG)	173
4.2.4 Sub-topik Gelombang Stasioner pada Tali (GST).....	185
4.3 Proses Pengubahan Konsepsi GBS.....	196
4.3.1 Proses Pengubahan pada Sub-topik GTL	197
4.3.2 Proses Pengubahan pada Sub-topik FCP.....	284
4.3.3 Proses Pengubahan pada Sub-topik PSG	374
4.3.4 Proses Pengubahan pada sub-topik GST.....	504
4.4 Efektivitas Perubahan Konsepsi GBS	615
4.4.1 Uji Normalitas	615
4.4.2 Uji Homogenitas.....	616
4.4.3 Uji Beda.....	617
4.4.4 Uji Lanjutan: <i>Effect Size</i>	618
4.5 Pengungkapan ATP	619
4.5.1 Karakteristik ATP pada Kelas Kontrol	619
4.5.2 Karakteristik ATP pada Kelas Eksperimen.....	623
4.5.3 Perbandingan ATP di Kelas Kontrol dan Ekseprimen.....	626
BAB V SIMPULAN, IMPLIKASI, DAN REKOMENDASI	630
5.1 Simpulan.....	630
5.2 Implikasi	632
5.3 Rekomendasi.....	633
DAFTAR RUJUKAN	635

DAFTAR TABEL

Tabel 1.1. Uraian Konsep pada Setiap Soal.....	2
Tabel 1.2. Studi literatur terkait konsep Gelombang yang belum dipahami siswa SMA berdasarkan penelitian sebelumnya	4
Tabel 2.1. Kriteria Kelayakan Media Pembelajaran Interaktif.....	28
Tabel 2.2. Kriteria Kelayakan Laboratorium Virtual yang telah diterapkan pengembang terdahulu	29
Tabel 2.3. Kriteria Validitas VirtumFi	29
Tabel 2.4. Rubrik keputusan tingkatan konsepsi siswa pada instrumen <i>four-tier</i>	34
Tabel 2.5. Kategori Perubahan Konsepsi.....	35
Tabel 2.6. Analisis Kurikulum topik Gelombang Berjalan dan Stasioner.....	40
Tabel 2.7. Miskonsepsi Siswa SMA berdasarkan Konsepnya.....	41
Tabel 2.8. Perbedaan Gelombang Transversam dan Longitudinal	44
Tabel 2.9. Hubungan Antara VirtumFi melalui Model ECIRR, Perubahan Konsepsi, dan Profil ATP	55
Tabel 3.1. Penjabaran Instrumen dalam Penelitian Tesis	68
Tabel 3.2. Sebaran Kisi-kisi Konstruksi Soal CIIWASTRA	70
Tabel 3.3. Daftar Simbol untuk Uji Validitas CIIWASTRA.....	73
Tabel 3.4. Petunjuk Interpretasi <i>Raw variance explained by measures</i>	76
Tabel 3.5. Hasil Uji <i>Item Dimensionality</i> CIIWASTRA	77
Tabel 3.6. Korelasi Terbesar antar Butir Soal Berdasarkan Sub-topik.....	77
Tabel 3.7. Rentang Pemenuhan Nilai MNSQ, ZSTD, dan PTMEASUR-AL CORR	78
Tabel 3.8. Interpretasi dari MNSQ, ZSTD, dan PTMEASUR-AL CORR.....	78
Tabel 3.9. Hasil Analisis Kesesuaian Butir pada Soal CIIWASTRA	79
Tabel 3.10. Kriteria Tingkat Kesukaran Butir CIIWASTRA.....	80
Tabel 3.11. Hasil Analisis Tingkat Kesukaran Butir Soal CIIWASTRA.....	80
Tabel 3.12. Syarat Nilai <i>Person Reliability</i> dan <i>Item Reliability</i>	81
Tabel 3.13. Syarat Nilai <i>Cronbach Alpha</i> (α).....	82
Tabel 3.14. Hasil Analisis Reliabilitas IMPAS.....	82
Tabel 3.15. Sebaran Karakteristik Butir Pernyataan Soal CIIWASTRA.....	83
Tabel 3.16. Sebaran Kisi-kisi Konstruksi Butir Pernyataan IMPAS	85
Tabel 3.17. Daftar Simbol untuk Uji Validitas IMPAS.....	87
Tabel 3.18. Hasil Uji <i>Item Dimensionality</i> IMPAS	89
Tabel 3.19. Korelasi Terbesar antar Butir Pernyataan di Setiap Faktor.....	90
Tabel 3.20. Hasil Analisis Kesesuaian Butir pada Angket IMPAS.....	91
Tabel 3.21. Kriteria Tingkat Kesukaran Angket IMPAS	93
Tabel 3.22. Hasil Analisis Tingkat Kesukaran Angket IMPAS	93
Tabel 3.23. Hasil Analisis Reliabilitas IMPAS.....	94
Tabel 3.24. Sebaran Karakteristik Butir Pernyataan Soal IMPAS.....	94
Tabel 3.25. Interpretasi Keterlaksanaan Pembelajaran.....	95
Tabel 3.26. Tahapan-tahapan Pengembangan VirtumFi	98
Tabel 3.27. Petunjuk Penskoran Uji Validitas VirtumFi.....	100
Tabel 3.28. Petunjuk Penskoran Uji Coba VirtumFi	101
Tabel 3.29. Kriteria Kepraktisan Media VirtumFi.....	101

Tabel 3.30. Rubrik Keputusan Tingkatan Konsepsi Siswa Menggunakan CIIWASTRA	102
Tabel 3.31. Persamaan <i>N-change</i> (<i>c</i>) berdasarkan keadaan skor siswa	102
Tabel 3.32. Penentuan Kategori Perubahan Konsepsi Siswa	103
Tabel 3.33. Interpretasi Tipe Perubahan Konsepsi	104
Tabel 3.34. Kategori Pengubahan Konsepsi Siswa	104
Tabel 3.35. Interpretasi Hasil Uji <i>Effect Size</i>	111
Tabel 3.36. Rubrik Penskoran IMPAS.....	112
Tabel 4.1. Hasil Temuan pada Setiap Sub-tahapan.....	113
Tabel 4.2. Daftar Kode untuk Uji Validitas Konten Media VirtumFi.....	122
Tabel 4.3. Rekapitulasi Validasi Konten Media VirtumFi pada Sub-topik GTL.....	126
Tabel 4.4. Rekapitulasi Validasi Konten Media VirtumFi pada Sub-topik FCP.....	126
Tabel 4.5. Rekapitulasi Validasi Konten Media VirtumFi pada Sub-topik PSG	127
Tabel 4.6. Rekapitulasi Validasi Konten Media VirtumFi pada Sub-topik GST	127
Tabel 4.7. Daftar Kode untuk Uji Validitas Konstruk Media VirtumFi.....	132
Tabel 4.8. Rekapitulasi Validasi Konstruk Media VirtumFi pada Sub-topik GTL.....	135
Tabel 4.9. Rekapitulasi Validasi Konstruk Media VirtumFi pada Sub-topik FCP.....	136
Tabel 4.10. Rekapitulasi Validasi Konstruk Media VirtumFi pada Sub-topik PSG	137
Tabel 4.11. Rekapitulasi Validasi Konstruk Media VirtumFi pada Sub-topik GST	139
Tabel 4.12. Perbaikan Media VirtumFi secara Konstruk.....	142
Tabel 4.13. Daftar Kode untuk Uji Kepraktisan Media VirtumFi	146
Tabel 4.14. Persentase Rata-rata Setiap Indikator Kepraktisan Media VirtumFi	148
Tabel 4.15. Sebaran Kegiatan dan Keterlaksanaan Pembelajaran di Kelas Kontrol dan Eksperimen	149
Tabel 4.16. Keunggulan VirtumFi dibandingkan dengan Media Pembelajaran GBS Lain	152
Tabel 4.17. Keunggulan VirtumFi Secara Teoretis.....	154
Tabel 4.18. Hasil <i>N-Change</i> Siswa Kelas Kontrol pada Sub-topik GTL	155
Tabel 4.19. Hasil <i>N-Change</i> Siswa Kelas Eksperimen pada Sub-topik GTL.....	156
Tabel 4.20. Hasil TK dan PTK Sub-topik GTL pada Kelas Kontrol.....	159
Tabel 4.21. Hasil TK dan PTK Sub-topik GTL pada Kelas Eksperimen	159
Tabel 4.22. Hasil <i>N-Change</i> Siswa Kelas Kontrol pada Sub-topik FCP	164
Tabel 4.23. Hasil <i>N-Change</i> Siswa Kelas Eksperimen pada Sub-topik FCP	165
Tabel 4.24. Hasil TK dan PTK Sub-topik FCP pada Kelas Kontrol.....	167
Tabel 4.25. Hasil TK dan PTK Sub-topik FCP pada Kelas Eksperimen.....	167
Tabel 4.26. Hasil <i>N-Change</i> Siswa Kelas Kontrol pada Sub-topik PSG.....	173
Tabel 4.27. Hasil <i>N-Change</i> Siswa Kelas Eksperimen pada Sub-topik PSG	174
Tabel 4.28. Hasil TK dan PTK Sub-topik PSG pada Kelas Kontrol	177
Tabel 4.29. Hasil TK dan PTK Sub-topik PSG pada Kelas Eksperimen.....	177
Tabel 4.30. Hasil <i>N-Change</i> Siswa Kelas Kontrol pada Sub-topik GST.....	185
Tabel 4.31. Hasil <i>N-Change</i> Siswa Kelas Eksperimen pada Sub-topik GST	186
Tabel 4.32. Hasil TK dan PTK Sub-topik GST pada Kelas Kontrol.....	189
Tabel 4.33. Hasil TK dan PTK Sub-topik GST pada Kelas Eksperimen	189
Tabel 4.34. Perbandingan Proses Pengubahan Konsep Soal GTL1 pada Kelas Kontrol dengan Kelas Eksperimen.....	206
Tabel 4.35. Perbandingan Proses Pengubahan Konsep Soal GTL2 pada Kelas Kontrol dengan Kelas Eksperimen.....	241

Tabel 4.36. Perbandingan Proses Pengubahan Konsep Soal GTL3 pada Kelas Kontrol dengan Kelas Eksperimen.....	265
Tabel 4.37. Perbandingan Proses Pengubahan Konsep Soal FCP1 pada Kelas Kontrol dengan Kelas Eksperimen.....	293
Tabel 4.38. Perbandingan Proses Pengubahan Konsep Soal FCP2 pada Kelas Kontrol dengan Kelas Eksperimen.....	314
Tabel 4.39. Perbandingan Proses Pengubahan Konsep Soal FCP3 pada Kelas Kontrol dengan Kelas Eksperimen.....	333
Tabel 4.40. Perbandingan Proses Pengubahan Konsep Soal FCP4 pada Kelas Kontrol dengan Kelas Eksperimen.....	356
Tabel 4.41. Perbandingan Proses Pengubahan Konsep Soal PSG1 pada Kelas Kontrol dengan Kelas Eksperimen.....	383
Tabel 4.42. Perbandingan Proses Pengubahan Konsep Soal PSG1 pada Kelas Kontrol dengan Kelas Eksperimen.....	405
Tabel 4.43. Perbandingan Proses Pengubahan Konsep Soal PSG3 pada Kelas Kontrol dengan Kelas Eksperimen.....	430
Tabel 4.44. Perbandingan Proses Pengubahan Konsep Soal PSG4 pada Kelas Kontrol dengan Kelas Eksperimen.....	464
Tabel 4.45. Perbandingan Proses Pengubahan Konsep Soal PSG5 pada Kelas Kontrol dengan Kelas Eksperimen.....	484
Tabel 4.46. Perbandingan Proses Pengubahan Konsep Soal GST1 pada Kelas Kontrol dengan Kelas Eksperimen.....	513
Tabel 4.47. Perbandingan Proses Pengubahan Konsep Soal GST2 pada Kelas Kontrol dengan Kelas Eksperimen.....	531
Tabel 4.48. Perbandingan Proses Pengubahan Konsep Soal GST3 pada Kelas Kontrol dengan Kelas Eksperimen.....	552
Tabel 4.49. Perbandingan Proses Pengubahan Konsep Soal GST4 pada Kelas Kontrol dengan Kelas Eksperimen.....	572
Tabel 4.50. Perbandingan Proses Pengubahan Konsep Soal GST5 pada Kelas Kontrol dengan Kelas Eksperimen.....	592
Tabel 4.51. Butir IMPAS yang Sangat Mudah disepakati oleh Siswa Kelas Kontrol	620
Tabel 4.52. Butir IMPAS yang Sangat Sulit disepakati oleh Siswa Kelas Kontrol	621
Tabel 4.53. Butir IMPAS yang Sangat Mudah disepakati oleh Siswa Kelas Eksperimen	624
Tabel 4.54. Butir IMPAS yang Sangat Sulit disepakati oleh Siswa Kelas Eksperimen .	624
Tabel 4.55. Butir IMPAS yang Sulit disepakati oleh Siswa Kelas Eksperimen, tetapi Mudah disepakati oleh Siswa Kelas Kontrol	628

DAFTAR GAMBAR

Gambar 1.1. Baseline Profil Konsepsi Siswa pada Topik GBS untuk Setiap Soal	2
Gambar 1.2. Baseline Profil ATP siswa SMA di Lapangan.....	7
Gambar 1.3. Persentase Pengguna Gawai berdasarkan Operating System-nya di Indonesia	11
Gambar 2.1. Arsitektur di dalam MOS Android	22
Gambar 2.2. Gelombang berjalan pada tali	43
Gambar 2.3. Perbandingan Gelombang pada (a) kolom udara dan (b) tali	43
Gambar 2.4. Perbedaan cepat rambat gelombang (<i>velocity wave</i>) dan kecepatan getar partikel pada tali (<i>velocity of rope particle</i>)	45
Gambar 2.5. Perambatan getaran gelombang pada tali beserta besarnya	46
Gambar 2.6. Pemantulan gelombang tali pada tali ujung terikat.....	48
Gambar 2.7. Pemantulan gelombang tali pada tali ujung bebas.....	49
Gambar 2.8. Pulsa gelombang yang saling mendekati.....	50
Gambar 2.9. Fenomena superposisi pada dua pulsa gelombang yang memiliki tanda amplitudo sama	51
Gambar 2.10. Fenomena superposisi pada dua pulsa gelombang yang memiliki amplitudo berlawanan tanda	52
Gambar 2.11. Kemungkinan bentuk gelombang baru hasil gabungan gelombang datang dan gelombang pantul pada tali ujung terikat	53
Gambar 2.12. Bagan <i>framework</i> penelitian tesis.....	60
Gambar 3.1. Skema mixed-methods dengan embedded experimental model design	66
Gambar 3.2. Alur Pengembangan Instrumen CIIWASTRA.....	70
Gambar 3.3. Contoh Butir Soal CIIWASTRA berformat <i>Four-tier Test</i>	72
Gambar 3.4. Hasil Validasi Konten dari CIIWASTRA	74
Gambar 3.5. Alur Pengembangan Instrumen IMPAS.....	84
Gambar 3.6. Contoh Butir Pernyataan pada Angket IMPAS.....	86
Gambar 3.7. Hasil Validasi Konten dari IMPAS	88
Gambar 3.8. <i>Flow-chart</i> Penelitian Tesis	96
Gambar 3.9. Kemungkinan Proses Pengubahan Konsepsi Siswa	105
Gambar 4.1. Contoh Storyboard Fitur Main Menu pada VirtumFi	116
Gambar 4.2. Contoh <i>Storyboard</i> Halaman Utama pada Sub-topik 1	117
Gambar 4.3. Contoh <i>Storyboard</i> Layar Praktikum Virtual pada Sub-topik	118
Gambar 4.4. <i>Storyboard</i> Materi Konten Fisika pada Sub-topik	119
Gambar 4.5. Fitur dalam VirtumFi untuk Model ECIRR.....	120
Gambar 4.6. <i>Flowchart</i> Pembuatan Media VirtumFi	121
Gambar 4.7. Hasil Analisis Varians Pengukuran Validitas Konten Media VirtumFi.....	123
Gambar 4.8. Hasil Uji Rater Validitas Konten Media VirtumFi.....	124
Gambar 4.9. Tampilan Petunjuk Penggunaan VirtumFi Sebelum Revisi.....	128
Gambar 4.10. Tampilan Petunjuk Penggunaan VirtumFi Setelah Revisi	129
Gambar 4.11. Contoh Tampilan Animasi Praktikum di PSG Sebelum Revisi	130
Gambar 4.12. Contoh Tampilan Animasi Praktikum di PSG Setelah Revisi	131
Gambar 4.13. Hasil Analisis Varians Pengukuran Validitas Konstruk Media VirtumFi	133
Gambar 4.14. Hasil Uji Rater Validitas Konstruk Media VirtumFi.....	133

Gambar 4.15. Hasil Analisis Varians Pengukuran Uji Coba Media VirtumFi.....	147
Gambar 4.16. Hasil Uji Rater pada Uji Coba Media VirtumFi	147
Gambar 4.17. Respons Siswa Kelas Eksperimen Tentang Sikap terhadap Media VirtumFi	150
Gambar 4.18. Respons Siswa Kelas Eksperimen Tentang Pemahaman di setiap Sub-topik terhadap Media VirtumFi	151
Gambar 4.19. Perbandingan Kategori <i>N-Change</i> pada Sub-topik GTL	157
Gambar 4.20. Perbandingan Pola PTK pada GTL1 di Kelas Kontrol dan Eksperimen	160
Gambar 4.21. Perbandingan Pola PTK pada GTL2 di Kelas Kontrol dan Eksperimen	161
Gambar 4.22. Perbandingan Pola PTK pada GTL3 di Kelas Kontrol dan Eksperimen	163
Gambar 4.23. Perbandingan Kategori <i>N-Change</i> pada Sub-topik FCP.....	166
Gambar 4.24. Perbandingan Pola PTK pada FCP1 di Kelas Kontrol dan Eksperimen.	168
Gambar 4.25. Perbandingan Pola PTK pada FCP2 di Kelas Kontrol dan Eksperimen.	169
Gambar 4.26. Perbandingan Pola PTK pada FCP3 di Kelas Kontrol dan Eksperimen.	170
Gambar 4.27. Perbandingan Pola PTK pada FCP4 di Kelas Kontrol dan Eksperimen.	172
Gambar 4.28. Perbandingan Kategori <i>N-Change</i> pada Sub-topik PSG	175
Gambar 4.29. Perbandingan Pola PTK pada PSG1 di Kelas Kontrol dan Eksperimen	178
Gambar 4.30. Perbandingan Pola PTK pada PSG2 di Kelas Kontrol dan Eksperimen	179
Gambar 4.31. Perbandingan Pola PTK pada PSG3 di Kelas Kontrol dan Eksperimen	180
Gambar 4.32. Perbandingan Pola PTK pada PSG4 di Kelas Kontrol dan Eksperimen	182
Gambar 4.33. Perbandingan Pola PTK pada PSG5 di Kelas Kontrol dan Eksperimen	184
Gambar 4.34. Perbandingan Kategori <i>N-Change</i> pada Sub-topik GST	187
Gambar 4.35. Perbandingan Pola PTK pada GST1 di Kelas Kontrol dan Eksperimen	190
Gambar 4.36. Perbandingan Pola PTK pada GST2 di Kelas Kontrol dan Eksperimen	191
Gambar 4.37. Perbandingan Pola PTK pada GST3 di Kelas Kontrol dan Eksperimen	193
Gambar 4.38. Perbandingan Pola PTK pada GST4 di Kelas Kontrol dan Eksperimen	194
Gambar 4.39. Perbandingan Pola PTK pada GST5 di Kelas Kontrol dan Eksperimen	195
Gambar 4.40. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Pengubahan Konsep sub-topik GTL di Kelas Kontrol	198
Gambar 4.41. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Pengubahan Konsep sub-topik GTL di Kelas Eksperimen.....	200
Gambar 4.42. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GTL1	202
Gambar 4.43. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GTL1	204
Gambar 4.44. Gambar untuk Butir Soal GTL1	235
Gambar 4.45. Siswa Kelas Kontrol Memanfaatkan Slingki untuk Eksperimen GTL...	236
Gambar 4.46. LKPD Sub-topik GTL pada Siswa Kelas Kontrol.....	236
Gambar 4.47. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GTL2	237
Gambar 4.48. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GTL2	239
Gambar 4.49. Gambar untuk Butir Soal GTL2	258
Gambar 4.50. Tampilan VirtumFi terkait Konsep GTL2.....	258
Gambar 4.51. Siswa Kelas Kontrol Memanfaatkan Slingki untuk Eksperimen GTL...	259
Gambar 4.52. LKPD GTL Siswa kelas Eksperimen	260
Gambar 4.53. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GTL3	261
Gambar 4.54. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GTL3	263
Gambar 4.55. Gambar untuk Butir Soal GTL3	283
Gambar 4.56. Tampilan VirtumFi terkait Konsep GTL3.....	283
Gambar 4.57. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Pengubahan Konsep sub-topik FCP di Kelas Kontrol.....	285

Gambar 4.58. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Perubahan Konsep sub-topik FCP di Kelas Eksperimen	287
Gambar 4.59. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal FCP1.....	289
Gambar 4.60. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal FCP1	291
Gambar 4.61. Gambar untuk Butir Soal FCP1	309
Gambar 4.62. Tampilan VirtumFi Berkaitan dengan FCP1.....	309
Gambar 4.63. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal FCP2.....	310
Gambar 4.64. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal FCP2	312
Gambar 4.65. Teks Deskripsi untuk Butir Soal FCP2.....	327
Gambar 4.66. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep FCP2....	327
Gambar 4.67. Tampilan Materi pada VirtumFi terkait Konsep FCP2	328
Gambar 4.68. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal FCP3.....	329
Gambar 4.69. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal FCP3	330
Gambar 4.70. Gambar untuk Butir Soal FCP3	350
Gambar 4.71. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep FCP3....	350
Gambar 4.72. Jawaban LKPD tentang Cepat Rambat dengan Laju dan Besar Hentakan dari Siswa Kelas Kontrol	351
Gambar 4.73. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal FCP4.....	352
Gambar 4.74. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal FCP4	354
Gambar 4.75. Gambar untuk Butir Soal FCP4.....	372
Gambar 4.76. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep FCP4....	372
Gambar 4.77. Jawaban LKPD tentang Cepat Rambat dengan Laju dan Besar Hentakan dari Siswa Kelas Eksperimen.....	373
Gambar 4.78. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Perubahan Konsep sub-topik PSG di Kelas Kontrol.....	375
Gambar 4.79. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Perubahan Konsep sub-topik PSG di Kelas Eksperimen.....	377
Gambar 4.80. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal PSG1	379
Gambar 4.81. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal PSG1	381
Gambar 4.82. Gambar untuk Butir Soal PSG1	399
Gambar 4.83. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep PSG1....	399
Gambar 4.84. Tampilan Materi pada VirtumFi terkait Konsep PSG1	400
Gambar 4.85. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal PSG2	401
Gambar 4.86. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal PSG2	403
Gambar 4.87. Contoh Jawaban LKPD Siswa kelas Kontrol mengenai Pemantulan Gelombang setelah Pembelajaran	422
Gambar 4.88. Gambar untuk Butir Soal PSG2.....	423
Gambar 4.89. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep PSG2....	424
Gambar 4.90. Tampilan Materi pada VirtumFi terkait Konsep PSG2.....	425
Gambar 4.91. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal PSG3	426
Gambar 4.92. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal PSG3	428
Gambar 4.93. Gambar untuk Butir Soal PSG3.....	458
Gambar 4.94. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep PSG3....	458
Gambar 4.95. Tampilan Materi pada VirtumFi terkait Konsep PSG3.....	459
Gambar 4.96. Kode Perubahan Konsepsi Siswa Kelas Kontrol pada Soal PSG4	460
Gambar 4.97. Kode Perubahan Konsepsi Siswa Kelas Eksperimen pada Soal PSG4	462
Gambar 4.98. Gambar untuk Butir Soal PSG4.....	477
Gambar 4.99. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep PSG4....	477

Gambar 4.100. Tampilan Materi pada VirtumFi terkait Konsep PSG3	478
Gambar 4.101. Contoh Jawaban Siswa Eksperimen pada LKPD Superposisi.....	479
Gambar 4.102. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal PSG5	480
Gambar 4.103. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal PSG5	482
Gambar 4.104. Gambar untuk Butir Soal PSG5.....	503
Gambar 4.105. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep PSG5..	503
Gambar 4.106. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Pengubahan Konsep sub-topik GST di Kelas Kontrol	505
Gambar 4.107. <i>Wright Map</i> dari Analisis <i>Stacking</i> pada Pengubahan Konsep sub-topik GST di Kelas Eksperimen.....	507
Gambar 4.108. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GST1	509
Gambar 4.109. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GST1	511
Gambar 4.110. Teks Deskripsi untuk Butir Soal GST1	524
Gambar 4.111. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep GST1..	525
Gambar 4.112. Tampilan Materi pada VirtumFi terkait Konsep GST1	526
Gambar 4.113. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GST2	527
Gambar 4.114. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GST2	529
Gambar 4.115. Contoh Jawaban LKPD Gelombang Stasioner dari Siswa Kelas Kontrol	545
Gambar 4.116. Gambar Stimulus untuk Butir Soal GST2.....	546
Gambar 4.117. Tampilan Laboratorium Virtual pada VirtumFi terkait Konsep GST2..	547
Gambar 4.118. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GST3	548
Gambar 4.119. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GST3	550
Gambar 4.120. Teks Deskripsi untuk Butir Soal GST3.....	566
Gambar 4.121. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GST4	568
Gambar 4.122. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GST4	570
Gambar 4.123. Tabel Data untuk Butir Soal GST4.....	586
Gambar 4.124. Aktivitas Presentasi Grafik terkait Panjang Gelombang Stasioner dan Massa Beban	587
Gambar 4.125. Kode Pengubahan Konsepsi Siswa Kelas Kontrol pada Soal GST5	588
Gambar 4.126. Kode Pengubahan Konsepsi Siswa Kelas Eksperimen pada Soal GST5	590
Gambar 4.127. Teks Deskripsi untuk Butir Soal GST5.....	612
Gambar 4.128. Tampilan Materi Terkait Konsep GST5.....	613
Gambar 4.129. Contoh Jawaban LKPD Hubungan Frekuensi-Amplitudo Gelombang Stasioner dari Siswa Kelas Eksperimen.....	614
Gambar 4.130. Hasil Uji Normalitas Data melalui SPSS	616
Gambar 4.131. Hasil Uji Normalitas Data melalui SPSS.....	617
Gambar 4.132. Hasil Olahan Uji t melalui SPSS	618
Gambar 4.133. <i>Wright Map</i> dari Karakteristik ATP Siswa Kelas Kontrol	620
Gambar 4.134. <i>Wright Map</i> dari Karakteristik ATP Siswa Kelas Eksperimen.....	623
Gambar 4.135. Perbandingan <i>Wright Map Item</i> terkait ATP pada Masing-masing Kelas	626

DAFTAR RUJUKAN

- Aâyıksoy, G., & Islek, D. (2017). The Impact of the Virtual Laboratory on Students' Attitude in a General Physics Laboratory. *International Journal of Online and Biomedical Engineering (IJOE)*, 13(04), 20-28.
- Abdjul, T., & Ntobuo, N. E. (2019). Penerapan media pembelajaran virtual laboratory berbasis phet terhadap hasil belajar siswa pada materi gelombang. *JPFT (Jurnal Pendidikan Fisika Tadulako Online)*, 7(3).
- Adadan, E., & Savasci. (2012). An Analysis of 16–17 Year-Old Students' Understanding of Solution Chemistry Concepts Using a Two-Tier Diagnostic Instrument. *International Journal of Science Education*, 34(4), 513–544.
- Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, M., Finkelstein, N. D., & Wieman, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physical Review Special Topics-Physics Education Research*, 2, 010101. doi:10.1103/PhysRevSTPER.2.010101.
- Adesina, A. O., & Akinbobola, A. O. (2005). The attitude of students towards part-time degree programme of the faculty of education, Obafemi Awolowo University, Ile-Ife. *Journal of Research of Education*, 2(1), 1-4.
- Agus, P., Nur, A., Syamsul, H., & Nita, A. (2020). The effects of the ECIRR learning model on mathematical reasoning ability in the curriculum perspective 2013: Integration on student learning motivation. *European Journal of Educational Research*, 9(2), 675-684.
- Ahlgren, A., & Walberg, H. J. (1973). Changing attitudes towards science among adolescents. *Nature*, 24, 187–190. doi: 10.1038/245187a0.
- Ahmad, F., & Khan, R. A. (2015). A power comparison of various normality tests. *Pakistan Journal of Statistics and Operation Research*, 331-345.
- Aisyah, D. D., & Sucahyo, I. (2022). Pengembangan Media Pembelajaran E-Book Berbasis Mobile Learning dan Pendekatan Inkuiri pada Materi Gelombang untuk Meningkatkan Pemahaman Konsep Siswa. *Inovasi Pendidikan Fisika*, 11(3), 23-31.
- Alam, A. (2022). Employing adaptive learning and intelligent tutoring robots for virtual classrooms and smart campuses: reforming education in the age of artificial intelligence. In *Advanced Computing and Intelligent Technologies: Proceedings of ICACIT 2022* (pp. 395-406). Singapore: Springer Nature Singapore.
- Allen, I. E., & Seaman, J. (2017). *Digital learning compass: Distance education enrollment report 2017*. Babson Survey Group.

- Al-Mutawah, M. A., & Fateel, M. J. (2018). Students' Achievement in Math and Science: How Grit and Attitudes Influence?. *International Education Studies*, 11(2), 97-105.
- Amalina, W., & Fadly, W. (2021). Diagnostics of Self-Efficacy Assessment Instruments in The Form of Problem Gain Test Based on Science Education Material. *Indonesian Journal of Science Learning (IJSL)*, 2(2), 48-60.
- Ambusaidi, A., Al Musawi, A., Al-Balushi, S., & Al-Balushi, K. (2018). The Impact of Virtual Lab Learning Experiences on 9th Grade Students' Achievement and Their Attitudes towards Science and Learning by Virtual Lab. *Journal of Turkish Science Education*, 15(2), 13-29.
- Aminudin, A. H., Kaniawati, I., Suhendi, E., Samsudin, A., Coştu, B., & Adimayuda, R. (2019). Rasch analysis of Multitier Open-ended Light-Wave Instrument (MOLWI): Developing and assessing second-years sundanese-scholars alternative conceptions. *Journal for the Education of Gifted Young Scientists*, 7(3), 557-579.
- Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Boston, MA: Allyn & Bacon.
- Ansumarwati, F., & Busyairi, A. (2021). Analisis Hukum Kekekalan Momentum pada Permainan Tradisional Kelereng dengan Menggunakan Video Stop Motion untuk Meningkatkan Motivasi Belajar Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, 6(3), 517-521.
- Ansyah, T. A., Kusairi, S., Supriana, E., & Ibad, M. I. (2021). Profil miskonsepsi siswa sma pada materi gelombang mekanik. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 6(10), 1551-1557.
- Archibald, S. (2006). Narrowing in on educational resources that do affect student achievement. *Peabody Journal of Education*, 81(4), 23-42.
- Ardianti, A. D. (2018). Pengembangan tes diagnostik untuk mendeteksi miskonsepsi mahasiswa pada materi usaha dan energi. *Ed-Humanistics: Jurnal Ilmu Pendidikan*, 3(1).
- Ardianti, N. (2019). *Pengaruh Model Pembelajaran Ecirr (Elicit, Confront, Identify, Resolve, Reinforce) Terhadap Kemampuan Penalaran Matematis Ditinjau Dari Motivasi Belajar Siswa* (Doctoral dissertation, UIN Raden Intan Lampung).
- Arifin, R., Tandililing, E., & Hamdani, H. (2019). INTEGRASI REMEDIASI MISKONSEPSI PESERTA DIDIK DENGAN MODEL PEMBELAJARAN ECIRR BERBANTUANPHET SIMULATION MOMENTUM DAN IMPULS DI SMA. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, 8(6).
- Arista, F. S., & Kuswanto, H. (2018). Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding. *International Journal of Instruction*, 11(1), 1-16.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Arslan, H. O., C. Cigdemoglu, & C. Moseley. (2012). A Three-Tier Diagnostic Test to Assess PreService Teachers' Misconceptions about Global Warming, Greenhouse Effect, Ozone Layer Depletion, and Acid Rain. *International Journal of Science Education*, 34(11), 1667–1686. doi: 10.1080/09500693.2012.680618
- Astuti, W. P., Ramli, M., & Suranto, S. (2022). Validity and Practicality of Sangiran Site-Based Virtual Laboratory Learning Media on Evolutionary Materials to Empower Science Literacy. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1378-1384.
- Ayşe, D. I. (2018). Use of technology in constructivist approach. *Educational Research and Reviews*, 13(21), 704-711.
- Azeta, J., Bolu, C. A., Hinvi, D., Abioye, A. A., Boyo, H., Anakhu, P., & Onwordi, P. (2019). An android based mobile robot for monitoring and surveillance. *Procedia Manufacturing*, 35, 1129-1134.
- Babateen, H. (2011) The Role of Virtual Laboratories in Science Education 2011. *5th International Conference on Distance Learning and Education (Singapore), Vol 12 (Singapore: IACSIT Press)*, 100–104.
- Bainbridge, K., Shute, V., Rahimi, S., Liu, Z., Slater, S., Baker, R. S., & D'Mello, S. K. (2022). Does embedding learning supports enhance transfer during game-based learning?. *Learning and Instruction*, 77, 101547.
- Bajpai, M. & Kumar, A. (2015). Effect of Virtual Laboratory on Students' Conceptual Achievement in Physics. *International Journal of Current Research*, 7(2), 12808-12813.
- Bani, M., & Masruddin, M. (2021). Development of Android-based harmonic oscillation pocket book for senior high school students. *JOTSE: Journal of Technology and Science Education*, 11(1), 93-103.
- Barniol, P., & Zavala, G. (2016). Mechanical waves conceptual survey: Its modification and conversion to a standard multiple-choice test. *Physical Review Physics Education Research*, 12(1), 010107.
- Baser, M. (2006). Promoting conceptual change through active learning using open source software for physics simulations. *Australasian Journal of Educational Technology*, 22(3).
- Bauer, K., & Malek-Ahmadi, M. (2021). Meta-analysis of Controlled Oral Word Association Test (COWAT) FAS performance in amnesic mild cognitive impairment and cognitively unimpaired older adults. *Applied Neuropsychology: Adult*, 1-7.
- Beichner, R. J. (1994). Testing Student Interpretation of Kinematics Graphs. *American Journal of Physics*, 62(8), 750–762.
- Bejtkovský, J. (2016). The current generations: The baby boomers, X, Y and Z in the context of human capital management of the 21st century in selected corporations in the Czech Republic. *Littera scripta*, 9(2), 25-45.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Bell, B., Freyberg, P., & Osborne, R. (1997). *Learning in science: The implications of children's science*. Heinemann.
- Bloom, B. S. (1956). *Taxonomy of educational objectives, Handbook I: The cognitive domain*. New York, NY: David McKay Co Inc.
- Bogusevski, D., Muntean, C., & Muntean, G. M. (2020). Teaching and learning physics using 3D virtual learning environment: A case study of combined virtual reality and virtual laboratory in secondary school. *Journal of Computers in Mathematics and Science Teaching*, 39(1), 5-18.
- Bond, T. G., & Fox, C. M. (2015). *Applying the Rasch model: Fundamental measurement in the human sciences (2nd ed.)*. Mahwah, NJ: Lawrence Erlbaum.
- Bond, T. G., Yan, Z., & Heene, M. (2020). Applying the rasch model: Fundamental measurement in the human sciences. In *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*. <https://doi.org/10.4324/9780429030499>
- Bonk, W. J., & Ockey, G. J. (2003). A many-facet Rasch analysis of the second language group oral discussion task. *Language Testing*, 20(1), 89-110.
- Boone, W. J., & Staver, J. R. (2020). Correction to: Advances in Rasch Analyses in the Human Sciences. In *Advances in Rasch Analyses in the Human Sciences*. https://doi.org/10.1007/978-3-030-43420-5_21
- Brisline, R. W. (1970). Back translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, 1, 185-216. <http://dx.doi.org/10.1177/135910457000100301>
- Bruner, J. (1973). *Going Beyond the Information Given*. New York: Norton.
- Buabeng, I., Conner, L., & Winter, D. (2015). The lack of physics teachers: “Like a bath with the plug out and the tap half on”. *American Journal of Educational Research*, 3(6), 721–730. doi:10.12691/education-3-6-9
- Burge, T. (1993). Concepts, definitions, and meaning. *Metaphilosophy*, 24(4), 309-325.
- Cahyani, N. I., & Azizah, U. (2019). Penerapan model pembelajaran inkuiri terbimbing untuk melatih keterampilan berpikir kritis siswa pada materi laju reaksi kelas XI SMA. *UNESA Journal of Chemical Education*, 8(3).
- Calanchini, J., & Sherman, J. W. (2013). Implicit attitudes reflect associative, non-associative, and non-attitudinal processes. *Social and Personality Psychology Compass*, 7(9), 654-667.
- Caleon, I. S., & Subramaniam, R. (2010a). Development and application of a three-tier diagnostic test to assess secondary students' understanding of waves. *International journal of science education*, 32(7), 939-961.
- Caleon, I. S., & Subramaniam, R. (2010b). Do Students Know What They Know and What They Don't Know? Using a Four-Tier Diagnostic Test to Assess the

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Nature of Students' Alternative Conceptions. *Research in Science Education*, 40, 313–337.
- Chen, C. C., H. S. Lin, & M. L. Lin. (2002). Developing a Two-Tier Diagnostic Instrument to Assess High School Students' Understanding- the Formation of Images by Plane Mirror. *Proceedings of the National Science Council Part D 12 (3)*, 106–121.
- Chen, S. M. (2009). Shadows: Young Taiwanese Children's Views and Understanding. *International Journal of Science Education*, 31(1), 59–79.
- Chi, M. T. (2020). Two kinds of conceptual change: Learning to understand a more accurate scientific conception and learning to debunk a scientific misconception. *Cognitive Science*, 44(8), e12877.
- Chi, S., Wang, Z., Liu, X., & Zhu, L. (2017). Associations among attitudes, perceived difficulty of learning science, gender, parents' occupation and students' scientific competencies. *International Journal of Science Education*, 39(16), 2171-2188.
- Chiodi, G. A., Soutadet, A. J., & Bosio, M. A. (2021). Virtual Laboratory and Mobile Devices as a Support Tool for the Teaching-Learning Processes of Physics in Pandemic Times. *International Journal of Recent Contributions from Engineering, Science & IT (IJES)*, 9(3), 76.
- Christidou, V. (2011). Interest, attitudes and images related to science: Combining students' voices with the voices of school Science, teachers, and popular science. *International Journal of Environmental and Science Education*, 6(2), 141–159.
- Civelek, T., Ucar, E., Ustunel, H., & Aydın, M. K. (2014). Effects of a haptic augmented simulation on K-12 students' achievement and their attitudes towards physics. *Eurasia Journal of Mathematics, Science and Technology Education*, 10(6), 565-574.
- Clement, J., Brown, D. E., & Zietsman, A. (1989). Not all preconceptions are misconceptions: finding 'anchoring conceptions' for grounding instruction on students' intuitions. *International Journal of Science Education*, 11, 554-565.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- Creswell, J. W. & Clark, V. L. P. (2017). *Designing and Conducting Mixed Methods Research*. Los Angeles: SAGE Publication.
- Creswell, J. W. & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Fifth Edition*. Los Angeles: Sage Publications, Inc.
- Cutnell, J. D. & Johnson, K. W. (2012). *Physics, 9th Edition*. Danvers: John Wiley & Sons, Inc.
- Darmaji, D., Astalini, A., Kurniawan, D. A., & Perdana, R. (2019). A study relationship attitude toward physics, motivation, and character discipline

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- students senior high school, in Indonesia. *International Journal of Learning and Teaching*, 11(3), 99-109.
- Darman, D. R., Anriani, N., Wibowo, F. C., Faizin, M. N., Samsudin, A., Suhandi, A., ... & Nulhakim, L. (2019, November). Effectiveness of learning support of asset (assessment simulation test) for reconstruction physics conception. In *Journal of Physics: Conference Series* (Vol. 1280, No. 5, p. 052063). IOP Publishing.
- Daryanto. (2010). *Instructional Media*. Yogyakarta: Gava Media
- Das, K. R., & Imon, A. H. M. R. (2016). A brief review of tests for normality. *American Journal of Theoretical and Applied Statistics*, 5(1), 5-12.
- Dasilva, B. E., Ardiyati, T. K., Suparno, S., Sukardiyono, S., Eveline, E., Utami, T., & Ferty, Z. N. (2019). Development of android-based interactive physics mobile learning media (IPMLM) with scaffolding learning approach to improve HOTS of high school students in Indonesia. *Journal for the Education of Gifted Young Scientists*, 7(3), 659-681.
- Dasilva, B. E., Ardiyati, T. K., SUPARNO, S., SUKARDIYONO, S., EVELINE, E., UTAMI, T., & FERTY, Z. N. (2019). Development of android-based interactive physics mobile learning media (IPMLM) with scaffolding learning approach to improve HOTS of high school students in Indonesia. *Journal for the Education of Gifted Young Scientists*, 7(3), 659-681.
- Da-Silva, C., Mellado, V., Ruiz, C., & Porlan, R. (2007). Evolution of the conceptions of a secondary education biology teacher: Longitudinal analysis using cognitive maps. *Science Education*, 91(3), 461-491.
- Davis, C. P., Altmann, G. T., & Yee, E. (2020). Situational systematicity: A role for schema in understanding the differences between abstract and concrete concepts. *Cognitive Neuropsychology*, 37(1-2), 142-153.
- Deleuze, G. (1990). *Bergsonism*. (H. Tomlinson & B. Habberjam, Trans). New York: Zone Books.
- Dellantonio, S., & Pastore, L. (2021). Ignorance, misconceptions and critical thinking. *Synthese*, 198(8), 7473-7501.
- Dev, H., Gupta, A., Jain, H., Agarwal, A., Gupta, R., & Kaur, K. (2018). Android Based Home-Automation using Microcontroller. *International Journal of Advanced Networking and Applications*, 10(1), 3724-3727.
- Dewi, P. Y., & Primayana, K. H. (2019). Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts. *International Journal of Education and Learning*, 1(1), 19-26.
- Dhanil, M., & Mufit, F. (2021). Design and Validity of Interactive Multimedia Based on Cognitive Conflict on Static Fluid Using Adobe Animate CC 2019. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 7(2), 177-190.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Diani, R., Yuberti, Y., Anggereni, S., Utami, G. N., Iqbal, A., & Kurniawati, I. (2020, June). ECIRR (Elicit, Confront, Identify, Resolve, Reinforce) learning model with the pictorial riddle method: is it effective in reducing physics misconceptions?. In *Journal of Physics: Conference Series* (Vol. 1572, No. 1, p. 012020). IOP Publishing.
- Diwakar, S., Radhamani, R., Sujatha, G., Sasidharakurup, H., Shekhar, A., Achuthan, K., ... & Nair, B. (2019). Usage and diffusion of biotechnology virtual labs for enhancing university education in India's urban and rural areas. In *Virtual Reality in Education: Breakthroughs in Research and Practice* (pp. 433-453). IGI Global.
- Doige, C. A., & Day, T. (2012). A typology of undergraduate textbook definitions of 'heat' across science disciplines. *International Journal of Science Education*, 34(5), 677–700. <https://doi.org/10.1080/09500693.2011.644820>
- Driver, R., & Easley, J. (1978). Pupils and paradigms: a review of literature related to concept development in adolescent science students. *Studies in Science Education*, 5, 61-84.
- Duda, H. J & Adpriyadi. (2020). Students' Misconception in Concept of Biology Cell. *Anatolian Journal of Education*, 5(1), 47-52.
- Dwiningsih, K., Sukarmin, M., & Rahma, P. T. (2018). Pengembangan media pembelajaran kimia menggunakan media laboratorium virtual berdasarkan paradigma pembelajaran di era global. *Kwangsan: Jurnal Teknologi Pendidikan*, 6(2), 156-176.
- Eagly, A. H., & Chaiken, S. (2005). Attitude Research in the 21st Century: The Current State of Knowledge. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), *The handbook of attitudes* (pp. 743–767). Lawrence Erlbaum Associates Publishers.
- Effendi, M., & Muhardjito, M. (2016). Pengaruh Model Pembelajaran ECIRR Terhadap Penguasaan Konsep Fisika pada Siswa SMK. *Jurnal Pendidikan Sains*, 4(3), 113-121.
- Ehrlén, K. (2009). Drawings as Representations of Children's Conceptions. *International Journal of Science Education*, 31(1), 41–57.
- Ekatushabe, M., Kwarikunda, D., Muwonge, C. M., Ssenyonga, J., & Schiefele, U. (2021). Relations between perceived teacher's autonomy support, cognitive appraisals and boredom in physics learning among lower secondary school students. *International Journal of STEM Education*, 8(1), 1-15.
- El Kharki, K., Berrada, K., & Burgos, D. (2021). Design and implementation of a virtual laboratory for physics subjects in Moroccan universities. *Sustainability*, 13(7), 3711.
- Enam, A., & Konduri, K. C. (2018). Time allocation behavior of twentieth-century American generations: GI generation, silent generation, baby boomers, generation X, and millennials. *Transportation Research Record*, 2672(49), 69-80.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Erdoğan, Ş., & Bozkurt, E. (2022). The effect of virtual laboratory applications prepared for Geometrical Optics Lesson on students' achievement levels and attitudes towards Physics. *Pegem Journal of Education and Instruction*, 12(2), 226-234.
- Ergashboevna, N. S. (2022). USE OF MULTIMEDIA TECHNOLOGIES IN THE PROCESS OF TEACHING BUILDING MATERIALS AND PRODUCTS. *Central Asian Journal of Theoretical and Applied Science*, 3(6), 126-129.
- Eryilmaz, A. (2002). Effects of conceptual assignments and conceptual change discussions on students' misconceptions and achievement regarding force and motion. *Journal of research in science teaching*, 39(10), 1001-1015.
- Faour, M.A., & Ayoubi, Z. (2017). The effect of using virtual laboratory on grade 10 students' conceptual understanding and their attitudes towards physics. *Journal of Education in Science Environment and Health*, 4(1), 54-68.
- Farghaly, M., Hussein, M., Hassan, A., Hegazy, M., & Sabbah, A. (2018). Testing of verbal fluency in Egyptians: cultural and educational challenges. *Cognitive and Behavioral Neurology*, 31(3), 133-141.
- Fariyani, Q., & Rusilowati, A. (2015). Pengembangan four-tier diagnostic test untuk mengungkap miskonsepsi fisika siswa sma kelas x. *Journal of Innovative Science Education*, 4(2).
- Febriyana, S. A., Liliawati, W., & Kaniawati, I. (2020). Identifikasi Miskonsepsi dan Penyebabnya pada Materi Gelombang Stasioner Kelas XI Menggunakan *Five-Tier Diagnostic Test*. *Konstan-Jurnal Fisika dan Pendidikan Fisika*, 5(2), 42-51.
- Fenditasari, K., & Istiyono, E. (2020, February). Identification of misconceptions on heat and temperature among physics education students using four-tier diagnostic test. In *Journal of Physics: Conference Series (Vol. 1470, No. 1, p. 012055)*. IOP Publishing.
- Feng, J., Shen, L., Chen, Z., Wang, Y., & Li, H. (2020). A two-layer deep learning method for android malware detection using network traffic. *IEEE Access*, 8, 125786-125796.
- Field, J. (2014). Lifelong learning and the new educational order. *Tertiary Education and Management*, 20(1), 1-12.
- Fishman, J., Yang, C., & Mandell, D. (2021). Attitude theory and measurement in implementation science: a secondary review of empirical studies and opportunities for advancement. *Implementation Science*, 16(1), 1-10.
- Fortus, D. (2009). The importance of learning to make assumptions. *Science Education*, 93(1), 86-108.
- Fратиwi, N. J., Ramalis, T. R., & Samsudin, A. (2019). The Three-tier Diagnostic Instrument: Using Rasch Analysis to Develop and Assess K-10 Students'

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Alternative Conceptions on Force Concept. In *RSU International Research Conference* (pp. 654-663).
- Gagne, R.M. (1977). *The conditions of learning (3rd ed.)*. New York: Holt, Rinehart & Winston.
- Gagne, R.M. (1985). *The conditions of learning (4th ed.)*. New York: Holt, Rinehart & Winston
- García, J., and Entrialgo, J., 2015. Using computer virtualization and software tools to implement a low cost laboratory for the teaching of storage area networks. *Computer Applications in Engineering Education*, 23, 715–723.
- Gardner, P. (1975). Attitudes to science: A review. *Studies in Science Education*, 2, 1–41. doi:10.1080/03057267508559818.
- Gargenta, M. (2011). *Learning Android*. Sebastopol: O'Reilly Media, Inc.
- Georgiou, H., & Sharma, M. D. (2012). University students' understanding of thermal physics in everyday contexts. *International Journal of Science and Mathematics Education*, 10(5), 1119–1142. <https://doi.org/10.1007/s10763-011-9320-1>
- Giambattista, A., Ricahrdson, B. M. & Richardson, R. C. (2010). *Physics, Second Edition*. New York: McGraw-Hill Companies, Inc.
- Giancoli, D. C. (2014). *Physics Principles with Applications, Seventh Edition*. Glenview: Pearson Education, Inc.
- Gill, M. G., Trevors, G., Greene, J. A., & Algina, J. (2022). Don't take it personally? The role of personal relevance in conceptual change. *The Journal of Experimental Education*, 90(1), 1-22.
- Gilski, P., & Stefanski, J. (2015). Android OS: A Review. *Tem Journal*, 4(1), 116.
- Girvan, C. (2018). What is a virtual world? Definition and classification. *Educational Technology Research and Development*, 66(5), 1087-1100.
- Giyoto, G., Prayitno, H. J., Inderasari, E., Santoso, T., Salam, A. A. N., & Alfisyahri, K. A. N. (2022). A Lessons in Pandemic Autonomous Learning Conflicts of Communicative Methods in English Curriculum 2013 along COVID-19 in Indonesia. *Randwick International of Education and Linguistics Science Journal*, 3(4). <https://doi.org/10.47175/rielsj.v3i4.578>
- Gök, M., & Ertem-Akbaş, E. (2019). Examining the attitude change of pre-service elementary school teachers towards a course of mathematics education within the framework of Theory of Didactical Situations. *International Online Journal of Education and Teaching (IOJET)*, 6(4), 879-904.
- Göksu, İ., & Atici, B. (2013). Need for mobile learning: technologies and opportunities. *Procedia-Social and Behavioral Sciences*, 103, 685-694.
- Goldberg, F. M., & L. C. McDermott. (1986). Student Difficulties in Understanding Image Formation by a Plane Mirror. *The Physics Teacher* 24 (8): 472–481.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Gordon, R. A., Peng, F., Curby, T. W., & Zinsser, K. M. (2021). An introduction to the many-facet Rasch model as a method to improve observational quality measures with an application to measuring the teaching of emotion skills. *Early Childhood Research Quarterly*, *55*, 149-164.
- Grassini, S., & Laumann, K. (2020). Questionnaire measures and physiological correlates of presence: A systematic review. *Frontiers in psychology*, *11*, 349.
- Green, T., & Labrecque, J. (2017). *Beginning Adobe Animate CC*. Apress.
- Griffard, P. B., & J. H. Wandersee. (2001). The Two-Tier Instrument on Photosynthesis: What Does It Diagnose?. *International Journal of Science Education*, *23(10)*, 1039–1052.
- Gunawan, G., Nisrina, N., Suranti, N. M. Y., Herayanti, L., & Rahmatiah, R. (2018, November). Virtual laboratory to improve students' conceptual understanding in physics learning. In *Journal of Physics: Conference Series (Vol. 1108, No. 1, p. 012049)*. IOP Publishing.
- Gürsel, F. G., & Akçay, B. (2022). Developing Two-Tier Diagnostic Instrument to Determine Misconceptions on Socioscientific Issues. *Cumhuriyet Uluslararası Eğitim Dergisi*, *11(1)*, 228-239.
- Haerunnisa, H., Prasetyaningsih, P., & Biru, L. T. (2022). Analisis miskonsepsi siswa SMP pada konsep getaran dan gelombang. *Pendipa Journal of Science Education*, *6(2)*, 428-433.
- Hahn, J. F., 2018. Virtual reality learning environments: Development of multi-user reference support experiences. *Information and Learning Science*, *119(11)*, 652–661.
- Hairuddin, K. (2021). Pattern of Multicultural Insights Development as a Strategy for Adaptation of Midwifery Students. *Journal of Education Research and Evaluation*, *5(4)*.
- Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamentals of Physics, Tenth Edition*. Danvers: John Wiley & Sons, Inc.
- Halloun, I. A. (1996). Schematic modeling for meaningful understanding of physics. *Journal of research in science teaching*, *33(9)*, 1019 -1041.
- Hamed, G., & Aljanazrah, A. (2020). The effectiveness if using virtual experiments on students' learning in the general physics lab.
- Hardahl, L. K., Wickman, P. O., & Caiman, C. (2019). The body and the production of phenomena in the science laboratory. *Science & Education*, *28(8)*, 865-895.
- Hasanah, N., Hidayat, A., & Koeshandayanto, S. (2020). Pengaruh strategi konflik kognitif ditinjau dari kemampuan awal siswa untuk mengurangi miskonsepsi pada materi gelombang mekanik. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5(5)*, 624-629.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Hassan, J., Devi, A., & Ray, B. (2022). Virtual Laboratories in Tertiary Education: Case Study Analysis by Learning Theories. *Education Sciences, 12*(8), 554.
- Hauben, M. (2018). A visual aid for teaching the Mann–Whitney U formula. *Teaching Statistics, 40*(2), 60-63.
- Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of research in science teaching, 47*(8), 978-1003.
- Hediansah, D., & Surjono, H. D. (2019). Building Motivation and Improving Learning Outcomes with Android-Based Physics Books: Education 4.0. *Anatolian Journal of Education, 4*(2), 1-10.
- Heeren, T., & D'Agostino, R. (1987). Robustness of the two independent samples t-test when applied to ordinal scaled data. *Statistics in medicine, 6*(1), 79-90.
- Hein, D., Mai, C., & Hußmann, H. (2018, May). The usage of presence measurements in research: a review. In *Proceedings of the International Society for Presence Research Annual Conference (Presence)* (pp. 21-22). Prague: The International Society for Presence Research.
- Helm (1980). Misconceptions in physics amongst South African students. *Physics Education, 15*, 92-105.
- Hendley, D., Parkinson, J., Stables, A., & Tanner, H. (1995). Gender differences in pupil attitudes to the national curriculum foundation subjects of English, mathematics, science and technology in Key Stage 3 in South Wales. *Educational Studies, 21*, 85–97
- Herman, Shara, A. M., Silalahi, T. F., Sherly, & Julyanthry. (2022). Teachers' Attitude towards Minimum Competency Assessment at Sultan Agung Senior High School in Pematangsiantar, Indonesia. *Journal of Curriculum and Teaching, 11*(1). <https://doi.org/10.5430/jct.v11n2p1>
- Hermita, N., Ningsih, H. S., Alim, J. A., Alpusari, M., Putra, Z. H., & Wijaya, T. T. (2020). Developing Science Comics for Elementary School Students on Animal Diversity. *Solid State Technology, 63*(1s), 2492-2500.
- Hermita, N., Suhandi, A., Syaodih, E., Samsudin, A., Sopandi, W., ... & Coştu, B. (2017). The effectiveness of using virtual simulation and analogy in the conceptual change oriented-physics learning on direct current circuits. *TOJET: The Turkish Online Journal of Educational Technology, 16*.
- Herwinarso, H., Untung, B., Wirjawan, J. V., & Pratidhina, E. (2020). Development of android app to assist high school students in learning physics quantities and measurement principles. *TEM Journal, 9*(1), 292-295.
- Hestenes, D., Wells, M. & Swackhamer, G. (1992). Force Concept Inventory. *The Physics Teacher, 30*, 141–158.
- Hewson, P. W. (1984). The Role of Conceptual Conliff in Conceptual Change and the Design of Science Instruction. *Instructional Science, 13*(1), 1-13.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
 Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Holleman, G. A., Hooge, I. T., Kemner, C., & Hessels, R. S. (2020). The ‘real-world approach’ and its problems: A critique of the term ecological validity. *Frontiers in Psychology, 11*, 721.
- Hornby, A.S. (2010). *Oxford Advanced Learner's Dictionary*. Oxford University Press.
- Houlden, S., & Veletsianos, G. (2021). The problem with flexible learning: Neoliberalism, freedom, and learner subjectivities. *Learning, Media and Technology, 46*(2), 144-155.
- Hovardas, T., Xenofontos, N. A., & Zacharia, Z. C. (2017). Using virtual labs in an inquiry context: The effect of a hypothesis formulation tool and an experiment design tool on students' learning. In *I. Levin & D. Tsybulsky (Eds.), Optimizing STEM education with advanced ICTs and simulations (pp. 58-83)*. Pennsylvania: IGI Global.
- Howell, D. C. (2011). *Fundamental Statistics for the Behavioral Sciences, Seventh Edition*. Wadsworth: Cengage Learning
- Hurtado-Bermúdez, S., & Romero-Abrio, A. (2020). The effects of combining virtual laboratory and advanced technology research laboratory on university students' conceptual understanding of electron microscopy. *Interactive Learning Environments, 1-16*.
- Hwang, G. J., & Wu, P. H. (2020). Applications, impacts and trends of personalized learning research: A review of journal publications from 2007 to 2018. *Computers & Education, 144*, 103701.
- Ishartono, N., Desstya, A., Prayitno, H. J., & Sidiq, Y. (2021). The Quality of HOTS-Based Science Questions Developed by Indonesian Elementary School Teachers. *Journal of Education Technology, 5*(2). <https://doi.org/10.23887/jet.v5i2.33813>
- Jamilah, J., Silitonga, H. T. M., & Hamdani, H. (2019). INTEGRASI REMEDIASI Miskonsepsi tentang Momentum dan Impuls Menggunakan Model Ecirr. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK), 8*(10).
- Jasmadi, 251121354. (2018). Penggunaan Media Virtual Laboratory dalam Pembelajaran Konsep Optik Geometri di SMK Kesehatan Asy-Syifa School Banda Aceh. *Skripsi thesis*, UIN Ar-Raniry Banda Aceh.
- Jauhariyah, M. N. R., Suprpto, N., Admoko, S., Setyarsih, W., Harizah, Z., & Zulfa, I. (2018, March). The students' misconceptions profile on chapter gas kinetic theory. In *Journal of Physics: Conference Series (Vol. 997, No. 1, p. 012031)*. IOP Publishing.
- Jensen, N., Von Voigt, G., Nejd, W., & Olbrich, S. (2004). Development of a virtual laboratory system for science education. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning, 2*(3).

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Jusniar, J., Effendy, E., Budiasih, E., & Sutrisno, S. (2020). Developing a three-tier diagnostic instrument on chemical equilibrium (TT-DICE). *Educación química*, 31(3), 84-102.
- Kafia, Y. B., & Resnick, M. (1996). *Introduction*. In Y. Kafai & M. Resnick. (Eds.), *Construction in practice designing, thinking and learning in a digital world*. Mahwah, NJ: Lawrence Erlbaum Associated Publisher
- Kaltakci-Gurel, D., & D. Didis. (2007). Identification of Pre-Service Physics Teachers' Misconceptions on Gravity Concept: A Study with a 3-Tier Misconception Test. In *Proceedings of the American Institute of Physics*, edited by S. A. Çetin and İ. Hikmet, 499–500. USA, 899
- Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science and Technology Education*, 11(5), 989-1008.
- Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2017). Development and application of a four-tier test to assess pre-service physics teachers' misconceptions about geometrical optics. *Research in science & Technological education*, 35(2), 238-260.
- Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2017). Development and application of a four-tier test to assess pre-service physics teachers' misconceptions about geometrical optics. *Research in science & Technological education*, 35(2), 238-260.
- Kamradt T. F. & Kamradt E. J. (1999). Structured design for attitudinal instruction. In Reigeluth C. M. (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (Vol. 2, pp. 563–590). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kang, J., & Keinonen, T. (2018). The effect of student-centered approaches on students' interest and achievement in science: Relevant topic-based, open and guided inquiry-based, and discussion-based approaches. *Research in science education*, 48(4), 865-885.
- Kaniawati, I., Fratiwi, N. J., Danawan, A., Suyana, I., Samsudin, A., & Suhendi, E. (2019). Analyzing Students' Misconceptions about Newton's Laws through Four-Tier Newtonian Test (FTNT). *Journal of Turkish Science Education*, 16(1), 110-122.
- Kapici, H. O., Akcay, H., & de Jong, T. (2019). Using hands-on and virtual laboratories alone or together—which works better for acquiring knowledge and skills?. *Journal of science education and technology*, 28(3), 231-250.
- Kaur, D., & Zhao, Y. (2017). Development of Physics Attitude Scale (PAS): An instrument to measure students' attitudes toward physics. *The Asia-Pacific Education Researcher*, 26(5), 291-304.

- Kaya, H., & Boyuk, U. (2011). Attitude towards Physics Lessons and Physical Experiments of the High School Students. *European journal of physics education, 2*(1), 23-31.
- Kaya, Z., Kaya, O. N., Aydemir, S., & Ebenezer, J. (2022). Knowledge of student learning difficulties as a plausible conceptual change pathway between content knowledge and pedagogical content knowledge. *Research in Science Education, 52*(2), 691-723.
- Kemendikbud. (2014). *Permendikbud No. 59 Tahun 2014 Tentang Kurikulum 2013 Sekolah Menengah Atas/Madrasah Aliyah*. Diakses secara online melalui <https://sma.kemdikbud.go.id/data/files/Permendikbud%20Nomor%2059%20Tahun%202014%20Kurikulum%202013%2010b.%20PMP%20BIO-minat%20SMA.pdf> pada tanggal 14 September 2022.
- Kemendikbud. (2018a). *Permendikbud No. 36 Tahun 2018 Tentang Perubahan atas Permendikbud No. 59 Tahun 2014*. Diakses secara online melalui <https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/Permendikbud%20Nomor%2036%20Tahun%202018.pdf> pada tanggal 14 September 2022.
- Kemendikbud. (2018b). *Permendikbud No. 37 Tahun 2018 Tentang Perubahan Atas Permendikbud No. 24 Tahun 2016 Tentang Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah*. Diakses secara online melalui <https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/Permendikbud%20Nomor%2037%20Tahun%202018.pdf> pada tanggal 14 September 2022.
- Kemendikbud. (2020). *Peta Jalan Pendidikan Indonesia 2020-2035*. Diakses secara online melalui http://eng.unila.ac.id/wp-content/uploads/2020/06/5.a-Peta-Jalan-Sistem-Pendidikan-2020-2035_Kemendikbud.pdf pada tanggal 2 September 2022.
- Kendeou, P., & O'Brien, E. J. (2020). Reading for learning: The power of self-explanation. *Educational Psychologist, 55*(4), 221-235.
- Khotimah, R. M. A., Ayunda, S. P., & Intan, V. P. (2023). Pengembangan Video Edukatif dengan Animasi Stop Motion pada Materi Garis dan Sudut Kelas VII SMP. *Diskusi Panel Nasional Pendidikan Matematika, 9*.
- Kim, Y., & Kim, D. (2021). The effects of reading strategies on text comprehension: Evidence from eye-movement data and post-reading performance. *Computers in Human Behavior, 118*, 106675.
- Kızılcık, H. S., & Güneş, B. (2011). Developing Three-Tier Misconception Test about Regular Circular Motion. *Hacettepe University Journal of Education, 41*, 278-292.
- Knight, R. D. (2017). *Physics for Scientists and Engineers: A Strategic Approach with Modern Physics*. Boston: Pearson Education, Inc.
- Kocakoyun, S., & Bicen, H. (2017). Development and Evaluation of Educational Android Application. *Cypriot Journal of Educational Sciences, 12*(2), 58-68.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Kocakülah, M. S., & Kural, M. (2010). Investigation of conceptual change about double-slit interference in secondary school physics. *International Journal of Environmental & Science Education*, 5(4), 435-460.
- Kok, Y. Y., Er, H. M., & Nadarajah, V. D. (2021). An analysis of health science students' preparedness and perception of interactive virtual laboratory simulation. *Medical science educator*, 31(6), 1919-1929.
- Konicek-Moran, R., & Keeley, P. (2015). *Teaching for conceptual understanding in science*. Arlington: NSTA Press, National Science Teachers Association.
- Kraft, M. A. (2020). Interpreting effect sizes of education interventions. *Educational Researcher*, 49(4), 241-253.
- Kristiyanto, W. (2019, July). Prospects of Physics Learning Media Based on Android: Strategic Studies Entering the Industrial Era in The 21st Century. In *6th International Conference on Educational Research and Innovation (ICERI 2018)* (pp. 467-471). Atlantis Press.
- Kunto, I., & Ariani, D. (2021). Ragam storyboard untuk produksi media pembelajaran. *Jurnal Pembelajaran Inovatif*, 4(1), 108-120.
- Kurnianto, A., Sunjaya, D. K., Rinawan, F. R., & Hilmanto, D. (2023). Validation and Reliability of Lifestyle Instruments for Indonesian Adolescents with Hypertension Family History: A Rasch Model. *Open Access Macedonian Journal of Medical Sciences*, 11(B), 109-114.
- Kurniawan, D. A., Perdana, R., & Kurniasari, D. (2018). Identification of student attitudes toward physics learning at Batanghari District high school. *The Educational Review, USA*, 2(9), 475-484.
- Kurniawan, F., Samsudin, A., Chandra, D. T., Sriwati, E., & Coştu, B. (2023). IMPAS: Modification of the PAS Questionnaire to Measure Attitudes of High School Students towards Physics in Indonesia. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, 5(2), 198-216.
- Kurniawati, D. M., & Ermawati, F. U. (2020, March). Analysis students' conception using four-tier diagnostic test for dynamic fluid concepts. In *Journal of Physics: Conference Series (Vol. 1491, No. 1, p. 012012)*. IOP Publishing.
- Kurniawati, L., Masruro, U., & Afidah, A. (2020). Pengaruh Strategi Pembelajaran ECIRR Terhadap Kemampuan Berpikir Kritis Matematis Siswa. *ALGORITMA: Journal of Mathematics Education*, 2(1), 86-99.
- Laksono, J., Silitonga, H. T. M., & Mursyid, S. (2020). Integrasi Remediasi Miskonsepsi tentang Gelombang Melalui Model Pembelajaran Generatif Peserta Didik SMA Negeri 2 Pontianak. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, 9(9).
- Laliyo, L. A. R., Sumintono, B., & Panigoro, C. (2022). Measuring changes in hydrolysis concept of students taught by inquiry model: stacking and racking analysis techniques in Rasch model. *Heliyon*, 8(3), e09126.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Laliyo, L. A. R., Tangio, J. S., Sumintono, B., Jahja, M., & Panigoro, C. (2020). Analytic Approach of Response Pattern of Diagnostic Test Items in Evaluating Students' Conceptual Understanding of Characteristics of Particle of Matter. *Journal of Baltic Science Education*, 19(5), 824-841.
- Lam, P. L., Ng, H. K., Tse, A. H., Lu, M., & Wong, B. Y. (2021). eLearning technology and the advancement of practical constructivist pedagogies: Illustrations from classroom observations. *Education and Information Technologies*, 26(1), 89-101.
- Langley, D., Ronen, M. & Eylon, B. S. (1997). Light Propagation and Visual Patterns: Preinstruction Learners' Conceptions. *Journal of Research in Science Teaching*, 34(4), 399-424.
- Levin, M. E., Krafft, J., Pistorello, J., & Seeley, J. R. (2019). Assessing psychological inflexibility in university students: Development and validation of the acceptance and action questionnaire for university students (AAQ-US). *Journal of Contextual Behavioral Science*, 12, 199-206.
- Lijnse, P., Eijkelhof, H., Klaassen, C., & Scholte, R. (1990). Pupils' and mass-media ideas about radioactivity. *International Journal of Science Education*, 12(1), 67-78.
- Liliarti, N., & Kuswanto, H. (2018). Improving the Competence of Diagrammatic and Argumentative Representation in Physics through Android-Based Mobile Learning Application. *International Journal of Instruction*, 11(3), 107-122.
- Lim, T. S., & Loh, W. Y. (1996). A comparison of tests of equality of variances. *Computational Statistics & Data Analysis*, 22(3), 287-301.
- Linacre, J. M. (2018). A user's guide to Winstep mini step Rasch-Model computer programs. Beaverton, OR: Winsteps.
- MacFarland, T. W., Yates, J. M., MacFarland, T. W., & Yates, J. M. (2016). Mann-whitney u test. *Introduction to nonparametric statistics for the biological sciences using R*, 103-132.
- Mager, R. (1968). *Developing attitude toward learning*. Palo Alto: Fearon
- Maghfiroh, A., & Kuswanto, H. (2022). Benthic android physics comic effectiveness for vector representation and critical thinking students' improvement. *International Journal of Instruction*, 15(2), 623-640.
- Maharani, I. P., & Subanji, S. (2018). Scaffolding Based on Cognitive Conflict in Correcting the Students' Algebra Errors. *International Electronic Journal of Mathematics Education*, 13(2), 67-74.
- Maison, A., Darmaji, D. A. K., & Rahmat Perdana, L. A. (2019). The Phenomenon of Physicology Senior High School Education: Relationship of Students' Attitudes toward Physic, Learning Style, Motivation. *Universal Journal of Educational Research*, 7(10), 2199-2207.
- Mamodiya, U., Singh, Y., & Jain, A. (2022). Adaptation of Android and Digital Applications in Education System. *ECS Transactions*, 107(1), 8469.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
 Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Manik, D. S., & Sinuraya, J. B. (2019). Pengaruh Model Problem Based Learning Berbantuan Laboratorium Virtual Terhadap Peningkatan Kemampuan Pemecahan Masalah Fisika Siswa Sma N 5 Medan. *JURNAL IKATAN ALUMNI FISIKA*, 5(2), 34-39.
- Mao, P., Cai, Z., He, J., Chen, X., & Fan, X. (2021). The Relationship Between Attitude Toward Science and Academic Achievement in Science: A Three-Level Meta-Analysis. *Frontiers in psychology*, 12.
- Marx, J. D., & Cummings, K. (2007). Normalized change. *American Journal of Physics*, 75(1), 87-91.
- Maskill, R., & Cachapuz, A. F. C. (1989). Learning about the Chemistry Topic of Equilibrium: The Use of Word Association Tests to Detect Developing Conceptualizations. *International Journal of Science Education*, 11(1), 57-69
- Matriano, E. A. (2020). Ensuring Student-Centered, Constructivist and Project-Based Experiential Learning Applying the Exploration, Research, Interaction and Creation (ERIC) Learning Model. *International Online Journal of Education and Teaching*, 7(1), 214-227.
- Mattern, N., & Schau, C. (2002). Gender differences in science attitude-achievement relationships over time among white middle-school students. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 39(4), 324-340.
- Maulidah, S. S., & Prima, E. C. (2018). Using Physics Education Technology as Virtual Laboratory in Learning Waves and Sounds. *Journal of Science Learning*, 1(3), 116-121.
- McDermott, L. C. (2001). Oersted Medal Lecture 2001: "Physics Education Research - The Key to Student Learning". *American Journal of Physics*, 69(11), 1127-1137. doi: 10.1119/1.1389280
- McDonnell, M., Dill, L., Panos, S., Amano, S., Brown, W., Giurgius, S., ... & Miller, K. (2020). Verbal fluency as a screening tool for mild cognitive impairment. *International Psychogeriatrics*, 32(9), 1055-1062.
- McKnight, P. E., & Najab, J. (2010). Mann-Whitney U Test. *The Corsini encyclopedia of psychology*, 1-1.
- Menia, M., Mudzakir, A., & Rochintaniawati, D. (2017, May). The effect of conceptual metaphors through guided inquiry on student's conceptual change. *In AIP Conference Proceedings (Vol. 1848, No. 1, p. 060009)*. AIP Publishing LLC.
- Métioui, A., & Trudel, L. (2021). Two-tier multiple-choice questionnaires to detect the students' misconceptions about heat and temperature. *Two-tier Multiple-choice Questionnaires to Detect the Students' Misconceptions about Heat and Temperature*, 6(1), 23-34.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Miller, L. B., & Erwin, E. F. (1961). Attitude changes in medical students during a comprehensive care program. *Academic Medicine*, *36*(5), 422-428.
- Morchid, N. (2020). The social constructivist response to educational technology. *International Journal of English Literature and Social Sciences*, *5*(1), 263-270.
- Morse, L.W. & Morse, D.T. (1995). The Influence of problem-solving strategies and previous training on performance of convergent and divergent thinking. *Journal of Instructional Psychology*, *22*, 4.
- Mortimer, E. F., & El-Hani, C. N. (2014). *Conceptual profiles: A theory of teaching and learning scientific concepts (Vol. 42)*. Springer Science & Business Media.
- Muis, K. R., Sinatra, G. M., Pekrun, R., Winne, P. H., Trevors, G., Losenno, K. M., & Munzar, B. (2018). Main and moderator effects of refutation on task value, epistemic emotions, and learning strategies during conceptual change. *Contemporary Educational Psychology*, *55*, 155-165.
- Mumu, J., Tanujaya, B., Charitas, R., & Prahmana, I. (2022). Likert Scale in Social Sciences Research: Problems and Difficulties. *FWU Journal of Social Sciences*, *16*(4). <https://doi.org/10.51709/19951272/Winter2022/7>
- Muslihin, H. Y., Suryana, D., Suherman, U., & Dahlan, T. H. (2022). Analysis of the Reliability and Validity of the Self-Determination Questionnaire Using Rasch Model. *International Journal of Instruction*, *15*(2), 207-222.
- Myers, R. E., & Fouts, J. T. (1992). A cluster analysis of classroom environments and attitude toward science. *Journal of Research in Science Teaching*, *29*, 929–937. doi:10.1002/tea.3660290904.
- Nanda, O. A., & Wilujeng, I. (2018). The effectiveness of android-assisted optical devices learning to improve students' conceptual understanding. *Jurnal Penelitian dan Pembelajaran IPA*, *4*(2), 105-115.
- Neumann, S., & Hopf, M. (2012). Students' conceptions about 'radiation': Results from an explorative interview study of 9th grade students. *Journal of Science Education and Technology*, *21*(6), 826-834.
- Ningrum, A. M. A., & Suliyannah, S. (2021). Model Pembelajaran ECIRR (Elicit-Confront-Identify-Resolve-Reinforce) Untuk Meningkatkan Hasil Belajar Pada Materi Gerak Lurus. *PENDIPA Journal of Science Education*, *5*(3), 444-450.
- Nissen, J. M., Talbot, R. M., Thompson, A. N., & Van Dusen, B. (2018). Comparison of normalized gain and Cohen's d for analyzing gains on concept inventories. *Physical Review Physics Education Research*, *14*(1), 010115.
- Nomilasari, G., & Sugiyarto, K. H. (2023, March). Learning media development during the pandemic to prevent students misconceptions: A need analysis in hydrolysis of salts. In *AIP Conference Proceedings* (Vol. 2556, No. 1). AIP Publishing.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Noris, M., & Saputro, S. (2022). The Virtual Laboratory Based on Problem Based Learning to Improve Students' Critical Thinking Skills. *The Virtual Laboratory Based on Problem Based Learning to Improve Students' Critical Thinking Skills*, 3(1), 35-47.
- Novak, J. D. (1996). Concept Mapping: A Tool for Improving Science Teaching and Learning. In *Improving Teaching and Learning in Science and Mathematics*, edited by D. F. Treagust, R. Duit and B. J. Fraser, 32–43. New York: Teachers College.
- Oberoi, MB. (2017). A Study of Errors and Misconceptions in Science in Relation to Scientific Attitude among Secondary School Students. *International Journal of Advanced Research (IJAR)*, 5(3), 1707-1710.
- Odoi, B., Twumasi-Ankrah, S., Samita, S., & Al-Hassan, S. (2022). The Efficiency of Bartlett's Test using Different forms of Residuals for Testing Homogeneity of Variance in Single and Factorial Experiments-A Simulation Study. *Scientific African*, e01323.
- OECD. (2019). OECD Multilingual Summaries PISA 2018 Results (Volume I) What Students Know and Can Do. *OECD Publishing*, I(Volume I).
- Ogan-Bekiroglu, F., & Oymak, O. (2017). Can we change attitude toward physics? Outcomes of technology supported and laboratory based instructions. *Research Highlights in Education and Science 2017*, 75.
- Ogunleye, L. I., Oyejola, B. A., & Obisesan, K. O. (2018). Comparison of some common tests for normality. *Int. J. Probab. Stat*, 7, 130-137.
- Onyesolu, M. O. (2009). Virtual Reality Laboratories: An Ideal Solution to the Problems Facing Laboratory Setup and Management. In *Proceedings of the World Congress on Engineering and Computer Science 2009 (WCECS 2009)* I, San Francisco, USA. doi:10.1016/j.compedu.2016.02.002.
- Oon, P.T., & Subramaniam, R. (2010). Views of physics teachers on how to address the declining enrolment in physics at the University level. *Research in Science & Technological Education*, 28(3), 277–289. doi:10.1080/02635143.2010.501749.
- Orellana, M. F., Martínez, D. C., Lee, C. H., & Montaña, E. (2012). Language as a tool in diverse forms of learning. *Linguistics and Education*, 23(4), 373–387. <https://doi.org/https://doi.org/10.1016/j.linged.2012.09.001>
- Orr, K. L., Golas, K. C., & Yao, K. (1994). Storyboard development for interactive multimedia training. *Journal of Interactive Instruction Development*, 6(3), 18-31.
- Ozkan, G., & Selçuk, G. S. (2012). How effective is “conceptual change approach” in teaching physics. *Journal of educational and Instructional Studies in the World*, 2(2), 182-190.

- Palmer, D. (2001). Students' Alternative Conceptions and Scientifically Acceptable Conceptions about Gravity. *International Journal of Science Education*, 23(7), 691–706.
- Pan, D., Wang, T., Zhang, X., Jia, M., & Li, Z. (2021). Use of collaborative concept mapping in team diagnosis. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 31(5), 469-483.
- Parente, S. C. (2019). *The Multiple Self-States Drawing Technique: Creative Assessment and Treatment with Children and Adolescents*. Routledge.
- Park, Y., & Bonk, C. J. (2017). Synchronous and asynchronous video communication in distance education. *Distance Education*, 38(3), 313-332.
- Pathoni, H., Kurniawan, W., Kurniawan, D. A., & Perdana, R. (2019). Motivation and Attitude of Students on Physics Subject in the Middle School in Indonesia. *International Education Studies*, 12(9), 15-26.
- Peşman, H., & Eryılmaz, A. (2010). Development of a Three-Tier Test to Assess Misconceptions about Simple Electric Circuits. *The Journal of Educational Research*, 103, 208–222.
- Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning (Vol. 1)*. USA: National Council of Teachers of Mathematics.
- Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, 2, 176-186. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1002/tea.3660020306/pdf>
- Piaget, J. (1970). Piaget's theory. In P. H. Mussen (Ed.), *Carmichael's manual of child psychology* (3rd ed., Vol. 1, pp. 703-732). New York: Wiley.
- Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures*. (A. Rosin, Trans). New York: The Viking Press.
- Planinic, M., Milin-Sipus, Z., Katic, H., Susac, A., & Ivanjek, L. (2012). Comparison of student understanding of line graph slope in physics and mathematics. *International journal of science and mathematics education*, 10(6), 1393-1414.
- Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Toward a theory of conceptual change. *Science education*, 66(2), 211-227.
- Potkonjak, V., Vukobratović, M., Jovanović, K., & Medenica, M. (2010). Virtual Mechatronic/Robotic laboratory—A step further in distance learning. *Computers & Education*, 55(2), 465-475.
- Pradibta, H., & Nurhasan, U. (2020). Utilization of virtual reality content for laboratory practicum learning. In *IOP Conference Series: Materials Science and Engineering*, 732(1), 12-87.
- Prakasiwi, L. R., & Gusemanto, T. G. (2021, March). Development of Adobe Animate Assisted Physics Learning Media as Online Learning Aid. In *6th*

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- International Seminar on Science Education (ISSE 2020)* (pp. 574-581). Atlantis Press.
- Prastiwi, A. C. (2016). Peningkatan Pemahaman Konsep Siswa Menggunakan Model ECIRR Berbantuan PhET Simulation Pada Teori Kinetik Gas. *Inovasi Pendidikan Fisika*, 5(3).
- Prastiwi, A. C., Kholiq, A., & Setyarsih, W. (2018, March). Implementation of ECIRR model based on virtual simulation media to reduce students' misconception on kinetic theory of gases. In *Journal of Physics: Conference Series (Vol. 997, No. 1, p. 012034)*. IOP Publishing.
- Pratama, A., & Sumardi, M. S. (2022). Contextual Teaching and Learning Using Local Content Material on Students' Reading Comprehension at a Junior High School in Indonesia. *SALEE: Study of Applied Linguistics and English Education*, 3(2). <https://doi.org/10.35961/salee.v3i2.494>
- Prayogi, S., & Verawati, N. N. S. P. (2020). The effect of conflict cognitive strategy in inquiry-based learning on preservice teachers' critical thinking ability. *Journal of Educational, Cultural and Psychological Studies (ECPS Journal)*, (21), 27-41.
- Prayogi, S., & Yuanita, L. (2018). Critical Inquiry-Based Learning: A model of learning to promote critical thinking among prospective teachers of physic. *Journal of Turkish Science Education*, 15(1), 43-56.
- Prodjosantoso, A. K., & Hertina, A. M. (2019). The Misconception Diagnosis on Ionic and Covalent Bonds Concepts with Three Tier Diagnostic Test. *International Journal of Instruction*, 12(1), 1477-1488.
- Prosser, M., Walker, P., & Millar, R. (1996). Differences in students' perceptions of learning physics. *Physics Education*, 31(1), 43.
- Puspendik. (2019). *Laporan Hasil Ujian Nasional*. Diakses dari https://hasilun.puspendik.kemdikbud.go.id/#2019!sma!daya_serap!99&99&999!a&D&T&T&1&!1!&i secara online pada tanggal 2 Juni 2022.
- Puspitarini, Y. D., & Hanif, M. (2019). Using Learning Media to Increase Learning Motivation in Elementary School. *Anatolian Journal of Education*, 4(2), 53-60.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving critical thinking skills and scientific attitudes by using comic. *Psikologi, Evaluasi, dan Teknologi dalam Penelitian Pendidikan*, 2(2), 69-80.
- Putri, H. N. P. A., & Rohmawati, L. (2018, March). Identification student's misconception of heat and temperature using three-tier diagnostic test. In *Journal of Physics: Conference Series (Vol. 997, No. 1, p. 012035)*. IOP Publishing.
- Putri, Z. S., & Kurniawati, Y. (2021). The Effectiveness of Learning Using Virtual Laboratory Toward Student Critical Thinking Ability on Acid-Base Titration

Lesson. *Journal of The Indonesian Society of Integrated Chemistry (On Progress)*, 13(1), 14-20.

- Quispe, R. C., Muñoz, E. M., Cadillo, A. V., & Ticse, R. (2019). Perception of medical communication skills during the clinical interview in a Peruvian teaching hospital: validation and application of an assessment tool. *Medwave*, 19(9), e7705-e7705.
- Rahayu, M. S. I., & Kuswanto, H. (2021). The Effectiveness of the Use of the Android-Based Carom Games Comic Integrated to Discovery Learning in Improving Critical Thinking and Mathematical Representation Abilities. *Journal of Technology and Science Education*, 11(2), 270-283.
- Rahmawati, R., Yusuf, W. A., & Khaeruddin, K. (2022). Penerapan Model Problem Based Learning (PBL) dengan Metode Brainstorming untuk Membenahi Pemahaman Konsep Siswa SMA pada Topik Gelombang Mekanik. *Jurnal Kajian Pendidikan Sains*, 8(1), 27-36.
- Ramadhan, S., Mardapi, D., Prasetyo, Z. K., & Utomo, H. B. (2019). The development of an instrument to measure the higher order thinking skill in physics. *European Journal of Educational Research*, 8(3), 743-751.
- Ranjan, A. K. A. S. H. (2017). Effect of virtual laboratory on development of concepts and skills in physics. *International Journal of Technical Research & Science*, 2(1), 15-21.
- Redish, E. F., Saul, J. M., & Steinberg, R. N. (1998). Student expectations in introductory physics. *American Association of Physics Teachers*, 66, 212–224. doi:10.1119/1.18847
- Reiska, P., Soika, K., & Canas, A. J. (2018). Using concept mapping to measure changes in interdisciplinary learning during high school. *Knowledge Management & E-Learning: An International Journal*, 10(1), 1-24.
- Rey, G. (1985). Concepts and conceptions: A reply to Smith, Medin and Rips. *Cognition*, 19(3), 297-303.
- Richardson, J. T. (2004). Methodological issues in questionnaire-based research on student learning in higher education. *Educational psychology review*, 16(4), 347-358.
- Risdianto, E., Dinissjah, M. J., Nirwana., & Kristiawan, M. (2020). The effect of ethno science-based direct instruction learning model in physics learning on students' critical thinking skill. *Universal Journal of Educational Research*, 8(2), 611-615.
- Rochon, J., Gondan, M., & Kieser, M. (2012). To test or not to test: Preliminary assessment of normality when comparing two independent samples. *BMC medical research methodology*, 12(1), 1-11.
- Román-Ibáñez, V., Pujol-López, F. A., Mora-Mora, H., Pertegal-Felices, M. L., and Jimeno-Morenilla, A., 2018. A low-cost immersive virtual reality system for teaching robotic manipulators programming. *Sustainability*, 10(4), 1102.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Rosada, D., Kadarisman, N. dan Raharjo. (2017). *Panduan Pengelolaan dan Pemanfaatan Laboratorium IPA*. Jakarta: Kementerian Pendidikan dan Kebudayaan.
- Rosli, R., Abdullah, M., Siregar, N. C., Hamid, N. S. A., Abdullah, S., Beng, G. K., ... & Bais, B. (2020). Student Awareness of Space Science: Rasch Model Analysis for Validity and Reliability. *World Journal of Education*, 10(3), 170-177.
- Sá, S. O., Gomes, C. A., & Sousa, C. M. (2022). Questionnaire Results (QEP) and the socio-economic problems of students in Higher Education in the time COVID-19. *Journal of Information Systems Engineering and Management*, 7(3).
- Safitri, I., Pasaribu, R., Simamora, S. S., & Lubis, K. (2019). The effectiveness of android application as a student aid tool in understanding physics project assignments. *Jurnal Pendidikan IPA Indonesia*, 8(4), 512-520.
- Sağır, Ş. U. (2018). The Relation Between Elementary School Students' Science Success and Science Attitude, Anxiety, Interest. *International Journal of Educational Researchers*, 9(1), 1-11.
- Sahin, D., & Yilmaz, R. M. (2020). The effect of Augmented Reality Technology on middle school students' achievements and attitudes towards science education. *Computers & Education*, 144, 103710.
- Samsudin, A., Afif, N. F., Nugraha, M. G., Suhandi, A., Fratiwi, N. J., Aminudin, A. H., ... & Coştu, B. (2021a). Reconstructing Students' Misconceptions on Work and Energy through the PDEODE* E Tasks with Think-Pair-Share. *Journal of Turkish Science Education*, 18(1), 118-144.
- Samsudin, A., Cahyani, P. B., Purwanto, P., Rusdiana, D., Efendi, R., Aminudin, A. H., & Coştu, B. (2021b). Development of a multitier open-ended work and energy instrument (MOWEI) using Rasch analysis to identify students' misconceptions. *Cypriot Journal of Educational Sciences*, 16(1), 16-31.
- Samsudin, A., Suhandi, A., Rusdiana, D., Kaniawati, I., & Coştu, B. (2016, June). Investigating the effectiveness of an active learning based-interactive conceptual instruction (ALBICI) on electric field concept. In *Asia-Pacific Forum on Science Learning and Teaching* (Vol. 17, No. 1, pp. 1-41). The Education University of Hong Kong, Department of Science and Environmental Studies.
- Samsudin, A., Suhandi, A., Rusdiana, D., Kaniawati, I., & Coştu, B. (2016, June). Investigating the effectiveness of an active learning based-interactive conceptual instruction (ALBICI) on electric field concept. In *Asia-Pacific Forum on Science Learning and Teaching* (Vol. 17, No. 1, pp. 1-41). The Education University of Hong Kong, Department of Science and Environmental Studies.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Santos, A. I., Aliagas, C., & Duarte, J. M. (2021). A systematic review of gamification in higher education: Influence on engagement and student learning. *Computers & Education*, 181, 104062.
- Saputra, M. R. D., & Kuswanto, H. (2018, September). Development of Physics Mobile (Android) Learning Themed Indonesian Culture Homblo Batu on the Topic of Newton's Law and Parabolic Motion for Class X SMA/MA. In *Journal of Physics: Conference Series* (Vol. 1097, No. 1, p. 012023). IOP Publishing.
- Saputra, O., Setiawan, A., & Rusdiana, D. (2019, February). Identification of student misconception about static fluid. In *Journal of Physics: Conference Series* (Vol. 1157, No. 3, p. 032069). IOP Publishing.
- Sari, F. P., Ratnaningtyas, L., Wilujeng, I., & Kuswanto, H. (2019, June). Development of android comics media on thermodynamic experiment to map the science process skill for senior high school. In *Journal of Physics: Conference Series* (Vol. 1233, No. 1, p. 012052). IOP Publishing.
- Sari, Y. N., & Margana, M. (2019). YouTube as a learning media to improve the student's speaking ability in 21st century. *Journal of English Language Teaching and Linguistics*, 4(2), 263.
- Sarwanto, Fajari, L. E. W., & Chumdari. (2021). Critical thinking skills and their impacts on elementary school students. *Malaysian Journal of Learning and Instruction*, 18(2), 161-188. <https://doi.org/10.32890/mjli2021.18.2.6>
- Savander-Ranne, C., & Kolari, S. (2003). Promoting the conceptual understanding of engineering students through visualisation. *Global Journal of Engineering Education*, 7, 189-200.
- Schecker, H., Wilhelm, T., Hopf, M., & Duit, R. (Eds.). (2018). *Schülervorstellungen und Physikunterricht: Ein Lehrbuch für Studium, Referendariat und Unterrichtspraxis [Preconceptions and physics teaching: A textbook for university education, in-service training and teaching practis]*. Springer Spektrum.
- Schwichow, M., Anna Hellmann, K., & Mikelskis-Seifert, S. (2022). Pre-service Teachers' Perception of Competence, Social Relatedness, and Autonomy in a Flipped Classroom: Effects on Learning to Notice Student Preconceptions. *Journal of Science Teacher Education*, 33(3), 282-302.
- Selçuk, G. s. (2010). The effects of problem-based learning on pre-service teachers' achievement, approaches and attitudes towards learning physics. *International Journal of Physical Sciences* 5(6):711-723
- Sencar, S., & Eryilmaz, A. (2004). Factors mediating the effect of gender on ninth-grade Turkish students' misconceptions concerning electric circuits. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 41(6), 603-616.
- Serway, R. A. & Vuille, C. (2017). *College Physics*, Eleventh Edition. Boston: Cengage Learning.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Setiawan, D., & Faoziyah, N. (2020). Development of a five-tier diagnostic test to reveal the student concept in fluids. *Physics Communication*, 4(1), 6-13.
- Shabrina & Kuswanto, H. (2018). Android-Assisted Mobile Physics Learning through Indonesian Batik Culture: Improving Students' Creative Thinking and Problem Solving. *International Journal of Instruction*, 11(4), 287-302.
- Sharma, M. D., Rosemary, M. R., & Wilson, K. (2006). *What is physics for prospective primary school teachers*. Sydney University Physics Education Research group. University of Sydney, Australia.
- Shields, R. (2003). *The Virtual*. New York: Routledge.
- Siersma, P. T., Pol, H. J., van Joolingen, W. R., & Visscher, A. J. (2021). Pre-university students' conceptions regarding radiation and radioactivity in a medical context. *International journal of science education*, 43(2), 179-196.
- Silaban, S. S., Suhandi, A., & Gunanto, Y. E. (2017, November). Aplikasi Media Simulasi Virtual pada Model Pembelajaran ECIRR untuk Meremediasi Miskonsepsi Siswa pada Materi Perubahan Wujud Zat. In *Prosiding SNFA (Seminar Nasional Fisika dan Aplikasinya) (Vol. 2, pp. 201-213)*.
- Sirbu, A. (2015). Language As a Tool of Communication. *ResearchGate*, 18(2).
- Sitorus, D. S., & Santoso, T. N. B. (2022). Pemanfaatan Quizizz sebagai media pembelajaran berbasis game pada masa pandemi Covid-19. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, 12(2), 81-88.
- Skilling, K., & Stylianides, G. J. (2020). Using vignettes in educational research: a framework for vignette construction. *International Journal of Research & Method in Education*, 43(5), 541-556.
- Snyder, D. M. (1983). On the nature of relationships involving the observer and the observed phenomenon in psychology and physics. *The Journal of Mind and Behavior*, 389-400.
- Soh, T. M. T., Arsad, N. M., & Osman, K. (2010). The relationship of 21st century skills on students' attitude and perception towards physics. *Procedia-Social and Behavioral Sciences*, 7, 546-554.
- Solikhah, B. (2014). An Application of Theory of Planned Behavior towards CPA Career in Indonesia. *Procedia - Social and Behavioral Sciences*, 164. <https://doi.org/10.1016/j.sbspro.2014.11.094>
- Sommerauer, P., & Fokkens, A. (2019, August). Conceptual change and distributional semantic models: An exploratory study on pitfalls and possibilities. In *Proceedings of the 1st International Workshop on Computational Approaches to Historical Language Change* (pp. 223-233).
- Song, J., Park, J., Kwon, S., & Chung, B. (2000). Idealization in Physics: Its types, roles and implications to physics learning. *Physics teacher education beyond*, 359-366.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Soomro, A. Q., Qaisrani, M. N., & Uqaili, M. A. (2011). Measuring students' attitudes towards learning physics: *Experimental research. Australian Journal of Basic and Applied Sciences*, 5(11), 2282-2288.
- Spitzer, D. R. (1975). What Is a Concept? *Educational Technology*, 15(7), 36–39. <http://www.jstor.org/stable/44418021>
- Sreenivasulu, B., and Subramaniam, R. (2013). University Students' Understanding of Chemical Thermodynamics. *International Journal of Science Education*, 35(4), 601–635.
- Statistica Research Department. (2022). *Market share of mobile operating systems in Indonesia from January 2013 to May 2022, by operating system*. Diakses secara online melalui <https://www.statista.com/statistics/262205/market-share-held-by-mobile-operating-systems-in-indonesia/> pada tanggal 6 September 2022
- Stiggins, R., Arter, J., Chappuis, S. & Chappuis, F. (2004). *Classroom Assessment for Student Learning: Doing It Right - Using it Well*. Assessment Training Institute, Portland, OR.
- Suantari, N. M. D. P., Suma, K., & Pujani, N. M. (2018). Development of three tier static electricity diagnostic test to identify student conceptions about static electricity. *International Research Journal of Engineering, IT and Scientific Research*, 4(5), 7-16.
- Suhandi, A., Samsudin, A., Suhendi, E., Hermita, N., Syamsiah, E. N., & Costu, B. (2020). Facilitating conceptual changes of high school students regarding concepts in static electricity and DC circuits through the use of VMSCDCCText. *Universal Journal of Educational Research*, 8(3), 815-822.
- Sujarwo, S., & Yahrif, M. (2019). Improving Students' English Learning Outcomes through PQ4R (Preview, Question, Read, Reflect, Recite, Review) Learning Model at the Eighth Grade of SMP Tunas Bangsa Makassar. *Celebes Education Review*, 1(2), 48-55.
- Sumarni, R. A., Bhakti, Y. B., Astuti, I. A. D., Sulisworo, D., & Toifur, M. (2020). The development of animation videos based flipped classroom learning on heat and temperature topics. *Indonesian Journal of Science and Mathematics Education*, 3(3), 304-315.
- Sumintono, B., & Widhiarso, W. (2015). *Aplikasi pemodelan Rasch pada assessment pendidikan*. Trim Komunikata. <http://eprints.um.edu.my/id/eprint/14228>
- Sumintono, B., & Widhiarso. (2014). *Aplikasi Model Rasch Untuk Penelitian Ilmu-Ilmu Sosial (Edisi Revisi; T. Bambang, ed.)*. Cimahi: Trim Komunikata Publishing House.
- Sundayana, R. (2020). *Statistika Penelitian Pendidikan*. Bandung: Alfabeta.

- Sundberg, M., Dini, M., & Li, E. (1994). Decreasing course content improves student comprehension of science and attitudes toward science among adolescent students. *Journal of Research in Science Teaching*, 31, 679–693.
- Sunjaya, D. K., Herawati, D. M. D., Indraswari, N., Megawati, G., & Sumintono, B. (2021). Training and assessing model for the ability of community health volunteers in anthropometric measurement using the rasch stacking and racking analyses. *Journal of environmental and public health*, 2021.
- Suparno P. (2013). *Miskonsepsi Perubahan Konsep Dalam Pendidikan Fisika*. Jakarta: Grasindo.
- Suprpto, N. (2020). Do we experience misconceptions?: An ontological review of misconceptions in science. *Studies in Philosophy of Science and Education*, 1(2), 50-55.
- Sürücü, L., & MASLAKÇI, A. (2020). Validity and reliability in quantitative research. *Business & Management Studies: An International Journal*, 8(3), 2694-2726.
- Suryadi, A. (2020). *Teknologi dan media pembelajaran jilid I*. CV Jejak (Jejak Publisher).
- Suweta, I. P. (2022). Implementasi Model Pembelajaran ECIRR untuk Meningkatkan Motivasi dan Prestasi Belajar Fisika Siswa Kelas X MIPA 2 SMA Negeri 1 Singaraja pada Semester Ganjil Tahun Pelajaran 2021/2022. *Daiwi Widya*, 9(1), 111-127.
- Talib, R., Iahad, N. A., Ashari, Z. M., Rameli, M. R. M., Bakar, Z. A., & Dollah, R. (2019). Rasch strategies for evaluating quality of the Conceptions and Alternative assessment Survey (CETAS). *Universal Journal of Educational Research*, 7(12A), 10-17.
- Tatli, Z., & Alipasa, A. Y. A. S. (2012). Virtual chemistry laboratory: Effect of constructivist learning environment. *Turkish Online Journal of Distance Education*, 13(1), 183-199.
- Tatli, Z., & Ayas, A. (2010). Virtual laboratory applications in chemistry education. *Procedia-Social and behavioral sciences*, 9, 938-942.
- Tatli, Z., & Ayas, A. (2013). Effect of a virtual chemistry laboratory on students' achievement. *Journal of Educational Technology & Society*, 16(1), 159-170.
- Tawil, M., & Said, M. A. (2022). Understanding the Newton's Motion Concept Through Qualitative and Quantitative Teaching. *JPPPF (Jurnal Penelitian dan Pengembangan Pendidikan Fisika)*, 8(1).
- Taylor, A. K., & Kowalski, P. (2014). Student misconceptions: Where do they come from and what can we do? In V. A. Benassi, C. E. Overson, & C. M. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum* (pp. 259–273). Society for the Teaching of Psychology.

- Thiagarajan, S. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Indiana Univ., Bloomington. Indiana University Bloomington, Indiana.
- Thomas, C. L., & Kirby, L. A. (2020). Situational interest helps correct misconceptions: An investigation of conceptual change in university students. *Instructional Science*, 48(3), 223-241.
- Tiandho, Y. (2018). Miskonsepsi gaya gesek pada mahasiswa. *J. Pendidik. Fis. dan Keilmuan*, 4(1), 1-9.
- Tipler, P. A. & Mosca, G. (2008). *Physics for Scientists and Engineers with Modern Physics*. New York: W. H. Freeman and Company.
- Tiwari, R., & Singh, K. (2011). Virtualisation of engineering discipline experiments for an Internet-based remote laboratory. *Australasian Journal of Educational Technology*, 27(4), 671-692.
- Topalsan, A. K. (2020). Development of Scientific Inquiry Skills of Science Teaching through Argument-Focused Virtual Laboratory Applications. *Journal of Baltic Science Education*, 19(4), 628-646.
- Tsui, C. Y., and D. Treagust. 2010. Evaluating Secondary Students' Scientific Reasoning in Genetics Using a Two-Tier Diagnostic Instrument. *International Journal of Science Education*, 32(8), 1073–1098.
- Tüysüz, C. (2010). The Effect of the Virtual Laboratory on Students' Achievement and Attitude in Chemistry. *International Online Journal of Educational Sciences*, 2(1).
- Tytler, R., & Osborne, J. (2012). Student attitudes and aspirations towards science. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education (Vol. 1, pp. 597–625)*. Dordrecht: Springer, Netherlands.
- Ubaid. (2010). *Media Pembelajaran*. Yogyakarta: Gava Media.
- Umar, N. F., Sinring, A., Pandang, A., & Anas, M. (2022). Career Self-Management Scale (CEDLE scale) in the Indonesian Version of The Social Cognitive Model. *INDONESIAN JOURNAL OF EDUCATIONAL STUDIES (IJES)*, 25(1), 10–20.
- Uttal, D. H., O'Doherty, K., Newland, R., Hand, L. L., & DeLoache, J. (2009). Dual representation and the linking of concrete and symbolic representations. *Child Development Perspectives*, 3(3), 156-159.
- Van Bavel, J. J., Jenny Xiao, Y., & Cunningham, W. A. (2012). Evaluation is a dynamic process: Moving beyond dual system models. *Social and Personality Psychology Compass*, 6(6), 438-454.
- Vandana, D., Gupta, P., Kumar, A., & Verma, A. C. (2020). Feasibility Study of Android Application in Architectural Education. *International Journal Of Scientific & Technology Research*, 9(2), 2682-2686.

- Veloo, A., Nor, R., & Khalid, R. (2015). Attitude towards physics and additional mathematics achievement towards physics achievement. *International Education Studies*, 8(3), 35-43.
- Venida, A. C., & Sigua, E. M. (2020). Predict-observe-explain strategy: Effects on students' achievement and attitude towards physics. *Jurnal Pendidikan MIPA*, 21(1), 78-94.
- Vergara, D., Extremera, J., Rubio, M. P., & Dávila, L. P. (2020). The proliferation of virtual laboratories in educational fields. *ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal*, 9(1), 85.
- Vorapongsathorn, T., Taejaroenkul, S., & Viwatwongkasem, C. (2004). A comparison of type I error and power of Bartlett's test, Levene's test and Cochran's test under violation of assumptions. *Songklanakarin J. Sci. Technol*, 26(4), 537-547.
- Vosniadou, S. (2019). The development of students' understanding of science. *Frontiers in Education*, 4, 2368.
- Vygotsky, L. (1986). *Thought and Language* (A. Kozulin, Trans.). Cambridge, MA: The MIT Press. (Originally published in Russian in 1934)
- Walberg, H. J. (1976). The psychology of learning environments: behavioral, structural, or perceptual? *Review of Research in Education*, 4, 142-178
- Wang, C. L., & Liou, P. Y. (2017). Students' motivational beliefs in science learning, school motivational contexts, and science achievement in Taiwan. *International Journal of Science Education*, 39(7), 898-917.
- Wästberg, B. S., Eriksson, T., Karlsson, G., Sunnerstam, M., Axelsson, M., & Billger, M. (2019). Design considerations for virtual laboratories: A comparative study of two virtual laboratories for learning about gas solubility and colour appearance. *Education and Information Technologies*, 24(3), 2059-2080.
- Weber, J., & Wilhelm, T. (2020). The benefit of computational modelling in physics teaching: a historical overview. *European Journal of Physics*, 41(3), 034003.
- Wenning C. J. & Vieyra, R. E. (2020). Teaching High School Physics: Interacting with Physics Students. *AIP Publishing (online)*: New York. DOI: <https://doi.org/10.1063/9780735422018>
- Wenning, C. J. (2008). Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education Online*, 5(1), 11-19.
- White, R., & Gunstone, R. (1992). *Probing Understanding*. London: The Falmer
- Whitelegg, E., & Parry, M. (1999). Real-life contexts for learning physics: meanings, issues and practice. *Physics Education*, 34(2), 68.
- Widodo, A., Maria, R. A., & Fitriani, A. (2017). Constructivist learning environment during virtual and real laboratory activities. *Biosaintifika: Journal of Biology & Biology Education*, 9(1), 11-18.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Wijaya, R. E., Mustaji, M., & Sugiharto, H. (2021). Development of Mobile Learning in Learning Media to Improve Digital Literacy and Student Learning Outcomes in Physics Subjects: Systematic Literature Review. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, 4(2), 3087-3098.
- Winarno, dkk.. (2009). *Teknik Evaluasi Multimedia Pembelajaran*. Yogyakarta: Genius Prima Media.
- Wittman, M. C. (1998). Making Sense of How Students Come to an Understanding of Physics: An Example From mechanical Waves. *Unpublished PhD thesis.*, University of Maryland, Maryland.
- Woodfield, B. (2005). *Virtual chemlab getting started*. Pearson Education Website. 25, 2005.
- Woolnough, B. E. (1994). Why students choose physics, or reject it. *Physics Education*, 29, 368–374. doi:10.1088/0031-9120/29/6/006.
- Wright, R. I. (1980). Instrument reliability. *Journal of Physics E: Scientific Instruments*, 13(1), 8.
- Wulandari, A. P., Salsabila, A. A., Cahyani, K., Nurazizah, T. S., & Ulfiah, Z. (2023). Pentingnya Media Pembelajaran dalam Proses Belajar Mengajar. *Journal on Education*, 5(2), 3928-3936.
- Yan, X., & Chuang, P. L. (2023). How do raters learn to rate? Many-facet Rasch modeling of rater performance over the course of a rater certification program. *Language Testing*, 40(1), 153-179.
- Yan, Y. K., & Subramaniam, R. (2018). Using a multi-tier diagnostic test to explore the nature of students' alternative conceptions on reaction kinetics. *Chemistry Education Research and Practice*, 19(1), 213-226.
- Yana, A. U., Antasari, L., & Kurniawan, B. R. (2019). Analisis pemahaman konsep gelombang mekanik melalui aplikasi online quizizz. *Jurnal Pendidikan Sains Indonesia*, 7(2), 143-152.
- Yen, W. M. (1984). Effects of local item dependence on the fit and equating performance of the three-parameter logistic model. *Applied Psychological Measurement*, 8(2), 125-145.
- Young, H. D & Freedman, R. A. (2016) *Universtity Physics with Modern Physics with Modern Physics*, 14th Edition. Boston: Pearson Education, Inc.
- Yuberti, Y., Suryani, Y., & Kurniawati, I. (2020). Four-tier diagnostic test with certainty of response index to identify misconception in physics. *Indonesian journal of science and mathematics education*, 3(2), 245-253.
- Yulianita, N. 1423025026 (2019). Pengembangan Laboratorium Virtual Materi Optika untuk Meningkatkan Literasi Sains Siswa SMP. *Masters Thesis*, Universitas Lampung.

Fatah Kurniawan, 2023

PENERAPAN VIRTUMFI BERBASIS ANDROID TERHADAP PENGUBAHAN KONSEPSI PADA GELOMBANG DAN PENGUNGKAPAN PROFIL ATTITUDE TOWARDS PHYSICS SISWA SMA
Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu

- Yuliarni, I., Marzal, J., & Kuntarto, E. (2019). Analysis of Multimedia Learning Mathematics Storyboard Design. *International Journal of Trends in Mathematics Education Research*, 2(3), 149-152.
- Yuliarsih, Y., & Sy, E. N. S. (2022). The Effect of E-Learning as Media in Teaching Reading: Quasi-Experimental Design at Wachid Hasyim Senior High School Pamekasan Regency, Indonesia. *International Journal of Multicultural and Multireligious Understanding*, 9(9), 224–230.
- Yuniarti, A., & Yeni, L. F. (2015). Pengembangan virtual laboratory berbasis Multimedia Interaktif Pada Penanaman Dan Pengecatan Bakteri di SMA. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa*, 4(12).
- Yuniarti, F., Dewi, P., & Susanti, R. (2012). Pengembangan virtual laboratory sebagai media pembelajaran berbasis komputer pada materi pembiakan virus. *Journal of Biology Education*, 1(1).
- Zar, J. H. (2010) *Biostatistical analysis 5th Ed*. New Jersey: Pearson.
- Zhan, Q., & Wang, Q. (2021). The Development of the College Students' Experience of Family Harmony Questionnaire (CSEFHQ). *Frontiers in psychology*, 12, 658430.
- Zheng, A., Tucker-Drob, E. M., & Briley, D. A. (2019). National gross domestic product, science interest, and science achievement: A direct replication and extension of the Tucker-Drob, Cheung, and Briley (2014) study. *Psychological Science*, 30(5), 776-788.
- Zhou, M. & Brown, D. (2017). *Educational Learning Theories: 2nd Edition. Education Open Textbooks*. 1. <https://oer.galileo.usg.edu/education-textbooks/1>
- Zulfikar, T., Dahliana, S., & Sari, R. A. (2019). An Exploration of English Students' Attitude towards English Learning. *English Language Teaching Educational Journal*, 2(1), 1-12.
- Zulkifli, Z., Azhar, A., & Syaflita, D. (2022). Application Effect of PhET Virtual Laboratory and Real Laboratory on the Learning Outcomes of Class XI Students on Elasticity and Hooke's Law. *Jurnal Penelitian Pendidikan IPA*, 8(1), 401-407.