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# Professional-oriented education approach in mechanics physics course for future career track

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## ABSTRACT

Future career prospects are crucial for guiding the next generation of physicists and scientific professionals. Many students struggle to identify the best future path based on their talents and abilities. The objective of this paper was to compare the effectiveness of a professional-oriented education approach to traditional teaching methods among high secondary school students in aligning students to their suitable career education track in Kazakhstan. The study underwent a two-group pretest-posttest quasi-experimental research design utilising a mechanics physics course. The samples involved two groups of students over 26 months - a control group (n=58) and an experimental group (n=57). A quantitative data was collected through a test administered before and after the learning class. The findings indicated that both teaching methods improved the Kazakhstan student's performance. However, the experimental group exhibited a significantly higher level of improvement than the control group where students were aligned to the best track, i.e., the general education track as compared to secondary vocational education or the initial vocational education track both categories as middle and lower track. In conclusion, this research demonstrates that a professional-oriented education can align students' future professions with their interests, capabilities, and strengths, enabling them to pursue their desired careers brightly.

**Contribution/Originality:** This study examines the effectiveness of a professional-oriented education compared to traditional teaching for high secondary school students in Kazakhstan. It will help students choose the best education track whether general education, secondary vocational education or initial vocational education that will align with their interests and fit their desired careers.

## 1. INTRODUCTION

Understanding future career prospects is crucial for secondary school students, particularly in physics as it provides direction and purpose. It helps students see the relevance of their studies and how physics applies across various fields (Hadzigeorgiou & Schulz, 2017). Exploring potential career paths in physics can inspire students and support informed decisions about their education and future. A physics background opens doors to diverse opportunities including roles in scientific research, engineering, finance, education and numerous other industries (Institute of Physics, 2024). Such awareness enables students to set meaningful goals, select suitable educational pathways and build the skills and knowledge required for their aspirations. Moreover, it fosters an appreciation of physics' broader societal and economic contributions, motivating students to pursue careers that drive scientific progress and innovation. Therefore, recognizing career opportunities in physics is vital for inspiring and guiding scientists and professionals. This research examines how the professional-oriented education approach tailored student's future academic paths. Students who perform well academically, i.e., high performance are directed towards the general education track. At the same time, those focusing on skills and competency are guided towards secondary vocational education, i.e., low performance. Additionally, a course is designed for students with academic and competency skills leading to the initial vocational track, i.e., average performance (Astana, 2016). It is crucial to help students choose the best track for their future professions at this level. This saves time and is cost-effective for students, parents and teachers ensuring that the chosen career track is not only suitable but also practical and beneficial.

Specialising further in a physics course enables students to align their studies with their career aspirations by providing advanced knowledge and expertise in specific areas of physics. Pursuing such advanced specialisation can unlock a wide range of career opportunities. It significantly enhances a physicist's prospects, paving the way for roles like senior researcher, high-energy physicist, astrophysicist, material scientist etc. (Institute of Physics, 2024; Sulaiman, Rosales Jr, & Kyung, 2023). Additionally, a specialised physics degree opens doors across various industries, including engineering, finance, education, biotechnology, meteorology, nanotechnology, and data analytics. Specialisation also equips students with transferable 21st-century skills such as problem-solving, analytical reasoning, research, data analysis, communication, and teamwork highly valued by employers across different sectors (Rosales & Sulaiman, 2020). This advanced focus gives students a competitive edge in the job market showcasing their expertise and dedication to a specific field of study. In essence, enhanced specialisation in physics empowers students with the knowledge, skills and experience needed to explore diverse and rewarding career paths within and beyond physics.

Therefore, the Republic of Kazakhstan's education policy strives to enhance and modernise its education system, focusing strongly on physics education. By decree of the government of the Republic of Kazakhstan dated September 22, 2023, No. 828, the national project "Quality Education, Educated Nation" emphasises the importance of natural sciences, including physics (Higher Education in Kazakhstan, 2017). It aims to improve the quality of teaching and learning in this subject. The program also includes initiatives to introduce English language instruction in natural sciences in secondary schools (Goodman, Nam, Yembergenova, & Malone, 2023) which is part of the broader modernisation of the general secondary education system. The education system in Kazakhstan has undergone significant changes over the years moving away from a more traditional teacher-centred approach inherited from the Soviet system (Abylkassymova, 2020). Today, the education system is diverse and modern with compulsory primary and secondary education provided for all students, free of charge. Post-secondary and tertiary education options are also available with many universities and higher education institutions offering academic and technical specialisations. Kazakhstan has substantially advanced in restructuring its higher education system and transitioning towards a market-oriented model (Massyrova, Tautenbaeva, Tussupova, Zhalalova, & Bissenbayeva, 2015).

Consequently, the government of the Republic of Kazakhstan has now introduced a program, one that is still at the testing stages which is the professional-oriented education approach, to align students at higher secondary schools in grades 10-11 with unique talents and interests to pursue their education level at three different tracks that are offered, i.e., secondary vocational education colleges, initial vocational education track, and general education track (Astana, 2016). Thus, this study seeks to determine whether this approach can be a model to align students with a suitable career education track afterward. This study is driven by the potential benefits of a professional-oriented for higher secondary students. This approach can guide students towards pursuing any of the three tracks; each designed to cater to students' unique talents and capabilities by improving their competency, developing their interests, and increasing their motivation. The approach is part of the commendable education policy of the republic which will help students make informed decisions about their academic pursuits, potentially saving them from the time and costs of choosing the wrong career path and guiding them towards a productive future.

The research questions, objectives and hypothesis are given below.

### *1.1. Research Objectives*

i. To study the effect of the professional-oriented education course program at a high secondary school in the Republic of Kazakhstan in aligning students' future professional education career track.

ii. To determine the pattern between low-performance, average-performance and high-performance tests before students choose their professional education career track.

### *1.2. Research Questions*

i. Is there a difference between the pre-test and the post-test for the control and the experimental groups in their mechanics physics topic test?

ii. Is there a difference between the control and experimental groups in their post-test?

iii. What is the pattern of low-performance, average-performance and high-performance tests for the control and experimental groups before students can further align their professional education career track?

### *1.3. Null Hypothesis*

*$H_{01}$: No significant difference between the pre-test and the post-test for the control and the experimental groups in their mechanics physics topic test.*

*$H_{02}$: No significant difference between the control and experimental groups in their post-test.*

## 2. LITERATURE REVIEW

### *2.1. The Education System in the Republic of Kazakhstan*

The education system in Kazakhstan is overseen by the Ministry of Education and administered locally. Schooling is mandatory for all children aged 6 to 15 with additional pre-university options available for students aged 16 to 18. Kazakhstan's education system comprises various levels starting with kindergarten and progressing to higher education opportunities for those seeking advanced degrees and diplomas (Balgabayeva et al., 2024; Higher Education in Kazakhstan, 2017).

Kindergarten education typically begins at age four followed by primary education which starts at age six and spans four academic years (grades 1 to 4). Lower secondary education or basic school resembles middle or junior high school in countries like the United States. It begins around age 10 or 11 and lasts five years (grades 5 to 9). Higher secondary school is crucial for guiding students' interests and career pathways after completing basic school. At this level, students can choose one of three educational tracks for grades 10 and 11, the secondary vocational education track, the initial vocational education track or the general education track. It is important to note that students must select only one track and cannot enroll in multiple tracks simultaneously (Álvarez-Galván, 2014; Higher Education in Kazakhstan, 2017). Colleges offer the secondary vocational education track which provides general academic and vocational training. Depending on the chosen field, programs typically last three to four years, covering grades 10 to 12 or courses 1 to 4 (Higher Education in Kazakhstan, 2017). The initial vocational education track provided by training schools focuses on specialized education and training in specific trades or professions. Program lengths vary from one to three years depending on the chosen field. Lycees, a key component of the initial vocational education track offer foundational vocational education combined with comprehensive academic learning. These programs typically span three years and cover grade 10 to 12.

Finally, tertiary education in Kazakhstan is provided by universities focusing exclusively on teaching rather than research. Following the Russian model of higher education (Chankseliani & Silova, 2018), universities in

Kazakhstan primarily concentrate on academic instruction with little emphasis on research activities. Figure 1 illustrates the structure of the education system in the Republic of Kazakhstan.

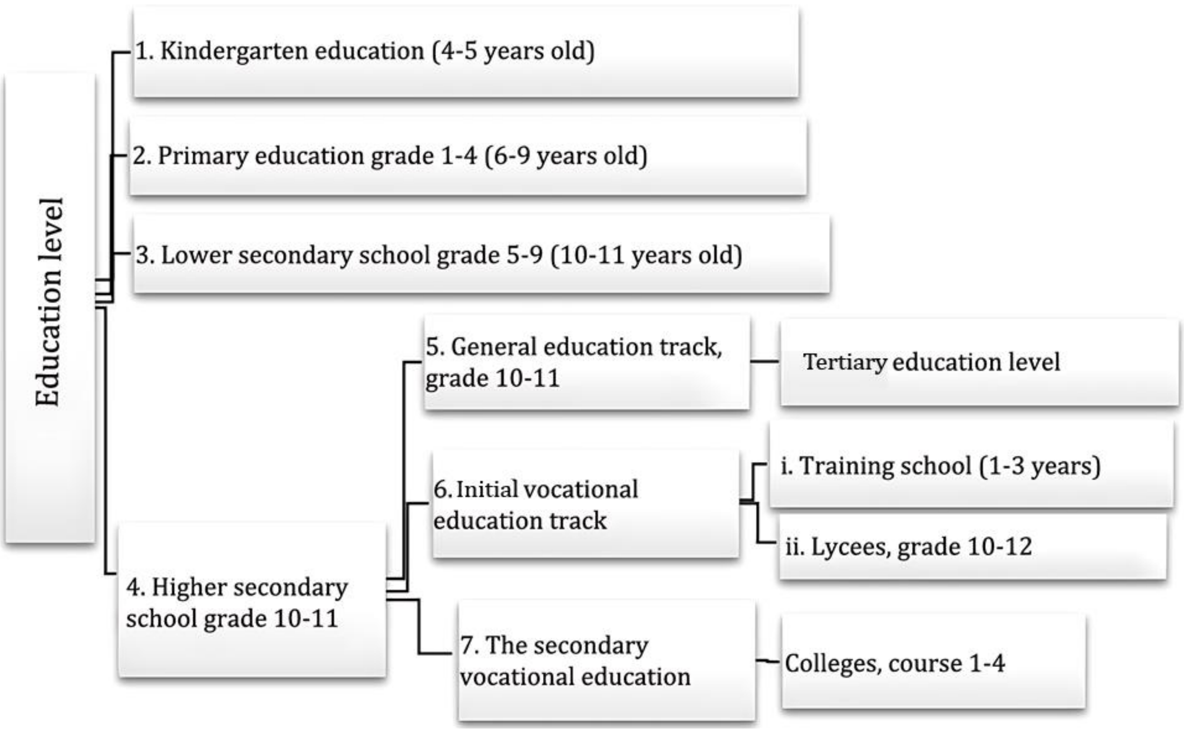


**Figure 1.** The education level in the Republic of Kazakhstan.

### *2.2. The Higher Secondary School Curriculum in the Republic of Kazakhstan*

The Republic of Kazakhstan's higher secondary school curriculum program aims to create a supportive learning environment that fosters academic excellence while preparing students for future opportunities. It focuses on developing critical skills such as analytical thinking, research proficiency, social competence, and personal growth while encouraging lifelong learning. Kazakh is the primary language of instruction and all subjects are taught in this language. The curriculum includes diverse subjects such as language and literature, mathematics and computer science, natural sciences, social sciences, art and technology and physical education. Students also have the option to select elective subjects tailored to their career interests. These elective subjects taught weekly include subject pairings like algebra/ physics, algebra / geography, biology/ chemistry, history of Kazakhstan/ geography, and algebra / computer science. The program is designed to promote multilingual proficiency ensure a safe and comfortable learning atmosphere and provide students with the necessary foundation for college or university enrollment through a balanced mix of core and elective subjects (Ministry of Education of the Republic of Kazakhstan, 2024). Therefore, focusing on professional orientations is essential as they address an individual's specific abilities (Algadheeb, 2015). However, recognizing or identifying an individual's interests and strengths is a complex task that teachers and organisational leaders face as they strive to guide students to pursue appropriate careers (Ari, Vatansever, & Uzun, 2009). Consequently, carefully planned elective courses can benefit high school students by offering familiar and relevant material. These courses can keep students engaged and motivated (Egorova, 2009).

This research aims to address whether implementing a professional-oriented educational approach in physics could assist students in making informed career choices that are aligned with their abilities and background. However, there is limited research on implementing professional-oriented education specifically for Kazakhstan's context. Very few studies have analysed the professional-oriented course systemically or proposed comprehensive models aligned with updated educational principles. More research is needed to evaluate current education practices, highlight gaps and suggest improvements holistically. The novelty and urgency of this research lie in addressing these research gaps by implementing this developed professional-oriented course in mechanics physics for students' future career paths in Kazakhstan and the potential behind it.

## 3. METHODS

### *3.1. The Research Design*

This study used the two groups (pre- and post-tests) of the quasi-experimental research design. This study conducted the mechanics physics topic test as the pre-tests (see Appendix A) and post-tests (see Appendix B). The rationale for including the control group in this study was to determine any changes from the pre-test to the post-test in the experimental group resulting from the intervention of a professional-oriented education approach. Table 1 presents the framework for the two groups (pre- and post-tests) in the quasi-experimental research design (Harris et al., 2004). The researcher measured the dependent variable ($O_1$) in the pre-test using the same instrument for the experimental and control groups. A week after the pre-test, the experimental group received the intervention (X), and the control group underwent the traditional approach (Y) for 26 months respectively. After the class, the researcher again measured the dependent variable ($O_2$) in the post-test using the same instrument for the experimental and control groups. However, the questions in the test were changed a bit to minimize the threat. Then, the pre- and post-test results were examined to identify the improvement of the dependent variable by identifying the significant difference in the mean values between $O_{2a}$ and $O_{1a}$ for the experimental group and between $O_{2b}$ and $O_{1b}$ for the control group, i.e., paired sample t-test. Additionally, the mean values of the post-test from the experimental group ($O_{2a}$) and the control group ($O_{2b}$) were also compared to investigate the effectiveness of the professional-oriented education approach (X) towards the dependent variable as compared to the traditional approach (Y), i.e., independent sample t-test.

**Table 1.** The two-group pre-test – post-test research design.

| Groups | Implementation | | |
|---|---|---|---|
| Experimental | $O_{1a}$ | X | $O_{2a}$ |
| Control | $O_{1b}$ | Y | $O_{2b}$ |

**Note:** X – Professional-oriented education approach;
Y– Traditional approach.
$O_{1a}$ - Pre-test; $O_{1b}$ - pre-test; $O_{2a}$ - post-test; $O_{2b}$ – post-test.

### *3.2. The Population and Sample*

The population in this research was high secondary school students in grades 10 and 11 in Kazakhstan who are taking mechanics physics courses. This specific course is a component of the offered natural science program in the direction of science and mathematics. The sample size was 115 students and the control group (N=58) was from D.I. Mendeleev Lyceum School No. 15, Shymkent, Kazakhstan who followed the traditional teaching approach. The experimental group (N=57) from T. Tazhibayeva Gymnasium School No. 47, Shymkent, Kazakhstan underwent the professional-oriented education approach. The study period lasted for 26 months.

### *3.3. Control and Experimental Groups*

#### *3.3.1. Control Group*

In the control group that employed the traditional approach, classroom instruction was typically delivered to the entire group with the teacher serving as the primary facilitator of learning. Some skills and knowledge were developed. However, the emphasis was primarily on conveying information in one-way communication and assessing students' understanding of new concepts. This approach was standard practice for education. The control group followed a structured process as outlined in Figure 2 which consisted of several stages. For instance, in the mechanics physics course, each of the 12 chapters was accompanied by learning activities that followed the flow chart format.

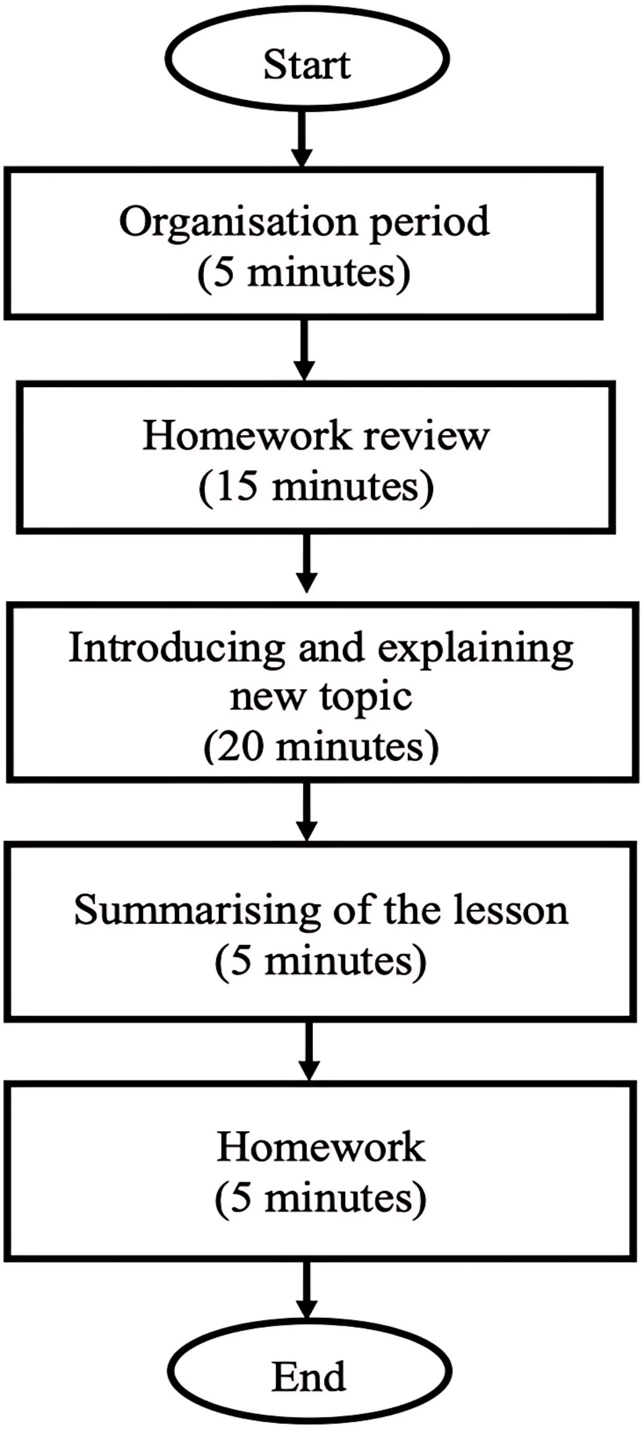


**Figure 2.** The control group class's teaching and learning flow.

### *3.3.2. The Experimental Group*

On the other hand, the experimental group will establish specific goals and objectives for each mechanics physics sub-chapter, i.e., 12 chapters. A distinctive module was designed and constructed meticulously. The module was implemented using the innovative professional-oriented education approach. The experimental group's whole teaching and learning activity involves adapting active learning and using technology teaching aids to develop students' 21st-century skills and direct them to the specific professional-oriented education career track, e.g., physicists, engineers, technicians, surveyors, etc. through the learning activities. Figure 3 shows the experimental group class and learning flow using the professional-oriented education approach module.

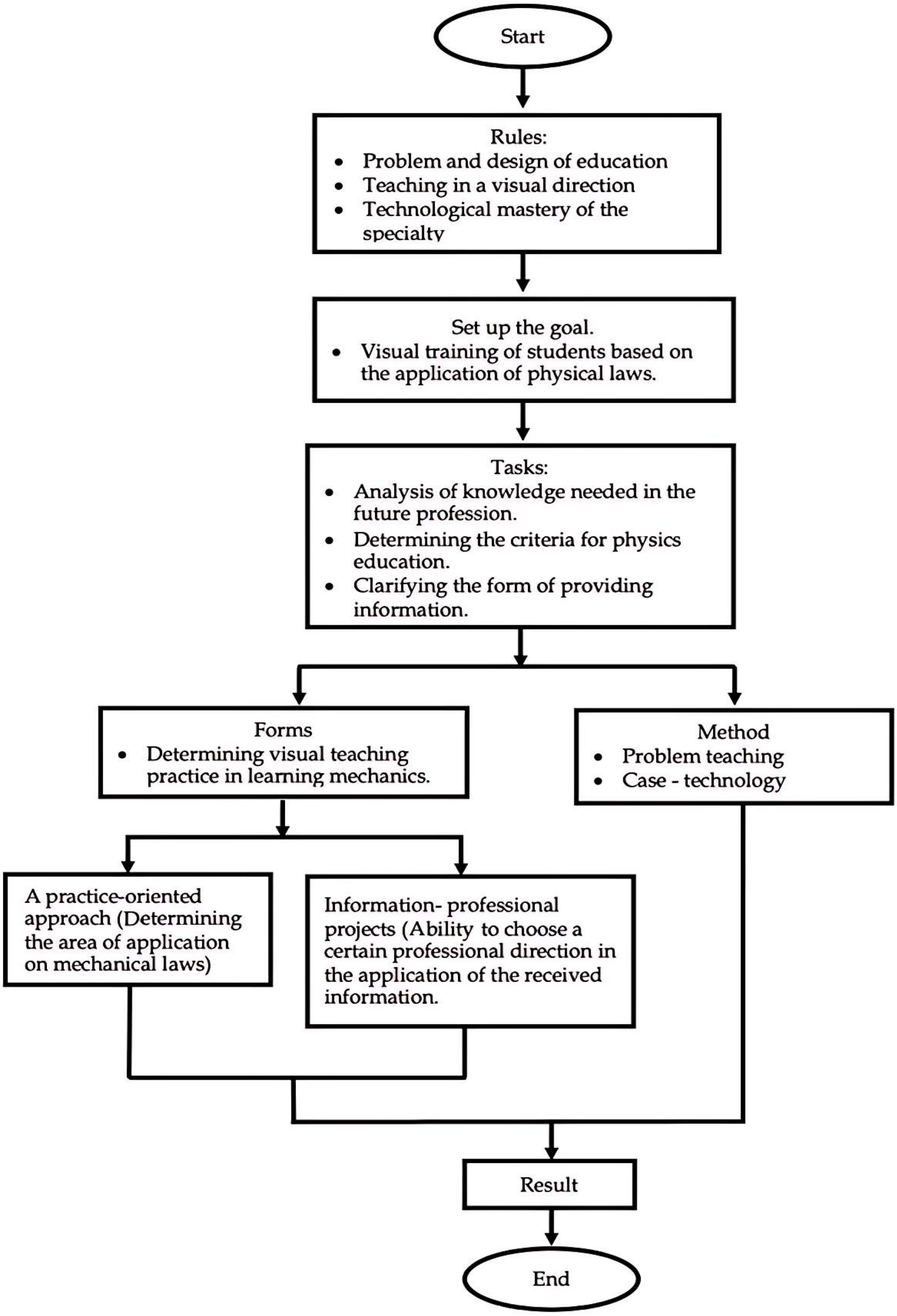


**Figure 3.** The experimental group class's learning flow using the professional-oriented-education approach module.

### *3.4. Data Collection and Analysis*

Quantitative data was collected using the mechanics physics topic test with pre-test and post-test administered to both groups before and after implementing the two approaches. The mechanics physics topic test consists of 20 multiple-choice questions related to mechanics physics with various hardness levels. Each question reflects the three education tracks i.e., easy, middle, and complex suitable for higher secondary school students' capabilities. This test also underwent rigorous checks for content validity and face validity.

The improvement of the dependent variable within groups was identified using paired sample t-tests with data from the pre- and post-tests. The independent sample t-test used post-test data to compare the dependent variable between groups. Additional analysis was conducted to identify patterns of student performance across three levels: low performance, average performance, and high performance. This performance data could be instrumental in guiding students towards the most suitable educational track based on their capabilities, interests, and motivations. Students with low performance may find their niche in secondary vocational education colleges, those with average performance may benefit from the initial vocational education track, and those with high performance may thrive in the general education track. The potential impact of these findings on students' educational journey is significant and warrants further exploration. SPSS Version 29.00 was used to analyse the data. Figures 1 and 2 show the distinct flow approaches of the traditional teaching and learning for the control group and professional-oriented education approaches for the experimental group.

## 4. FINDINGS

Table 2 shows the results of descriptive statistical analysis for the mechanics physics topic test. It shows the mean test score in the post-test (mean = 11.33 and SD = 4.33) was relatively higher than the pre-test (mean = 10.07 and SD = 4.21) in the control group. Meanwhile, in the experimental group, the mean score in the post-test (mean = 13.26 and SD = 4.72) was even higher than the pre-test (mean = 10.09 and SD = 4.30).

**Table 2.** Results on descriptive statistical analysis for the mechanics physics topic test.

| Groups | Tests | N | Mean | Std. deviation | Min. | Max. |
|---|---|---|---|---|---|---|
| Control group | Pre-test | 58 | 10.07 | 4.21 | 2.00 | 18.00 |
| | Post-test | 58 | 11.33 | 4.33 | 4.00 | 20.00 |
| Experimental group | Pre-test | 57 | 10.09 | 4.30 | 4.00 | 19.00 |
| | Post-test | 57 | 13.26 | 4.72 | 5.00 | 20.00 |

A test of normality was conducted on the mean scores of the mechanics physics topic test. In this study, a numerical method was employed to check the normality of the data. The Shapiro-Wilk test was conducted; skewness and kurtosis were also identified to examine the assumption of normality of the data. Based on Shapiro-Wilk test statistics analysis findings, if the p-value is more than the significance value ($p > 0.05$), the data are normally distributed. If the p-value is less than or equal to the significance value ($p \leq 0.05$), the data are not normally distributed (Mishra et al., 2019). In terms of skewness and kurtosis, if the Z-values for either skewness or kurtosis are between -1.96 and 1.96, the data are sufficient to be normally distributed. The Z-value can be obtained by dividing the skewness values or excess kurtosis by their standard errors (Kim, 2013; Mishra et al., 2019). Therefore, the normality of the data needed to be checked before employing the inferential statistics. For control and experimental groups, the test mean scores in pre- and the post-tests were normally distributed. Based on the Shapiro-Wilk test, the p-values were exceeded 0.05 ($p > 0.05$) as well as skewness and kurtosis and the Z-values were estimated between -1.96 and 1.96 ($Z < |1.96|$). Therefore, inferential statistics in the form of parametric tests could be carried out towards the research data set since the research data set was normally distributed. Table 3 shows the test of normality for the mechanics physics topic test.

**Table 3.** Test of normality for the mechanics physics topic test.

| Groups | Tests | Kolmogorov-Smirnov | | | Shapiro-Wilk | | | Skewness | | | Kurtosis | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Statistic | df | Sig. | Statistic | df | Sig. | Statistic | SE | Z | Statistic | SE | Z |
| Control group | Pre-test | 0.114 | 56 | 0.067 | 0.964 | 56 | 0.092 | 0.076 | 0.316 | 0.24 | -1.094 | 0.623 | -1.76 |
| | Post-test | 0.103 | 56 | 0.200* | 0.958 | 56 | 0.048 | 0.098 | 0.316 | 0.31 | -0.902 | 0.623 | -1.45 |
| Experimental group | Pre-test | 0.169 | 56 | $<0.001$ | 0.928 | 56 | 0.003 | 0.218 | 0.316 | 0.69 | -1.195 | 0.623 | -1.92 |
| | Post-test | 0.159 | 56 | 0.001 | 0.910 | 56 | $<0.001$ | -0.400 | 0.316 | -1.27 | -1.028 | 0.623 | -1.65 |

**Note:** *The data are normally distributed at $p > 0.05$ and $Z < |1.96|$.
df = Degree of freedom.
SE = Standard error.

A paired samples t-test was conducted to evaluate the impact of the professional-oriented education approach module on students' tests in the mechanics physics topic as shown in Table 4. There was a statistically difference increase in the test of the control group from the pre-test (mean = 10.07 and SD = 4.21) to the post-test (mean = 11.33, SD = 4.33), t (57) = -5.163, p < .001* (two-tailed). The mean difference was -1.26 with a 95% confidence interval ranging from -1.753 to -0.773. The Cohen's d was 1.847 which indicated a large effect size. Additionally, in the experimental group, there was also a statistically difference increase from the pre-test (mean = 10.09 and SD = 4.30) to the post-test (mean = 13.26 and SD = 4.72), t (56) = -8.968, p < .001* (two-tailed). The mean difference was -3.17 with a 95% confidence interval ranging from -3.884 to -2.466. The Cohen's d was 2.673 which also indicated a large effect size. This output answered the first research question and the null hypothesis 1 ($H_{01}$): No significant difference between the pre-test and the post-test for the control and the experimental groups in their mechanics physics topic test was rejected. A significant difference exists between the pre- and the post-tests for the control and the experimental groups in their mechanics physics topic test. Table 4 shows the results of the paired samples t–test for the mechanics physics topic test.

**Table 4.** Results of paired samples t–test for the mechanics physics topic test.

| Groups | Tests | Mean | SD | t | df | P (2-tailed) | Mean difference | 95% CI Lower | 95% CI Upper | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|---|
| Control group | Pre-test | 10.07 | 4.21 | -5.163 | 57 | <0.001* | -1.26 | -1.753 | -0.773 | 1.847 |
| | Post-test | 11.33 | 4.33 | | | | | | | |
| Experimental group | Pre-test | 10.09 | 4.30 | -8.968 | 56 | <0.001* | -3.17 | -3.884 | -2.466 | 2.673 |
| | Post-test | 13.26 | 4.72 | | | | | | | |

**Note:** *The mean difference is significant at p ≤ 0.05.
SD = Standard deviation.
df= Degree of freedom.
CI = Confidence interval of the difference.

An independent samples t–test was conducted to compare the mean post-test of the mechanics physics topic test between the control and the experimental groups after the intervention of a professionally-oriented education approach and the results of the test are shown in Table 5. There was a statistically significant difference in the mean post-test between the control group (mean = 11.33, SD = 4.33) and the experimental group (mean = 13.26, SD = 4.72) in the post-test *t* (112) = -2.28, p = 0.025 (two-tailed). In addition, the assumption of homogeneity of variances was tested and not violated through Levene's Test, F (112) = 0.597, p = 0.441. The magnitude of the difference in the means (mean difference = -1.93, 95% CI: -3.61 to 0.25) indicated a large effect size with Cohen's d = 4.529. This output answered the second research question and the null hypothesis 2 ($H_{02}$): No significant difference between the control and experimental groups in their post-test was rejected. A significant difference exists between the control and experimental groups in their post-test. A professional oriented education approach in the mechanics physics module was able to significantly improve experimental group students in the mechanics physics topic test. Table 5 shows the results of the independent samples t-test for the mechanics physics topic test.

**Table 5.** Results of independent samples t-test for the mechanics physics topic test.

| Groups | Tests | Mean | SD | Levene's test F | Levene's test Sig. | t-test t | t-test df | t-test P (2-tailed) | t-test Mean difference | t-test 95% CI Lower | t-test 95% CI Upper | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Control group | Post-test | 11.33 | 4.33 | 0.597 | 0.441 | -2.28 | 112 | .025* | -1.93 | -3.61 | 0.25 | 4.529 |
| Experimental group | | 13.26 | 4.72 | | | | | | | | | |

**Note:** *The mean difference is significant at p ≤ 0.05.
SD = Standard deviation.
df= Degree of freedom.
CI = Confidence interval of the difference.

Further analysis was also conducted to understand how these approaches assist students in choosing their future educational and career paths, i.e., the initial vocational education track, the secondary vocational education colleges, or the general education track effectively. In the Republic of Kazakhstan education system, the student's total post-test score determines the track. Low performers will be placed in the initial vocational education track, average performers will be directed to thethe secondary vocational education colleges track, and high performers will be placed in the general education track (Abylkassymova, 2020; Ministry of Education of the Republic of Kazakhstan, 2024). Table 6 compares the control and experimental groups using pre- and post-tests marks that are categorized into three different performances, i.e., low performance X ≤ 7 marks, average performance, 8 ≤ X ≤15 marks, and high performance 16 ≤ X marks. The highest total marks are 20. The control group which utilised a traditional approach showed 29 students with average performance. Therefore, students with average performance will now be directed to enroll in colleges in the initial vocational education track. Students with low academic performance, totalling 16 can immediately enroll in secondary vocational education colleges while those with high performance recorded as 13 will be directed towards pedagogical educational institutions to the general education track for their future career prospects. For the experimental group, the post-test results showed that most students also scored an average performance with 24 students falling into this category. Only 13 students scored below average while 20 students achieved high performance. Based on these scores, all students will be placed in their respective education tracks. This information provides insight into the third research question revealing that the majority of students are average performers and will be directed to the initial vocational education track. Figure 4 shows a bar chart comparison of pre- and post-tests performance for control and experimental groups.

**Table 6.** The students' achievement of low performance, average performance and high performance of both control and experimental groups.

| Performance (Total marks = 20) | Control group (N=58) | | Experimental group (N=57) | |
|---|---|---|---|---|
| | Pre-test | Post-test | Pre-test | Post-test |
| Low: X ≤ 7 marks | 21 | 16 | 23 | 13 |
| Average: 8 ≤X≤15 marks | 27 | 29 | 26 | 24 |
| High: 16 ≤ X marks | 10 | 13 | 8 | 20 |

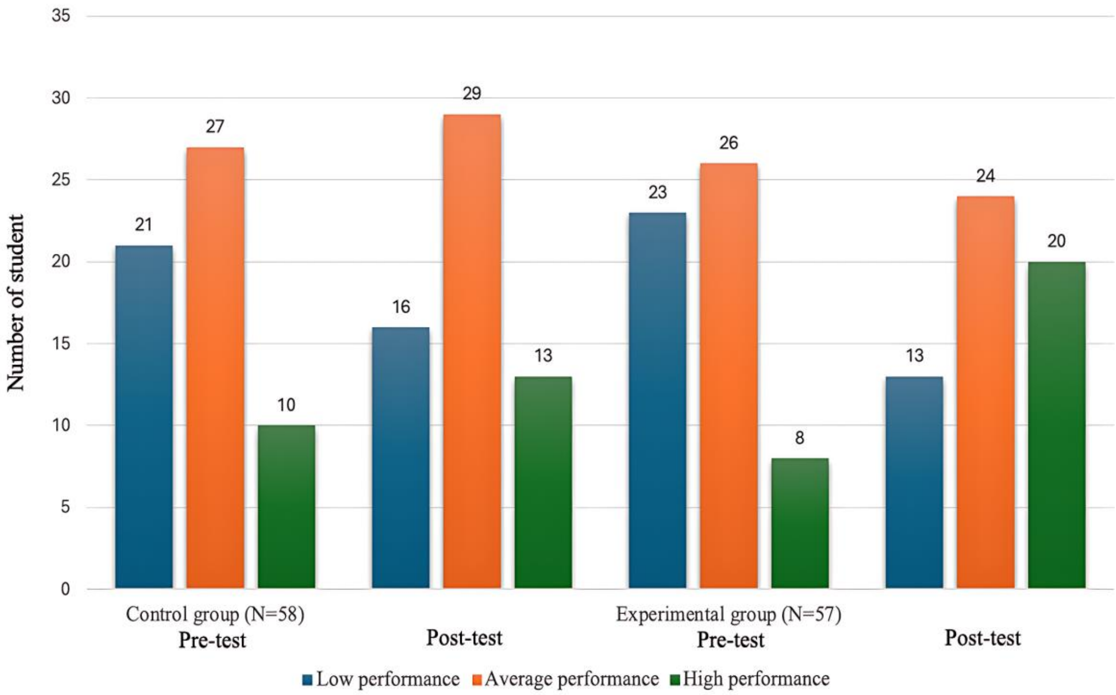


**Figure 4.** The bar chart shows students' pre-test and post-test performance in both the control and the experimental groups.

From the findings, both approaches show a dominance of students with average performance indicating a balance output between the secondary vocational education colleges, low performers and the general education track - high performer. However, the bar chart also reveals another insightful pattern. In the experimental group, the number of students who can directly enroll in the general education track is higher than in the control group. This underscores the value of the professional-oriented approach in the experimental group which effectively motivates students to learn mechanics physics fundamentally in-depth by implementing constructive active learning elements in class in contrast to the passive approach of traditional classes.

## 5. DISCUSSION

Professional-oriented education approach may help students shape their future work career and teachers play a crucial role in guiding students towards the proper education track that can help them achieve their goals. The findings of this research promote the education system in Kazakhstan in empowering students' capability and talent through their interests and motivation to channel them to the right tracks. Incorporating physics courses, i.e., mechanics physics into the existing curriculum of natural science subjects at higher secondary schools in Kazakhstan can positively impact students' learning experience. This approach offers a more personalised and diverse learning experience which can enhance students' skills and competencies (Sulaiman et al., 2023). Therefore, the research has significant practical implications as it can help students better understand the real-world applications of the concepts, they learn in their core subjects (Sulaiman et al., 2023; Zhumabaeva et al., 2016). Through the professional-oriented education approach, it plays a crucial role in shaping a student's professional competency beyond theoretical education. This course contributes to a more comprehensive and enriched educational experience for the future workforce by providing opportunities to develop essential skills and knowledge (Zhumabaeva et al., 2016) as compared to the normal traditional class. Lee and Sulaiman (2017a) and Lee and Sulaiman (2017b) highlight the importance of adopting a practical and hands-on approach to learning physics, like the one used in professional-oriented education. This allows students to understand better and value the learning process even more. Students can develop a more profound interest and motivation and gain clarity regarding their future career paths by providing a more professional-oriented education. Such an approach is highly constructive in the long run. Thus, the model of formation of career competence through the professional-oriented education approach emphasises criteria, rates, and performance levels crucial in preparing students to meet the demands of their chosen professions.

As in the context of Kazakhstan, the educational landscape is continually evolving and there is a growing need to adopt a more competence-based pedagogical approach to better equip students with the necessary skills for the modern workforce and society (Higher Education in Kazakhstan, 2017). By emphasising the development of 21st-century skills such as problem-solving, teamwork, and adaptability as what is being implemented through the professional-oriented education approach, Kazakhstan is aiming to close the gap between theoretical knowledge and practical skills. The Kazakhstan Government's role in aligning students' work experience with industrial demand is crucial as it is a key factor in their success in the labour market (Higher Education in Kazakhstan, 2017). However, a significant question arises: What sectors does the government envision for its students? Is it an academic focus, a practical one, or a balanced combination of both? The Kazakhstan education ministry must strategically design the tracks for their future work experience to meet the industrial demand by creating a robust professional-oriented education line-up. Therefore, education sectors increasingly emphasise the need for students to possess relevant skills and competencies through the three aforementioned distinct tracks. This requires aligning curriculum content, teaching methods, and assessment practices to produce outcomes that meet the evolving needs of both students and employers (Higher Education in Kazakhstan, 2017). Hence, implementing a professional-oriented education approach course at higher secondary schools in Kazakhstan is a positive step towards a more student-centred, competency-driven educational system and can be a smart plan for shaping the future-competence workforce. The professional-oriented education approach is a promising path to empower students to identify their interests and capabilities enabling them to gain confidence and focus on their talents. This framework not only helps structure the syllabus and curriculum but also provides a benchmark to be used in other courses and benefit students. Thus, the potential of this approach is vast and with additional research and data, it could be a game-changer for the education industry.

## 6. IMPLICATION

Incorporating the professional-oriented education approach in mechanics physics has significant implication. The mechanics physics subject offered as an elective course may enhance students' beliefs in learning physics, promote their problem-solving skills (Rosales & Sulaiman, 2020) and promote their personal growth as they become more involved in their learning and assume a more positive outlook compared to traditional classes. When students take elective courses that concentrate on professional teaching and learning training, they gain additional skills, expanded opportunities, diverse techniques, and multifaceted competencies that enrich their perspective and aid their personal development. Therefore, it is essential to ensure students know their capabilities and interests to optimise their potential and save time learning courses that benefit them less. Some students may feel that specific elective courses do not contribute to their intellectual development and there may be challenges related to course selection due to quota restrictions. Therefore, it is crucial to pinpoint students' capabilities early. Thus, the design of elective courses is vital for teachers in helping students to learn effectively.

Moreover, a professional-oriented education approach can positively impact students' social skills, personal development, and academic achievement (Diachok, Chernukha, Tokaruk, Udovenko, & Petrova, 2020). It is essential to carefully design and evaluate this approach without compromise to ensure we maximise the benefits for students, teachers, and other stakeholders in the education system. This will enable us to effectively guide each student onto the appropriate educational track, ultimately saving resources and enhancing the education systems in Kazakhstan. This aligns with what Gerber, Wittekind, Grote, and Staffelbach (2009) have suggested where professional orientations refer to the various attitudes and inclinations that reflect an individual's interest in pursuing a particular career path. These orientations encompass a wide range of behaviours and tendencies influencing the individual's decision-making process regarding career pathways. At the end of the day, an individual's professional orientation is a key factor that shapes their career trajectory and contributes to their overall success and fulfilment in the workplace.

In addition, teachers also need to be ready to shift from traditional teaching methods to more dynamic ways of constructive and active learning. This will be a challenge for teachers at the early stage as they are comfortable with the present way of teaching and learning. However, every shareholder needs to make changes to benefit our students to make education relevant and meet industrial demand. As for the government, they also need to put more budget to make education more flexible and livelier and can meet students' needs. To create a practical, professional-oriented course, educational institutions require a substantial budget to cover essential equipment such as computer simulation software, complete high-end lab equipment, appropriate classroom settings, and adequately trained teachers who can effectively facilitate student learning activities. These resources are imperative for fostering an optimal learning environment and thus will help successfully implement professional-oriented education.

## 7. CONCLUSION

This research successfully achieved its objectives, addressed all research questions, and responded to hypotheses showing significant performance increases in both control and experimental groups. However, the experimental group exhibited better performance than the control group which indicates that the professional-orientation education approach can enhance students' understanding and give them a clear vision of their future career track. The Republic of Kazakhstan aims to produce a science-based workforce while maintaining skills and competence. Therefore, it is highly beneficial for more students to pursue the general education track. The pattern of the students who were directed towards different education tracks was also identified and addressed in a clear manner. Overall, the results of the research provide clear and constructive insights into the effectiveness of the professional-oriented education system and can be used to improve the teaching and learning structures and outcomes of students.

## 8. SUGGESTIONS

To broaden the research, one can explore other courses besides mechanics physics, like electricity and magnetism, modern physics, thermodynamics or other subjects. Additionally, consider increasing the number of samples to create a more comprehensive understanding of the impact on students beyond just test scores and alignment to the right education tracks. Gathering qualitative data would also help teachers and researchers better understand the effect on the students e.g., emotionally and psychologically. Furthermore, it's of utmost importance to develop a professional-oriented education approach syllabus and course instruction that not only considers the students' needs from the very beginning but also aligns with their education tracks. This dual focus can lead to the creation of a more effective and efficient teaching strategy that benefits all when combined with insightful data.

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**Transparency:** The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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# APPENDIX

**Appendix A.** The mechanics physics topic test pre – tests (Before lesson).

Instruction: Answer all questions Time : 1 hour and 30 minutes

| No. | Questions |
|---|---|
| 1 | What is mechanical motion? |
| a. | Change in the position of a body relative to other bodies over time |
| b. | Force applied to a body |
| c. | Speed of motion |
| d. | Mass of a body |
| 2. | In which units is speed measured? |
| a. | Newton |
| b. | Meter |
| c. | Second |
| d. | Meter per second (m/s) |
| 3. | What is acceleration? |
| a. | The rate of change of velocity |
| b. | Force acting on a body |
| c. | Distance covered by a body |
| d. | Work done by a body |
| 4. | How is Newton's second law formulated? |
| a. | Force equals mass multiplied by acceleration |
| b. | Force equals mass multiplied by distance |
| c. | Force equals velocity multiplied by time |
| d. | Force equals mass divided by acceleration |
| 5. | What is the law of conservation of momentum? |
| a. | The momentum of a system of bodies remains constant if no external forces act on it |
| b. | The speed of a system of bodies remains constant |
| c. | The acceleration of a system of bodies remains constant |
| d. | The mass of a system of bodies remains constant |
| 6. | In which units is momentum measured? |
| a. | Newton |
| b. | Kilogram-meter per second (kg·m/s) |
| c. | Joule |
| d. | Watt |
| 7 | What is work in physics? |
| a. | The product of force and distance |
| b. | Acceleration of a body |
| c. | Speed of motion |

| | |
|---|---|
| d. | Momentum of a body |
| 8 | Which formula describes power? |
| a. | P = W/t |
| b. | P = F·v |
| c. | P = m·g |
| d. | P = a·t |
| 9 | What is inertia? |
| a. | The property of a body to maintain its state of rest or uniform linear motion |
| b. | The ability of a body to change its speed |
| c. | The ability of a body to change its shape |
| d. | Force acting on a body |
| 10 | Which quantity is a measure of inertia? |
| a. | Mass |
| b. | Force |
| c. | Speed |
| d. | Acceleration |
| 11 | Who formulated the law of universal gravitation? |
| a. | Isaac Newton |
| b. | Albert Einstein |
| c. | Galileo Galilei |
| d. | Nicolaus Copernicus |
| 12 | Which of the following does NOT affect gravitational attraction? |
| a. | Mass of the bodies |
| b. | Distance between the bodies |
| c. | Speed of the bodies |
| d. | Type of material of the bodies |
| 13 | Which of Newton's laws describes the interaction of two bodies? |
| a. | Newton's third law |
| b. | Newton's second law |
| c. | Newton's first law |
| d. | Hooke's Law |
| 14 | What happens to a body when all forces acting on it are balanced? |
| a. | The body moves uniformly in a straight line or remains at rest |
| b. | The body accelerates |
| c. | The body changes its shape |
| d. | The body decelerates |
| 15 | Which statement describes the resultant force? |
| a. | It is the force that causes the same acceleration as the sum of all applied forces |
| b. | It is the force equal to the sum of all applied forces |
| c. | It is the force equal to the product of mass and acceleration |
| d. | It is the force equal to the product of mass and velocity |

16 How is the resultant force determined for two forces directed along the same line but in opposite directions?
a. By the difference of their magnitudes
b. By the sum of their magnitudes
c. By the product of these forces
d. By the ratio of these forces
17 Which of Newton's laws describes the interaction of two bodies?
a. Newton's third law
b. Newton's second law
c. Newton's first law
d. Hooke's Law
18 Which statement describes the resultant force?
a. It is the force that causes the same acceleration as the sum of all applied forces
b. It is the force equal to the sum of all applied forces
c. It is the force equal to the product of mass and acceleration
d. It is the force equal to the product of mass and velocity

19 What happens to a body when all forces acting on it are balanced?
a. The body moves uniformly in a straight line or remains at rest
b. The body accelerates
c. The body changes its shape
d. The body decelerates

20 How is the resultant force determined for two forces directed along the same line but in opposite directions?
a. By the difference of their magnitudes
b. By the sum of their magnitudes
c. By the product of these forces
d. By the ratio of these forces

Question Ended

**Appendix B.** The mechanics physics topic test post – tests (After lesson)

Instruction: Answer all questions Time : 1 hour and 30 minutes
No. Questions
1 What characterizes uniform linear motion?
a. Change in the position of a body relative to other bodies over time
b. Force applied to a body
c. Speed of motion
d. Mass of a body

2. What equation describes the distance covered in uniform motion?
a. $S = vt$
b. $S = at^2/2$
c. $S = v^2/2a$

d. $S = ma$

3. What causes free fall?
a. Gravitational attraction
b. Magnetic field
c. Electric field
d. Air pressure

4. What is the value of gravitational acceleration on Earth?
a. $9.8\ m/s^2$
b. $5\ m/s^2$
c. $10\ m/s^2$
d. $1\ m/s^2$

5. What is potential energy?
a. The energy a body possesses due to its position in space
b. The energy a body possesses due to its motion
c. Work done by a body
d. Speed of motion

6. Which formula is used to calculate kinetic energy?
a. $Ek = mv^2/2$
b. $Ek = mg \cdot h$
c. $Ek = F \cdot s$
d. $Ek = m \cdot g$

7 What is the acceleration called in circular motion?
a. Centripetal acceleration
b. Gravitational acceleration
c. Tangential acceleration
d. Radial acceleration

8 What expression describes centripetal acceleration?
a. $ac = v^2/r$
b. $ac = g$
c. $ac = v/t$
d. $ac = F/m$

9 What is momentum?
a. The product of a body's mass and its velocity
b. The product of force and distance
c. The product of a body's mass and its acceleration
d. The rate of change of a body's position

10 Under what conditions is the momentum of a system of bodies conserved?
a. In the absence of external forces
b. In the presence of friction

c. During uniform motion
d. During constant acceleration

11 Which statement is true for a body moving on an inclined plane?
a. It is acted upon by gravity and friction
b. It is only acted upon by gravity
c. It is only acted upon by friction
d. It is not acted upon by any force

12 What is the role of the angle of inclination of the plane on a body's motion?
a. The angle affects the magnitude of the force acting on the body
b. The angle does not affect the body's motion
c. The angle changes the body's mass
d. The angle increases the time of motion
13 What does the sliding friction force depend on?
a. The normal force
b. The mass of the body

c. The speed of the body
d. The temperature of the surface
14 Which statement about friction force is true?
a. Friction force always acts opposite to the direction of motion
b. Friction force acts along the direction of motion
c. Friction force does not depend on the speed of the body
d. Friction force is proportional to the speed of the body

15 What is the center of gravity of a body?
a. The point of application of the resultant of all gravitational forces acting on the body
b. The point of application of the friction force
c. The point where the mass of the body is evenly distributed
d. The point where the body begins to move
16 Which statement is true about the center of gravity of a body?
a. It can be located outside the body
b. It is always located at the center of the body
c. It changes with the motion of the body
d. It depends on the speed

17 How is the resultant force determined for two forces directed along the same line but in opposite directions?
a. By the difference of their magnitudes
b. By the sum of their magnitudes
c. By the product of these forces
d. By the ratio of these forces

18 Which statement describes the resultant force?

a. It is the force that causes the same acceleration as the sum of all applied forces
b. It is the force equal to the sum of all applied forces
c. It is the force equal to the product of mass and acceleration
d. It is the force equal to the product of mass and velocity

19 What happens to a body when all forces acting on it are balanced?
a. The body moves uniformly in a straight line or remains at rest
b. The body accelerates
c. The body changes its shape
d. The body decelerates

20 Which of Newton's laws describes the interaction of two bodies?

a. Newton's third law
b. Newton's second law
c. Newton's first law
d. Hooke's Law

Question Ended