The Role of The Flipped Classroom in Promoting Multidimensional Learning Outcomes at Physics Subject: Evidence from Inferential Statistics, Structural Equation Modeling, and Rasch Analysis

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Abstract

To meet 21st century educational demands, the flipped classroom fosters multidimensional physics learning outcomes by relocating direct instruction outside the classroom and emphasizing cognitive, affective, and psychomotor engagement during in-class activities. This study investigates the role of the flipped classroom in promoting multidimensional physics learning outcomes among high school students, comprehensively in three domains: cognitive, affective, and psychomotor. The research employed 2x3 factorial quasi experimental to compare student's learning outcomes from flipped classroom and traditional lectured based method (control). Data were collected from 72 high school student in science major at SMAN 39 Jakarta and analyzed to capture both latent constructs and item-level measurement precision by integrate inferential statistics, Partial Least Squares-Structural Equation Modelling (SEM-PLS) and Rasch model. The n-gain scores indicate that the flipped classroom significantly enhances cognitive (0,74), affective (0,71) and psychomotor domains (0,83). Inferential analyses through independent t-test demonstrate significant differences between flipped classroom and control group ($p < 0.001$) in all learning outcome domains. The SEM-PLS analysis revealed that the psychomotor domain exerted the strongest interaction effect on learning outcomes ($\beta = 2.519$), followed by the cognitive ($\beta = 2.420$) and affective domains ($\beta = 1.333$). The affective domain also exhibited indirect effects through its impact on the other two domains. The SEM-PLS also confirm significant p-valui on all those relationship. Rasch analysis further validates the measurement instrument and provides the differences of measurement level of each person in before-after treatment in flipped classroom intervention group. These results offer robust empirical support for the implementation of flipped classroom as an effective pedagogical strategy to foster holistic student learning outcomes in high school.

Keywords Flipped Classroom; Rasch Model; SEM-PLS; Physics Learning Outcomes; Quasi Experiment.

1. INTRODUCTION

Over the past decade, the rapid evolution of digital technology has significantly accelerated the transformation of education worldwide. This shift has gradually replaced traditional teacher-centered paradigms with more student-centered approaches that emphasize active learning, collaboration, and autonomy. Among these emerging instructional models, flipped learning has gained substantial attention for its potential to enhance student engagement, foster independent learning, and promote deeper understanding of subject matter (Bergmann & Sams, 2012; Lo & Hew, 2017)

Flipped learning reconfigures the traditional instructional sequence by shifting content delivery outside of classroom hours—typically through video lectures or other online resources—allowing face-to-face time to be used for active learning activities, such as group discussions, collaborative problem-solving, and contextual application (O'Flaherty & Phillips, 2015). In practice, this approach has demonstrated positive effects on learner motivation and classroom interaction across multiple educational levels, including higher education and vocational training (Zainuddin & Halili, 2016).

This pedagogical transformation closely aligns with the demands of 21st-century education, which emphasize not only the cognitive domain but also affective and psychomotor skills. These three domains, as defined by the revised Bloom's Taxonomy, are essential for developing holistic learners who are capable of critical thinking, emotional intelligence, and practical skill application in real-world contexts (Anderson & Krathwohl, 2001; Krathwohl, 2002).

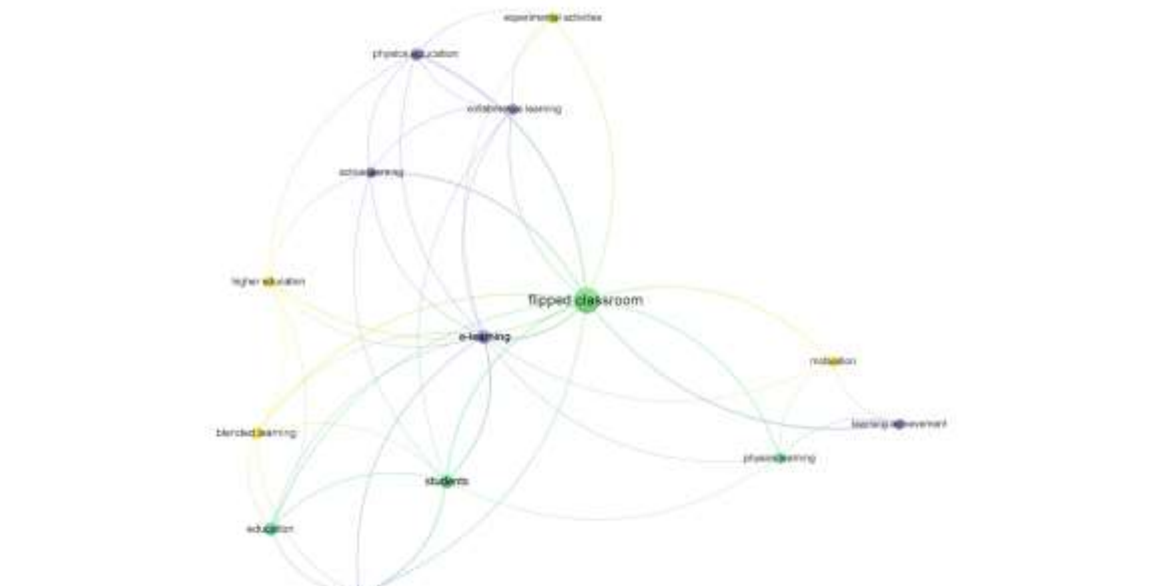
However, within the past ten years, research on flipped learning has remained predominantly focused on cognitive outcomes, such as test performance and content retention. Systematic reviews and meta-analyses have revealed that the affective and psychomotor domains remain significantly underexplored, despite their vital role in enhancing learner engagement, workplace readiness, and lifelong learning capabilities (Lo & Hew, 2017; Van Alten et al., 2019). This disproportionate focus risks offering an incomplete picture of flipped learning's true impact in complex, contemporary educational contexts.

In response to this gap, the present study adopts a multidimensional approach to evaluate the effectiveness of flipped learning across cognitive, affective, and psychomotor dimensions. Learning improvement is measured using the Normalized Gain (N-Gain) to assess progress before and after the intervention. Additionally, Structural Equation Modeling–Partial Least Squares (SEM-PLS) is employed to investigate the causal relationships among the three learning domains and their contribution to overall learning outcomes (Sarstedt et al., 2021)

This approach reflects a broader trend in recent educational research, which combines psychometric analysis and learning analytics to yield deeper, data-informed insights. Consequently, this study not only advances theoretical understanding of flipped learning but also offers practical implications for educators, curriculum designers, and policymakers striving to modernize instructional practices to better serve the needs of digital-native learners and the demands of the modern workforce.

1.1 Implementing Flipped Classroom Strategy in Physics Learning

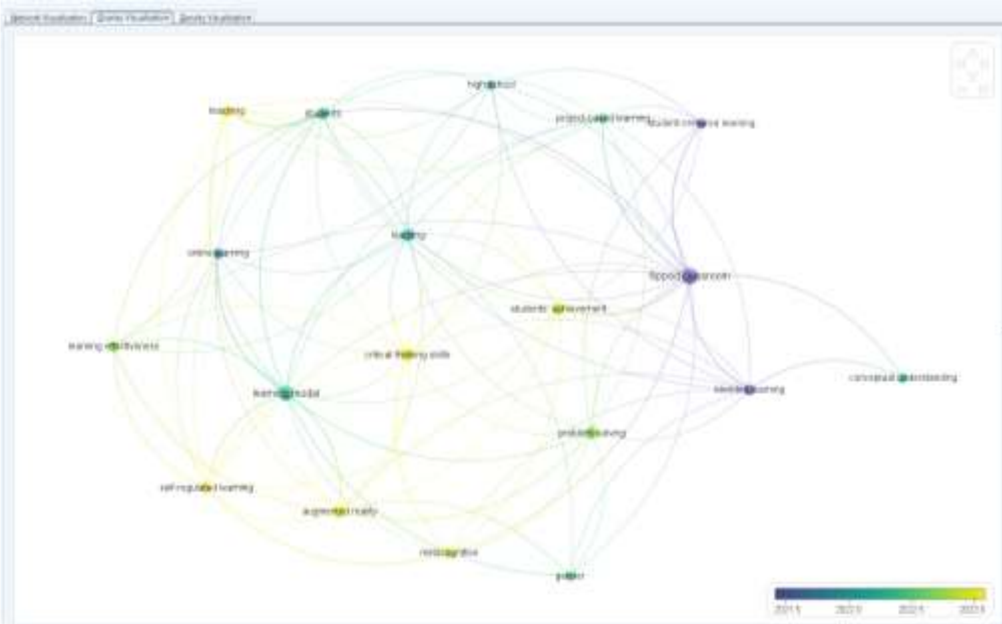
Penelitian tentang implementasi flipped classroom pada pembelajaran fisika mengalami peningkatan yang signifikan selama satu dekade terakhir, terutama pada jenjang pendidikan tinggi. Flipped classroom merupakan bagian dari strategi pembelajaran yang berpusat pada siswa, khususnya active learning. Flipped classroom seringkali dirancang untuk meningkatkan interaksi dalam pembelajaran dan pemahaman konseptual pada pembelajaran fisika.



Implementasi flipped classroom dapat melibatkan collaborative learning (pembelajaran kolaboratif) dan experimental activities (aktivitas eksperimen), di mana aktivitas eksperimen tampak sebagai fokus yang lebih baru secara visual (~2022) pada peta. Tren 5 tahun terakhir menunjukkan Flipped classroom dalam pembelajaran fisika juga terhubung erat dengan konsep kunci lain terutama students (siswa) dalam konteks physics education (pendidikan fisika) dan higher education (pendidikan tinggi). Penelitian dalam lingkup ini juga mengkaji keterkaitannya dengan modalitas seperti e-learning dan blended learning , serta dampaknya terhadap aspek penting seperti motivation (motivasi) siswa dan learning achievement (pencapaian belajar).

Meskipun daftar kata kunci mencakup learning achievement (pencapaian belajar) serta strategi spesifik seperti active learning, collaborative learning, dan experimental activities, hubungan empiris yang kuat dan eksplisit antara penerapan metode-metode aktif spesifik ini dengan pengukuran learning achievement tampaknya kurang tereksplorasi secara mendalam atau kurang divisualisasikan secara menonjol dalam peta jaringan. Peta visual ("image_c954ad.jpg") bahkan tidak secara jelas menampilkan learning achievement sebagai node utama yang terhubung kuat ke strategi-strategi tersebut. Ini menunjukkan potensi kesenjangan dalam riset yang secara langsung mengukur dampak dari intervensi aktif yang spesifik (kolaboratif, eksperimental) terhadap hasil belajar yang terukur.

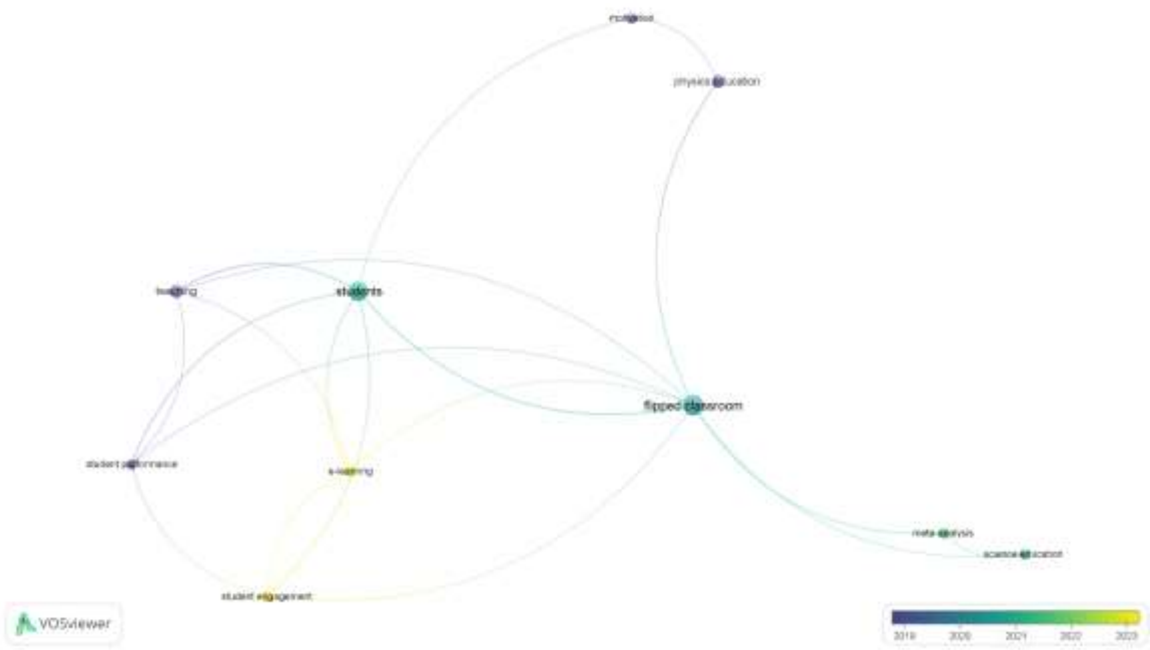
1.2 The Role Flipped Classroom in Promoting Cognitive Domain on Physics Subject



Berdasarkan daftar kata kunci yang tersedia dan dielaborasi melalui struktur peta jaringan ("kognitif.jpg"), penelitian pendidikan ini secara substantif mengeksplorasi berbagai learning model (model pembelajaran) dan dampaknya terhadap proses learning (pembelajaran) bagi students (siswa/mahasiswa). Model spesifik seperti flipped classroom, project-based learning, dan blended learning banyak dikaji (tampak dalam klaster visual merah pada peta), seringkali dalam konteks high school dan dihubungkan dengan evaluasi students' achievement (prestasi siswa) serta conceptual understanding (pemahaman konseptual). Fokus penting lainnya adalah pengembangan keterampilan kognitif seperti critical thinking skills (keterampilan berpikir kritis) dan problem solving (pemecahan masalah) (terlihat dalam klaster hijau dan sebagai penghubung antar klaster di peta), serta penilaian learning effectiveness (efektivitas pembelajaran), termasuk dalam lingkungan online learning. Selain itu, penelitian ini juga mendalami aspek kemandirian pembelajar melalui self-regulated learning (pembelajaran mandiri) dan metacognition (metakognisi) (terkelompok dalam klaster biru di peta), bahkan mengaitkannya dengan potensi teknologi augmented reality dan variabel gender. Keseluruhan pendekatan ini tampak menekankan filosofi student-centered learning (pembelajaran berpusat pada siswa) dengan peran teaching (pengajaran) sebagai fasilitator proses pembelajaran tersebut.

Keterkaitan antara Strategi Spesifik dan Hasil Belajar: Meskipun daftar kata kunci mencakup `students' achievement` (prestasi siswa) dan `conceptual understanding` (pemahaman konseptual), serta strategi spesifik seperti `project-based learning`, `flipped classroom`, dan `active learning`, hubungan empiris yang kuat dan mekanisme *bagaimana* strategi ini secara spesifik meningkatkan hasil belajar tersebut (terutama `conceptual understanding` yang memiliki link strength rendah dalam daftar) mungkin kurang dieksplorasi secara mendalam. Peta visual ("kognitif.jpg") menunjukkan adanya hubungan, namun kedalaman analisis mekanisme ini bisa menjadi celah penelitian

1.3 The Role Flipped Classroom in Promoting Affective Domain on Physics Subject

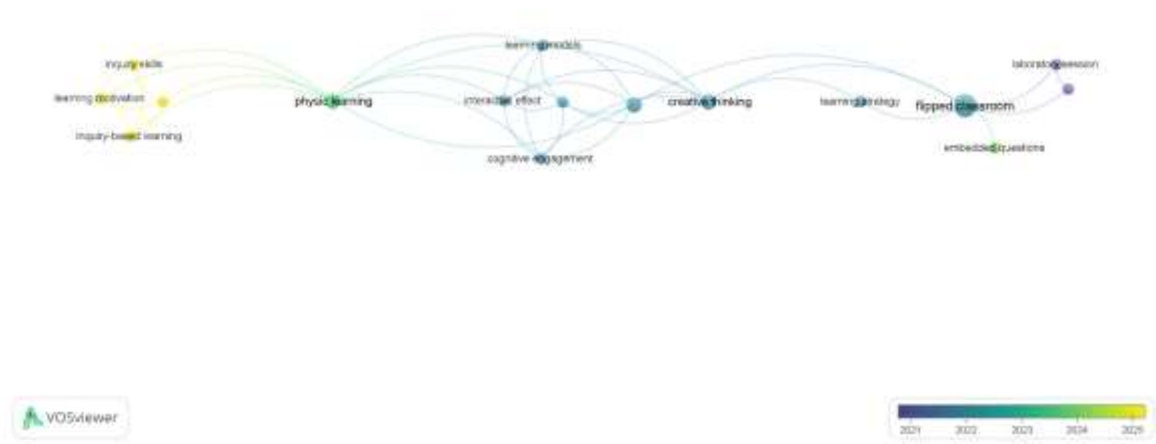


Berdasarkan daftar kata kunci yang tersedia, penelitian yang berpusat pada `flipped classroom` dalam konteks `physics education` dan `science education` secara ekstensif melibatkan `students` dan peran `teaching`. Fokus penting dalam riset ini adalah pada domain afektif, yaitu `motivation` dan `student engagement`, meskipun keduanya memiliki kemunculan yang lebih sedikit dalam daftar ini. Elaborasi menggunakan peta visual ("afektiv.png") mengindikasikan adanya evolusi temporal, di mana perhatian pada `motivation` tampak lebih awal (~2019.5-2020 dalam skala peta), sedangkan `student engagement` menjadi fokus yang lebih kuat dan baru (~2022-2023 dalam skala peta), seringkali terkait dengan implementasi `e-learning`. Penelitian ini juga mengkaji dampak terhadap `student performance` (yang juga tampak sebagai fokus awal di peta) dan terkadang disintesis melalui studi `meta-analysis` untuk mendapatkan gambaran yang lebih luas.

Mekanisme Pengaruh Flipped Classroom: Peta ("afektiv.png") menunjukkan hubungan antara flipped classroom dengan motivation dan student engagement. Namun, mekanisme spesifik bagaimana desain instruksional atau aktivitas konkret dalam flipped classroom (yang tidak terinci dalam peta ini atau daftar kata kunci ini) mempengaruhi kedua aspek afektif tersebut tampaknya kurang dieksplorasi secara mendalam dalam literatur yang dipetakan.

Peran Spesifik E-learning dalam Keterlibatan: Meskipun peta ("afektiv.png") menunjukkan hubungan terkini (~2023) antara student engagement dan e-learning, kedua kata kunci ini memiliki statistik rendah dalam daftar. Hal ini menyarankan kesenjangan dalam memahami fitur atau praktik spesifik dalam platform e-learning yang paling efektif untuk mendorong student engagement ketika digunakan untuk mendukung implementasi flipped classroom.

1.4 The Role Flipped Classroom in Promoting Psychomotor Domain on Physics Subject



Analisis peta jaringan kata kunci VOSviewer ("psikomotor.png") dengan overlay temporal (~2021 hingga ~2025) ini mengungkap evolusi fokus penelitian, dengan indikasi kuat ke arah domain psikomotor dalam konteks pembelajaran fisika. Setelah fokus awal (sekitar 2021-2022, warna biru/biru kehijauan) pada penerapan model `flipped classroom`, `learning strategy` (strategi belajar), dan aspek `cognitive engagement` (keterlibatan kognitif), penelitian tampak bergeser melalui eksplorasi `learning models` (model pembelajaran) umum dan `creative thinking` (berpikir kreatif) pada periode pertengahan (~2022.5-2023, warna hijau/cyan).

Yang paling signifikan adalah munculnya klaster tren riset yang sangat baru atau diproyeksikan ke masa depan (sekitar 2024-2025, warna kuning). Klaster terbaru ini secara jelas menekankan pada pendekatan `inquiry-based learning` (pembelajaran berbasis inkuiri), perancangan `learning activities` (aktivitas pembelajaran) spesifik, dan pengembangan `inquiry skills` (keterampilan inkuiri). Meskipun kata kunci 'psikomotor' tidak muncul secara eksplisit, fokus yang kuat pada keterampilan dan aktivitas berbasis inkuiri dalam konteks `physics learning` (pembelajaran fisika) ini sangat menyiratkan adanya pergeseran fokus riset. Evolusi ini menunjukkan bahwa penelitian bergerak dari penerapan model pembelajaran awal menuju investigasi mendalam tentang bagaimana model tersebut dapat dioptimalkan, khususnya melalui pendekatan inkuiri dan aktivitas praktis, untuk menumbuhkan **keterampilan proses sains yang lebih komprehensif, yang secara inheren melibatkan domain psikomotor** (misalnya, keterampilan manipulatif dalam eksperimen, observasi, pengukuran).

Berdasarkan daftar kata kunci yang spesifik ini, penelitian dalam konteks `physic learning` (pembelajaran fisika) dan `education` (pendidikan) secara umum mengeksplorasi implementasi `flipped classroom` atau `flipped learning` dengan penekanan kuat pada pengembangan keterampilan praktis dan proses sains. Hal ini terindikasi dari keberadaan kata kunci seperti `inquiry-based learning` (pembelajaran berbasis inkuiri), `inquiry skills` (keterampilan inkuiri), `experimental design` (desain eksperimen), `laboratory method` (metode laboratorium), serta pemanfaatan `virtual lab` (laboratorium virtual) atau `structured virtual laboratory`. Elaborasi menggunakan peta visual ("psikomotor.png") mengkonfirmasi bahwa fokus pada `inquiry-based learning` dan `inquiry skills` merupakan tren riset yang sangat baru atau bahkan masa depan (~2024-2025 dalam skala peta). Pendekatan pembelajaran ini juga dikaitkan dengan upaya peningkatan aspek kognitif, termasuk `creative thinking` (berpikir kreatif), `critical thinking` (berpikir kritis), dan `higher-order thinking skills` (keterampilan berpikir tingkat tinggi), sambil turut mempertimbangkan faktor `cognitive engagement` (keterlibatan kognitif) dan `learning motivation` (motivasi belajar) siswa (`student`). Penelitian ini juga mencakup investigasi terhadap `learning models` (model pembelajaran) dan `learning strategy` (strategi belajar) secara lebih luas, serta teknik spesifik seperti `embedded questions` (pertanyaan tertanam) dan `gamification`, yang semuanya didukung oleh peran `technology in education` (teknologi dalam pendidikan).

Kuantitas dan Kedalaman Riset Keterampilan Praktis/Inkuiri: Kata kunci yang paling relevan dengan domain psikomotor dan praktis seperti inquiry skills, inquiry-based learning, experimental design, laboratory method, virtual lab, dll., semuanya memiliki jumlah kemunculan (occurrences) yang sangat rendah (umumnya hanya 1) dalam daftar. Meskipun peta ("psikomotor.png") menyoroti fokus pada inkuiri sebagai tren baru/masa depan (~2024-2025), statistik rendah ini menunjukkan bahwa riset kuantitatif yang secara spesifik mendalami aspek-aspek praktis/psikomotor dalam konteks model pembelajaran modern ini kemungkinan masih sangat terbatas.

Asesmen Keterampilan Praktis/Inkuiri: Daftar kata kunci ini **tidak secara eksplisit mencantumkan kata kunci yang terkait dengan *asesmen* atau pengukuran** `inquiry skills` atau kompetensi psikomotor lainnya yang dikembangkan melalui aktivitas laboratorium atau inkuiri. Ini menunjukkan kemungkinan adanya **kesenjangan signifikan dalam penelitian mengenai pengembangan, validasi, dan penerapan instrumen asesmen** yang otentik dan reliabel untuk mengukur keterampilan praktis dalam lingkungan pembelajaran ini.

1.5 Research Questions

1. Does the flipped classroom improve cognitive, affective, and psychomotor learning outcomes based on n-gain score?
2. Are there significant differences in these outcomes between the flipped classroom and control groups based on independent t-test sample?
3. How do the cognitive, affective, and psychomotor domains individually and collectively influence learning outcomes in the flipped classroom group according to structural path SEM-PLS analysis?
4. Does the instruments used to assess learning outcomes meet validity and reliability criteria based on Rasch modeling?
5. How does individual learning progress in the flipped classroom setting based on stacking Rasch model?

2. METHODS

The method used should be accompanied by references; the relevant modification should be explained. The procedure and data analysis technique should be emphasized in a literature review article. The stages and analysis of the research must be explained in detail.

2.1 n-gain score?

2.2 independent t-test sample?

2.3 structural path SEM-PLS analysis?

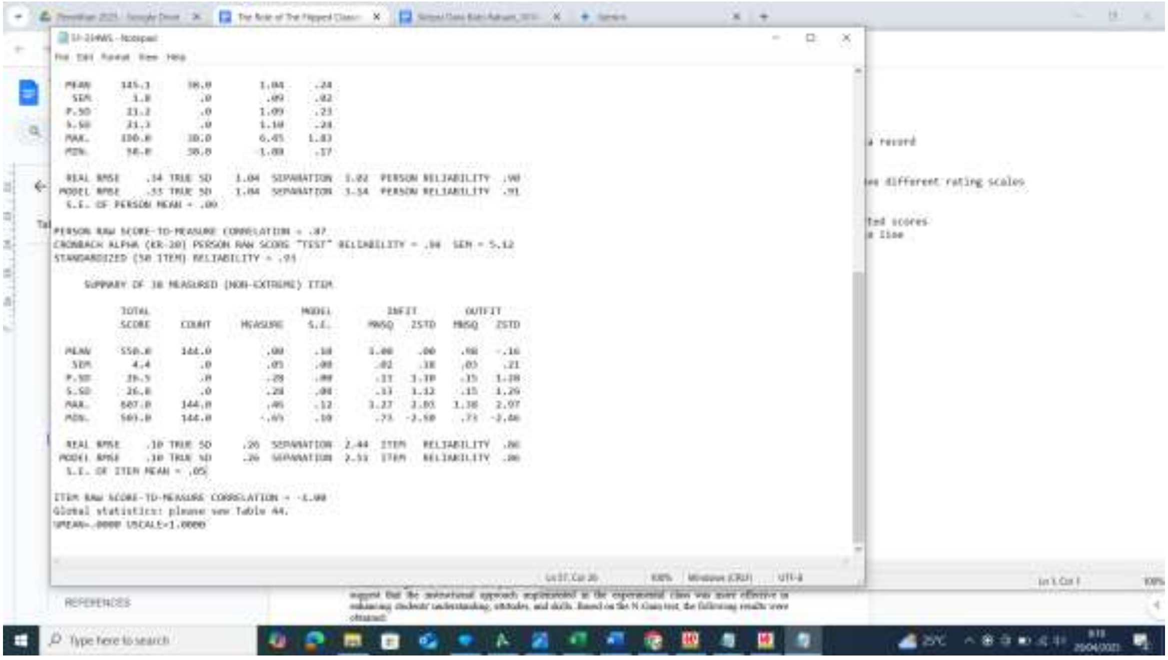
2.4 validity and reliability criteria based on Rasch modeling?

2.5 on stacking Rasch model?

3. RESULTS AND DISCUSSION

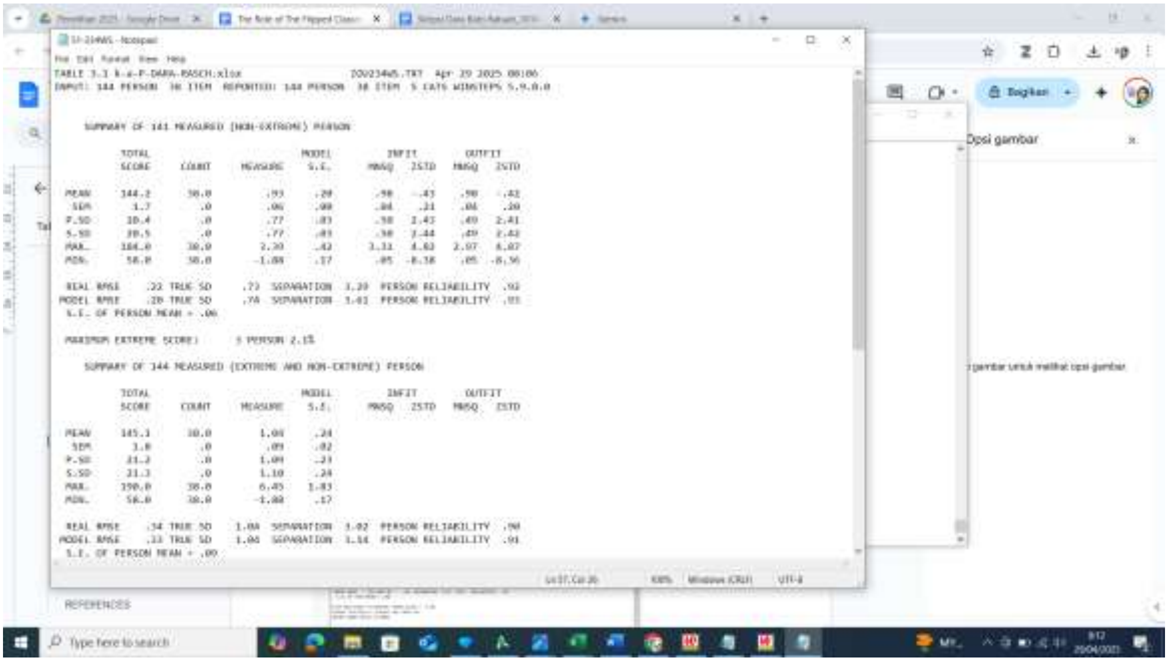
3.1 The Validity And Reliabilitu Of Research Instrument By Using Rasch Model

AFEKTIF - SUMMARY -ITEM



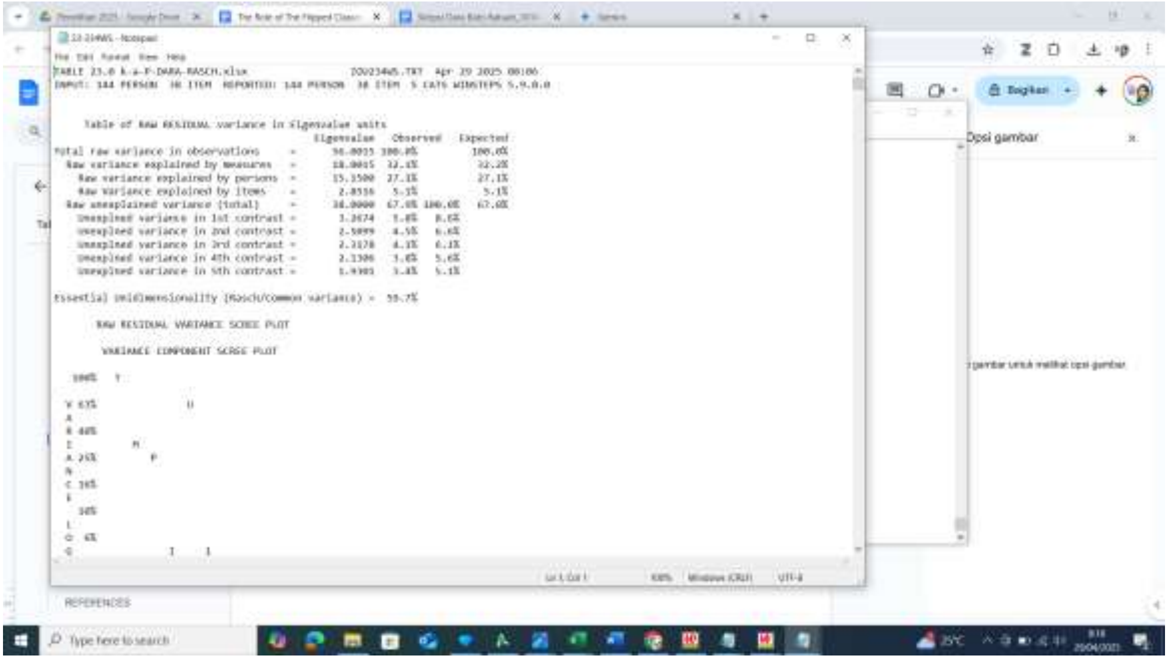
```
 MEAN     145.1      38.0        1.04     .24
  SEM       1.8        .0         .09     .02
 P.SD      21.2        .0        1.09     .23
 S.SD      21.3        .0        1.10     .24
 MAX.     190.0      38.0        6.45    1.83
 MIN.      58.0      38.0       -1.88     .17

 REAL RMSE    .34 TRUE SD    1.04  SEPARATION  3.02  PERSON RELIABILITY  .90
MODEL RMSE    .33 TRUE SD    1.04  SEPARATION  3.14  PERSON RELIABILITY  .91
 S.E. OF PERSON MEAN = .09

PERSON RAW SCORE-TO-MEASURE CORRELATION = .87
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .94  SEM = 5.12
STANDARDIZED (50 ITEM) RELIABILITY = .93

     SUMMARY OF 38 MEASURED (NON-EXTREME) ITEM

          TOTAL                         MODEL         INFIT        OUTFIT
          SCORE      COUNT    MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD

 MEAN     550.0      144.0        .00     .10      1.00    .00    .98   -.16
  SEM       4.4         .0        .05     .00       .02    .18    .03    .21
 P.SD      26.5         .0        .28     .00       .11   1.10    .15   1.28
 S.SD      26.8         .0        .28     .00       .11   1.12    .15   1.29
 MAX.     607.0      144.0        .46     .12      1.27   2.03   1.38   2.97
 MIN.     503.0      144.0       -.65     .10       .73  -2.50    .73  -2.46

 REAL RMSE    .10 TRUE SD     .26  SEPARATION  2.44  ITEM   RELIABILITY  .86
MODEL RMSE    .10 TRUE SD     .26  SEPARATION  2.51  ITEM   RELIABILITY  .86
 S.E. OF ITEM MEAN = .05

ITEM RAW SCORE-TO-MEASURE CORRELATION = -1.00
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000
```

AFEKTIF-SUMMARY-PERSON

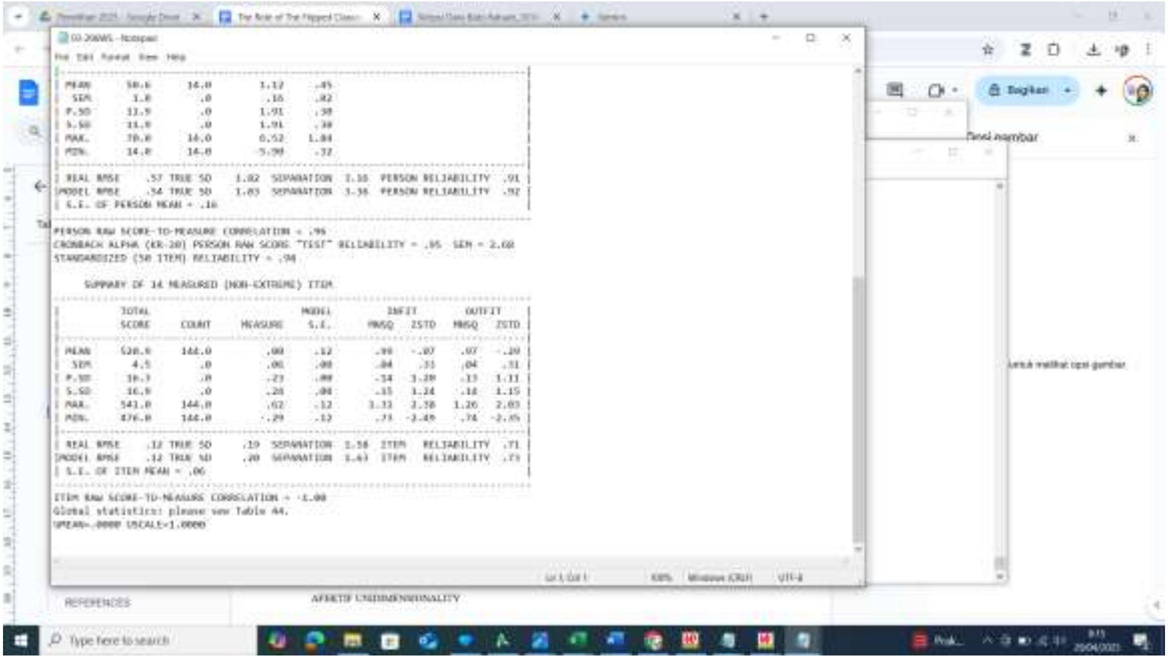


```
TABLE 3.1 k-a-P-DARA-RASCH.xlsx             ZOU234WS.TXT  Apr 29 2025 08:06
INPUT: 144 PERSON  38 ITEM  REPORTED: 144 PERSON  38 ITEM  5 CATS WINSTEPS 5.9.0.0

     SUMMARY OF 141 MEASURED (NON-EXTREME) PERSON

          TOTAL                         MODEL         INFIT        OUTFIT
          SCORE      COUNT    MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD

 MEAN     144.2      38.0        .93     .20       .98   -.43    .98   -.42
  SEM       1.7        .0        .06     .00       .04    .21    .04    .20
 P.SD      20.4        .0        .77     .03       .50   2.43    .49   2.41
 S.SD      20.5        .0        .77     .03       .50   2.44    .49   2.42
 MAX.     184.0      38.0       2.30     .42      3.11   6.82   2.97   6.87
 MIN.      58.0      38.0      -1.88     .17       .05  -8.38    .05  -8.56

 REAL RMSE    .22 TRUE SD     .73  SEPARATION  3.29  PERSON RELIABILITY  .92
MODEL RMSE    .20 TRUE SD     .74  SEPARATION  3.61  PERSON RELIABILITY  .93
 S.E. OF PERSON MEAN = .06

 MAXIMUM EXTREME SCORE:      3 PERSON 2.1%

     SUMMARY OF 144 MEASURED (EXTREME AND NON-EXTREME) PERSON

          TOTAL                         MODEL         INFIT        OUTFIT
          SCORE      COUNT    MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD

 MEAN     145.1      38.0       1.04     .24
  SEM       1.8        .0        .09     .02
 P.SD      21.2        .0       1.09     .23
 S.SD      21.3        .0       1.10     .24
 MAX.     190.0      38.0       6.45    1.83
 MIN.      58.0      38.0      -1.88     .17

 REAL RMSE    .34 TRUE SD    1.04  SEPARATION  3.02  PERSON RELIABILITY  .90
MODEL RMSE    .33 TRUE SD    1.04  SEPARATION  3.14  PERSON RELIABILITY  .91
 S.E. OF PERSON MEAN = .09
```

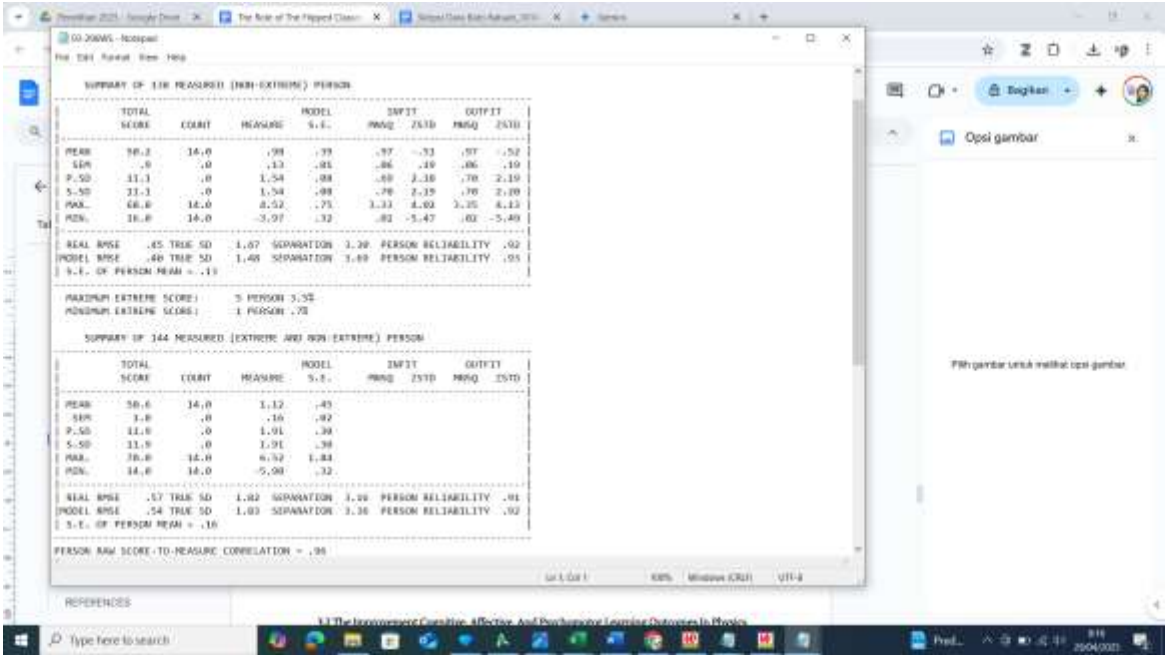
AFEKTIF UNIDIMENSIONALITY



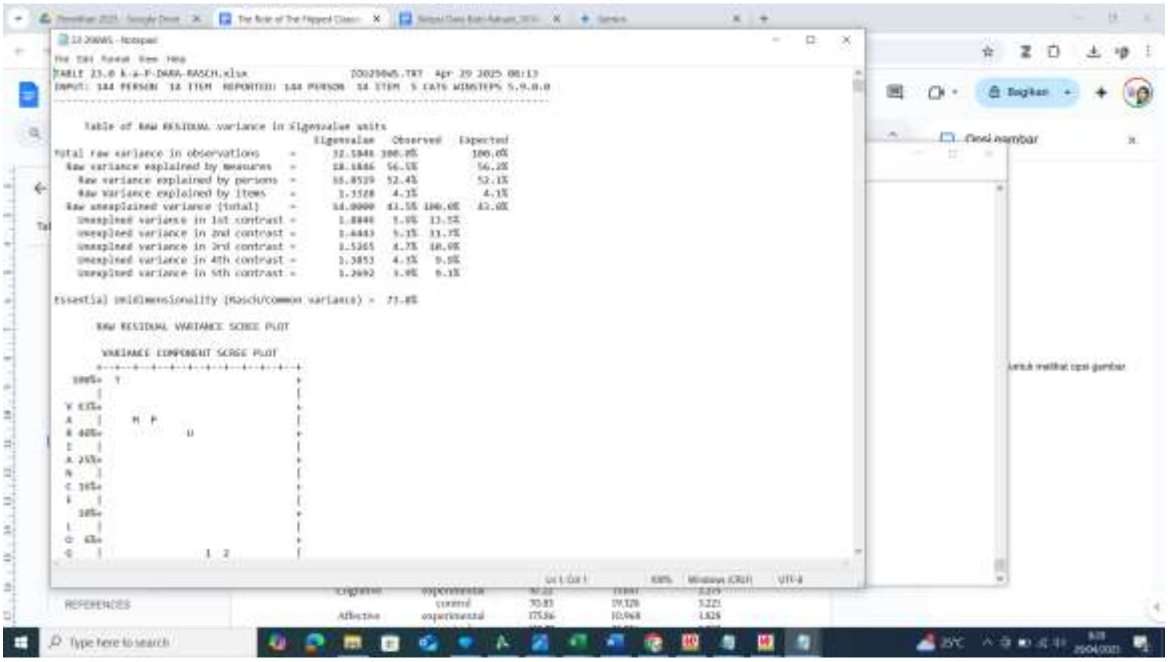
PSIKOMOTOR-SUMMARY - ITEM



PSIKOMOTOR-SUMMARY = PERSON



PSIKOMOTOR-UNIDIMENSIONALITY



3.2 The Improvement Cognitive, Affective, And Psychomotor Learning Outcomes In Physics Based On N-Gain Score in Fllipped Classroom Group

Based on the prerequisite analysis conducted, the research data is normally distributed, but there is heterogeneity of variance in the cognitive domain. Therefore, for hypothesis testing, the researcher used a parametric test, specifically the t-test. The results of the hypothesis testing using the t-test are presented below.

Table 1 Group Statistics

Domain	Group	Mean	Std Deviation	Std Error Mean
Cognitive	experimental	87.22	13.651	2.275
	control	70.83	19.328	3.221
Affective	experimental	175.86	10.968	1.828
	control	152.72	21.556	3.593
Psychomotor	experimental	65.28	5.522	.920
	control	58.44	7.784	1.297

Overall, students in the experimental class achieved higher average scores across all three learning domains—cognitive, affective, and psychomotor—compared to those in the control class. These findings suggest that the instructional approach implemented in the experimental class was more effective in enhancing students' understanding, attitudes, and skills. Based on the N-Gain test, the following results were obtained:

Table 2 N-Gain Test Results

Domain	Group	N-Gain Score	Interpretation
Cognitive	experimental	74.02	Quite Effective
	control	42.83	Less Effective
Affective	experimental	71.16	Quite Effective
	control	31.06	Not Effective
Psychomotor	experimental	83.08	Effective
	control	52.75	Less Effective

Based on the results of the N-Gain test for the experimental class XI MIPA 4 and the control class XI MIPA 5 in the table, it shows that in the cognitive domain, Flipped Classroom learning is classified as quite effective with a score of 74.02. In the affective domain, with a score of 71.16, it is categorized as quite effective, and in the psychomotor domain, with a score of 83.08, it is categorized as effective. Meanwhile, in the control class XI MIPA 5, the cognitive and psychomotor domains are classified as less effective with scores of 42.83 and 52.75, respectively. In the affective domain, it is categorized as not effective with a score of 31.06.

3.3 The Difference Significancies Between Students Multidimensional Learning Outcome Exposed to Flipped Classroom And Control Group According To Independent t-Test Sample

Table 3 Independent t Test Samples in each Learning Outcome Domains

Domain	Group	t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Std.Error Difference
Cognitive	experimental	4.156	70	.000	3.944
	control	4.156	62.961	.000	3.944
Affective	experimental	5.740	70	.000	4.031
	control	5.740	51.984	.000	4.031
Psychomotor	experimental	4.296	70	.000	1.591
	control	4.296	63.107	.000	1.591

This shows that the treatment or approach in the experimental class has a positive impact on students' understanding, attitude, and skills. Based on the testing in the table, it can be concluded that Flipped Classroom learning is effective in improving student learning outcomes on the material of solid material elasticity.

3.4 Modeling the Structural Relationship of Affective, Psychomotor, and Cognitive Domains on Learning Outcomes in a Flipped Classroom Environment Based On Structural Path SEM Model

To understand the structural relationships among learning domains in the context of flipped classroom, an analysis was conducted using Structural Equation Modeling Partial Least Squares (SEM-PLS), as shown in the following figure.

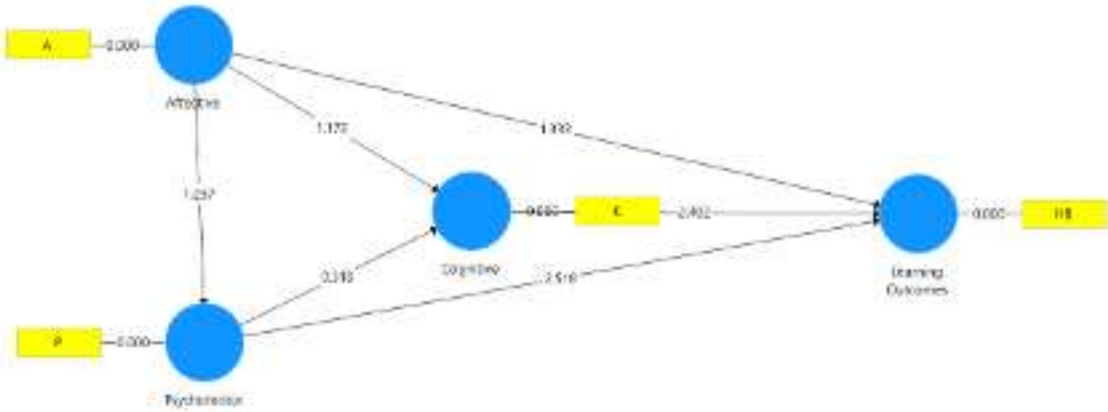


Figure 1 The structural path model obtained from the SEM-PLS

The structural path model obtained from the SEM-PLS analysis provides an overview of the direct and indirect contributions of the affective, psychomotor, and cognitive domains to learning outcomes.

Relationship	Path Coefficient	P-Value	Interpretation
Affective → Cognitive	1.172	0.000	Significant – The affective domain also influences students' cognitive mastery.
Psychomotoric → Cognitive	0.318	0.000	Significant, though small effect – Shows that practical skills also support students' thinking abilities.
Affective → Psychomotoric	1.257	0.000	Significant – Students' emotions and attitudes contribute to their psychomotor skills..
Affective → Learning Outcomes	1.333	0.000	Significant – The affective domain has a positive and significant effect on learning outcomes.
Psychomotoric → Learning Outcomes	2.518	0.000	Very Significant – This path has the highest coefficient. Psychomotor skills have a major contribution to learning outcomes
Cognitive → Learning Outcomes	2.402	0.000	Significant – Indicates that thinking skills remain crucial for determining learning outcomes.

The three domains (affective, psychomotor, and cognitive) contribute significantly to learning outcomes. Psychomotor is the most dominant factor influencing students' learning outcomes, followed by cognitive. Affective has both a direct effect and an indirect effect through mediation paths to cognitive and psychomotor domains. All relationships in this model are statistically significant (p-value = 0.000), meaning that the model you built is structurally very strong.

3.5 The Patterns Of Individual Learning Progress Among Students Participating In The Flipped Classroom Intervention.

The results and discussion should be presented in the same part, clearly and briefly. The discussion part should contain the benefit of the research result, not the repeat result part. The results and discussion part can be written in the same part to avoid the extensive quotation. Tables or graphs must present different results. The results of data analysis must be reliable in answering research problems. References to the discussion should not repeat the references in the introduction. Comparisons to the findings of previous studies must be included.

kognitif

Name	DIF	D MEASURE	CONTRAST	Chi-squ prob
	pretest	Postest		

K1	.49	.49	.00	1.000

afektif

Name	DIF D MEASURE		CONTRAST	Chi-squ prob
	pretest	Postest		
AFF1	.12	-.26	-.37	.2387
AFF2	.54	.06	-.48	.1241
AFF3	-.34	-.09	.25	.3569
AFF4	.09	.11	.02	.9400
AFF5	.24	.00	-.23	.4469
AFF6	-.52	.02	.54	.0620
AFF7	-.07	.25	.31	.2459
AFF8	-.50	.14	.65	.0367
AFF9	-.14	-.05	.09	.7821
AFF10	-.05	.27	.32	.2672
AFF11	.46	.38	-.08	.7842
AFF12	-.59	.37	.96	.0014
AFF13	-.11	-.52	-.41	.1840
AFF14	.10	-.03	-.13	.6557
AFF15	-.09	-.02	.07	.8041
AFF16	-.18	.20	.38	.1590
AFF17	-.37	-.16	.21	.4484

AFF18	.11	.02	-.09	.7434
AFF19	.01	-.18	-.19	.5446
AFF20	-.06	-.34	-.27	.3828
AFF21	-.36	.07	.43	.1682
AFF22	-.14	.16	.30	.2922
AFF23	.09	-.24	-.32	.3169
AFF24	-.22	-.61	-.39	.2365
AFF25	-.62	.34	.96	.0004
AFF26	.19	.45	.26	.3910
AFF27	-.12	-.53	-.41	.1694
AFF28	.09	-.51	-.60	.0642
AFF29	-.23	-.23	.00	1.000
AFF30	-.43	-.05	.37	.2692
AFF31	.17	-.34	-.52	.1159
AFF32	.14	-.47	-.61	.0746
AFF33	-.25	-.81	-.56	.1080
AFF34	.08	-.23	-.31	.3166
AFF35	-.52	.28	.80	.0015
AFF36	-.13	.54	.66	.0270
AFF37	.32	.26	-.06	.8378
AFF38	-.02	-.07	-.05	.8615

psikomotorik

Name	DIF D MEASURE		CONTRAST	Chi-squ prob
	pretest	Postest		
PSI1	.78	.12	-.66	.0117
PSI2	.41	-.04	-.45	.0931
PSI3	.12	-.17	-.29	.2529
PSI4	.07	.20	.13	.6277
PSI5	.26	.00	-.26	.3247
PSI6	.07	-.25	-.32	.2301
PSI7	.03	-.17	-.20	.4521
PSI8	.42	.22	-.20	.4828
PSI9	-.18	-.04	.14	.5906
PSI10	.16	.16	.00	1.000
PSI11	-.08	-.19	-.11	.6932
PSI12	.31	.12	-.18	.4642
PSI13	.25	-.08	-.33	.2114
PSI14	.16	-.03	-.19	.4505

4. CONCLUSION

The Flipped Classroom is effective in improving students' learning outcomes on the topic of solid material elasticity. This method has a positive impact on students' cognitive, affective, and psychomotor aspects by allowing them to understand concepts more deeply through independent learning before face-to-face sessions. During classroom activities, students become more active in discussions and experiments, which contributes to a better understanding of concepts as well as practical skills. Additionally, the implementation of the Flipped Classroom encourages students to be more independent in their learning and increases their engagement in the learning process. However, the success of this method largely depends on the teacher's readiness to design interactive materials and the students' access to adequate learning resources. Therefore, for more effective implementation, support from technology and strategies that align with the needs of the students and their learning environment are necessary. Thus, the results of this research can serve as a reference in the development of innovative teaching strategies to enhance students' science skills, particularly in the topic of solid material elasticity and physics in general.

REFERENCES

Use the "Insert Citation" button to add citations to this document.