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Improving the Students' Achievement by Comparing the Effectiveness of Two Methods of Teaching Physics to Undergraduate Students: A Small Number of Complex Tasks and a Large Number of Graded Difficulty Tasks

Nazarali Aitjanov[1], Ratova Nurshat[2], Nursultan Japashov[3], Mustafa Abdulbakioglu[4], Zhantilek Khumarkhan[5], Resul Uzuntash[6], Samat Maxutov[7]

Abstract

This study examines the impact of two different types of physics assignments on the academic performance of undergraduate students. In particular, it compares how completing a a small number of complex tasks versus a large number of graded difficult tasks affects student success, as measured by test results and homework. Two groups were used in the quasi-experimental project: one was allocated to the main group (which used a small number of complex tasks), and the other was allocated to the control group (which used a large number of classified complex tasks). The data obtained indicate that there was no noticeable difference in the assimilation of knowledge between the two groups, which suggests that neither approach had a significant impact on students' academic achievements in terms of GPA. In addition, the study did not reveal a noticeable effect of gender differences on the assimilation of information by students.

Keywords: *Undergraduate Education, Physics, Electrodynamics, Problem Solving, Teaching Methods*

INTRODUCTION

In an effort to improve the quality of education, it is important to study the effectiveness of various approaches to teaching physics (Fraser et al., 2014). The purpose of this article is to find out which method, based on the use of a small number of complex tasks and a large number of graded difficulty tasks, is more effective in teaching physics to undergraduates. The results of this study can provide teachers and policy makers with valuable information about the optimal method for assessing academic performance in physics, which will ultimately lead to improved student academic performance. Moreover, research conducted in other disciplines consistently demonstrates that the applied approach to learning significantly affects the academic achievements of students. This highlights the importance of this research in the field of physical education (Fraser et al., 2014). Getting a comprehensive understanding of the impact of various assessment methods on physics teaching is crucial to improving the overall quality of education. Previous research in this area shows that using a strategy with a small number of complex tasks when teaching physics can lead to improved academic performance of college students (Henderson & Dancy, 2009). The obtained results emphasize the need to develop a physics curriculum in which priority would be given to a small number of complex tasks, rather than a multitude of complex tasks with different levels of complexity (Taylor et al., 2010). This study supports and develops the work of Fraser et al. (2014), who highlighted the benefits of using multiple challenging assignments to improve learning outcomes in the physics learning process. The results of this study provide additional evidence of the effectiveness of this approach in undergraduate physics courses. This study highlights the significant impact of learning approaches on student academic performance in physics, based on research conducted by Fraser et al. (2014) and Taylor et al. (2010). This study provides valuable information on how

[1] SDU University, E-mail: nazarali.aitjanov@sdu.edu.kz

[2] SDU University

[3] State University of New York at Albany, Albany, NY, United States of America.

[4] SDU University

[5] Ualikhanov University

[6] Suleyman Demirel College Lyceum

[7] SDU University

certain teaching methods can improve the quality of education and highlights the benefits of using research-based tactics and active learning to maximize learning outcomes in undergraduate physics programs.

By addressing the research questions outlined below:

1. How does the use of a small number of complex tasks and a large number of graded difficulty tasks impact undergraduate students' understanding of physics?
2. Do male and female students differ in their attitudes and approaches to problem-solving?
3. How do the end-of-term GPA marks and subsequent GPA results differ between undergraduate physics students taught using a small number of complex tasks versus those taught with a larger number of graded difficulty tasks?

LITERATURE REVIEW

Physical education is of paramount importance for the education of students who have the necessary skills and knowledge to get a job in the fields of natural sciences, technology, engineering and mathematics (Taylor et al., 2010). The use of effective learning strategies is essential to achieve successful learning outcomes in the field of physical education (McDermott, 2001). In addition, it is important to take into account differences in problem-solving skills in different people. Kalyuga et al. suggest an individual method for determining the difficulty of a task, taking into account the individual abilities of students. This method leads to a significant improvement in learning outcomes (Kalyuga et al., 2012).

Research on physical education has comprehensively focused on the development of effective teaching methods to improve the learning outcomes of older students.

Recent studies have shown the importance of using active training methods in the field of physical education (Pivarči & Raganová, 2017). The integration of complex tasks into physics lessons has shown encouraging results in improving students' ability to think and analyze information critically (Vondráček, 2003). Nevertheless, the effectiveness of these tasks is still controversial in comparison with the traditional method of using a large number of graded difficulty tasks.

Positive Impact of a Small Number of Complex Tasks

Several research papers have explored the implications of including a limited number of challenging activities in physics lessons and highlighted their positive impact on student understanding. The results show that challenging assignments, with proper support, can improve students' understanding and problem-solving ability.

Fraser et al. (2014) showed that the use of active learning tactics, such as: the use of integrated classes, significantly improve the learning outcomes of students both in the immediate and in a longer period. Involving students in exercises of varying difficulty can improve their understanding and long-term memory of physical ideas.

In their study, Pivarči and Raganová (2017) found that the introduction of active learning tactics, such as the inclusion of challenging classes, can significantly improve students' understanding and mastery of physics. These tasks improve the mastery of physical ideas by developing students' conceptual understanding and problem-solving skills.

The cumulative results show that the inclusion of a limited number of complex problems in physics lessons can have a good effect on students' understanding.

Positive Impact of a Large Number of Graded Difficulty Tasks

Several studies have examined the effects of using a large number of graded difficulty tasks in the field of physics teaching and highlighted their positive impact on student understanding. The data obtained indicate that the use of active teaching methods, especially by including complex tasks, can significantly improve student academic performance in the field of physics.

Etkina and Van Heuvelen (2007) investigated the impact of various homework assignments on high school students' understanding of physics. Presumably, the study examined how classes of a small number of complex tasks influenced students' understanding and application of physical ideas, rather than just focusing on a few difficult problems. Their findings can provide valuable insight into how classes of varying complexity affect student learning outcomes.

Emphasizing the importance of projects that incorporate student problem-solving skills while remaining achievable, Larkin and Reif (1979) suggested that gradually increasing the complexity of tasks could make learning easier and enhance the self-awareness of physics students.

Similarly, Hsu et al. (2004) suggested that a systematic increase in the complexity of tasks can contribute to the growth of problem-solving skills and conceptual understanding of students through a well-organized learning process.

Vygotsky's scaffolding theory, first introduced in 1978, supports assignments based on students' existing levels of understanding, which become increasingly complex as their competence increases. This theoretical framework highlights the need for support and guidance in complex actions aimed at maximizing student achievement.

In their 1992 study, Heller et al. We found that the inclusion of problems with a high level of contextual information led to an improvement in the conceptual learning of students in the field of physics. This means that including difficult tasks in appropriate settings can improve students' understanding of the principles of physics and long-term memory.

In addition, Hake (1998) compared approaches to interactive interaction and standard lecture methods to determine their usefulness in basic physics courses. Interactive interaction strategies sometimes involve doing homework consisting of a significant number of simple topics. The study, which surveyed a sample of more than six thousand students, showed that students who attend classes using interactive interaction methods scored higher on mechanical engineering exams than in typical lecture-based courses. Thus, by integrating interactive teaching methods such as various simple exercises, students' understanding of the principles of physics can be improved.

Research often uses methods that incorporate active learning tactics, which include a variety of teaching methods designed to encourage student engagement and participation. Active learning methods include problem-based learning, collaborative learning, and research approaches.

The sample used in these studies mainly includes undergraduate students, which is consistent with the emphasis on higher education in the field of physical research. The researchers intend to evaluate the effectiveness of tasks with difficulty levels in improving students' understanding of physics ideas in higher education by analyzing groups of students.

Several studies have shown that students can solve quantitative problems using algorithmic equations. However, these studies have also shown that students may not develop the skills necessary to apply their understanding and solve more complex problems. Studies (e.g., Heller, Keith, & Anderson, 1991; Heller & Hollabaugh, 1991; Thacker, Kim, Trefz, & Lea, 1994; Maloney, 1994; Hsu, Brewe, Foster, & Harper, 2004; Meltzer, 2005) confirm this conclusion. In order to develop the necessary skills to understand and solve complex problems, we conduct a study to compare the effectiveness of two approaches: active participation in complex problem-solving activities and performing a variety of tasks of varying complexity.

Gender Differences in Physics Education

Several studies has been conducted to examine the effect of problem solvers' gender on problem-solving (e.g., Good, Maries, & Singh, 2022; Wilson, Low, Verdon, & Verdon, 2016; Balta & Asikainen, 2019; Zohar & Sela, 2003; Haeruddin, Kamaluddin, Kade, & Pabianan, 2022; Duran, 2016; Gallagher, De Lisi, Holst, McGillicuddy-De Lisi, Morley & Cahalan, 2000; Sirait, Sutrisno, Balta & Mason, 2017). However, there is no conclusive evidence that suggests that representatives of both sexes have a higher ability to solve problems than representatives of the opposite sex. Consequently, further studies are needed to address this issue.

A study by Balta and Asikainen (2019) found that there were no statistically significant differences in the attitude and methods of solving physics problems between male and female students.

Good, Maries and Singh (2022) found that at the end of the study period, women experienced a statistically significant increase in the average AAPS score compared to men. In addition, the women showed significantly better results on questions about problem-solving skills such as the use of diagrams and independent work. These results suggest that women may have a more favorable attitude towards solving physical problems compared to men.

The differences in the behavior of male and female students among male and female students indicate the possibility of differences in their approach to scenario modeling. Although male students often performed better than female students, there have been several cases where female students performed better, especially on topics that provided a more conceptual or theoretical basis. A study by Wilson and co-authors (2016) revealed significant gender differences in favor of male students on issues related to projectile movement, the content of two-dimensional movement or forces, as well as reading diagrams.

In their study, Zohar and Sela (2003) found that although boys and girls received the same overall points on admission to the university, boys performed better on the matriculation exams, while girls received higher marks from teachers. It was found that many women are negatively influenced by factors such as excessive competitiveness and insufficient understanding education.

Haeruddin et al. (2022) conducted a study in which they examined the attitude and problem-solving methods of physics students using the Attitude and Problem-solving Techniques (AAPS) survey. The results of the study showed that there were no significant differences between men and women.

Generalizing the data of the listed studies may not lead to an adequate conclusion, since each study gives different results. In addition, it is important to compare the skills of different scientific specialties to solve problems, because in the corresponding courses you will have different difficulties in solving problems. This may affect your approach to solving the problem. The results of our study will contribute to the current research and will be devoted to this particular specialty, which is currently missing.

Exploring the Impact of Teaching Methods on End-of-Term GPA in Physics Education

In the quest to enhance physics education, understanding how different teaching methods influence students' academic achievements, particularly their end-of-term GPA, has become a focal point of research (McDermott & Redish, 1999). For instance, Ryan et al. (2016) provide evidence supporting tailored problem-solving instruction as a means to improve student performance, suggesting that the structured complexity of tasks may lead to significant improvements in end-of-term grades. This aligns with findings indicating that active engagement with challenging problems enhances learning and retention, positively influencing students' final grades (McDermott, 2001).

A crucial step toward effective intervention involves establishing a system capable of continuously monitoring students' performance and predicting their future academic outcomes, such as graduation probability and final GPA, while considering their current performance (Cen, Koedinger, & Junker, 2006; Feng, Heffernan, & Koedinger, 2009; Yu et al., 2010; Pardos & Heffernan, 2010). By leveraging these insights, we can forecast students' GPAs at the end of the semester and evaluate their academic progress in subsequent terms. Analyzing the disparity between these GPAs enables us to assess the effectiveness of this approach.

In summary, elucidating the relationship between teaching methodologies and end-of-term GPA marks is essential for refining the quality of physics education. This research provides valuable insights into the ongoing discourse surrounding optimal instructional strategies and their impact on academic achievements in physics education. Integrating cognitive load theory, addressing socio-psychological barriers, and considering gender disparities are vital aspects of enhancing teaching strategies and promoting equitable learning outcomes.

The study focused on the impact of different learning approaches on student academic performance, in particular on their grade point average at the end of the semester, in order to improve physics teaching (McDermott & Redish, 1999). For example, Ryan et al. (2016) provide evidence supporting the use of individualized problem-solving training to improve student achievement. They imply that the organized complexity of tasks can lead to a significant increase in final grades. This is consistent with research that shows that active participation in solving complex issues improves learning and memory, which has a positive effect on students' overall grades (McDermott, 2001).

An important aspect of a successful intervention is the implementation of a system that can consistently track students' academic performance and predict their future academic performance, such as the likelihood of obtaining a degree and their final grade. This system takes into account their current performance, as evidenced by studies performance (Cen, Koedinger, & Junker, 2006; Feng, Heffernan, & Koedinger, 2009; Yu et al., 2010; Pardos & Heffernan, 2010). Using these observations, we can predict the average scores (GPA) of students at the end of the semester and assess their academic performance in subsequent periods. By analyzing the difference in average scores, we can assess the success of this method.

Understanding the relationship between teaching methods and end-of-semester grade point average results is crucial to improving the quality of physics teaching. This study provides useful information about the current discussion of the most effective teaching methods and how they affect academic performance in physics lessons. The inclusion of cognitive load theory, overcoming socio-psychological barriers and recognition of gender differences are crucial elements in improving teaching methods and ensuring equal learning outcomes.

Purpose

The main objective of this study was to evaluate the impact of two different categories of physics tasks on the academic performance of university students. More precisely, the influence of students' performance on their test and homework results can be explained by the presence of several complex tasks for which points are awarded.

METHODOLOGY

Participants

The participants in this study were selected from a convenient sample of third-year students studying at the Faculty of Pedagogy of Natural Sciences and specializing in Physics-Informatics. " Students have prior experience in solving physics issues, as they successfully completed six physics courses in various subjects before this exam. To mitigate the impact of novelty, the training sessions were familiar to students. The experiment was conducted in the spring semester as part of the electrodynamics physics course, which enrolled all students who had prior knowledge in the field of physics.

During the electrodynamics course, students were taught according to the "buffet" principle, when the lecturer devoted 10-15 minutes of training time to discuss one or two additional homework tasks with the class. If the students could not answer the difficulties individually, they were solved collectively.

Two indistinguishable classes were randomly allocated for the study: P-2 and P-3. The P-2 class used a homework system consisting of a limited number of difficult tasks, while the P-3 class implemented a homework system that included a significant number of graded difficult tasks. Specifically, 13 students in the P-2 class used a " a small number of complex tasks" while 18 students in the P-3 class used an "a large number of graded difficulty tasks." as a homework technique. Both groups of students used pen and paper assignments for their homework.

Design and Procedures

In their study, Frenkel and Wallen (1996) used a quasi-experimental scheme consisting of two groups: pre and post the test. One group was assigned for treatment, while the other group served as a control group. During the preliminary exam, students of both groups were asked to choose one of the sections. The part to which they were assigned was chosen by most of the students who chose this section. As a result, students from the P-2 group were transferred to a traditional group, where they were offered several complex tasks. On the other hand, the students of the P-3 group were placed in a control group, where they were given several tasks, which gradually became more complicated.

Both the main and control groups received physical homework, which was evaluated manually. Most of the homework was taken from the textbook " Randall.D.Knight Physics for Scientists and Engineers A Strategic (13th edition)". To improve the effectiveness of homework, at the beginning of each lecture, the teacher conducted a test, created on the basis of the assignments, which lasted 15 minutes. During the semester, a total of twelve homework assignments were assigned to each group. The results were evaluated using percentage estimates, and then average values were calculated to determine the assessment of homework. The preliminary and follow-up examination was conducted in a quiz format with comparable questions for both groups.

Structure of Groups

The formation of the in-groups consisted of students of all levels, including both high and low-performing students in the P-2 and P-3 groups. The level of difficulty of homework assigned to the students was derived from the reputable textbook "Randall. D. Knight Physics for Scientists and Engineers A Strategic (13th edition)". With 13 published editions, this textbook can be considered highly reliable. The textbook presents three types of problem difficulty levels: A, B, and challenging problems. For instance, the P-3 group was assigned approximately 10-15 problems per homework, while the P-2 group was assigned 4-6 physics problems per homework. In total, there were 12 homework assignments given throughout the semester.

RESULTS

Comparison of Knowledge Quality between Groups

Our main goal in our first research question was to examine the impact of applying a limited number of difficult tasks and a large number of graded difficulty tasks on improving students' understanding and mastery of physics. The questions before and after the test included three main topics: magnetic field, electromagnetic induction and electromagnetic waves. The scope of our study included both control and experimental groups. To evaluate the equality of knowledge quality between these groups, we conducted a one-way Normality Test (Table 1) and employed either an Independent Samples T-Test (Table 2) or a Mann-Whitney U test (Table 3) to compare the pre-test results of the two groups.

Table 1. Normality test (Shapiro-Wilk).

	W	p
The Magnetic Field pre-test	0.938	0.123
Electromagnetic Induction pre-test	0.927	0.065
Electromagnetic Waves pre-test	0.871	0.004

Note: A low p-value suggests a violation of the assumption of normality.

Table 1 presents the results of the Normality Test (Shapiro-Wilk), which assesses the assumption of normality. A low p-value suggests a violation of the normality assumption. Based on this test, we determined that the T-Test is suitable for analyzing the pre-test responses related to the magnetic field and electromagnetic induction, while the Mann-Whitney U test is appropriate for evaluating the responses pertaining to electromagnetic waves.

Table 2. Independent samples T-test.

		Statistic	df	p
The Magnetic Field pre-test	Student's t	0.784	24.0	0.440
Electromagnetic Induction pre-test	Student's t	-0.954	24.0	0.350

Table 3. Independent Samples T-Test.

		Statistic	df	p
Electromagnetic Waves pre-test	Student's t	-0.164	24.0	0.871
	Mann-Whitney U	67.5		0.816

The T-Test results for the pre-test responses of the magnetic field and electromagnetic induction are reported in Table 2. However, the Mann-Whitney U test conducted for the pre-test responses concerning electromagnetic waves revealed no significant difference between the control and experimental groups (Table 3). These findings indicate that the knowledge levels of both groups were comparable.

To further examine the equality of knowledge quality between the groups, we analyzed the post-test results using a Normality Test (Table 4) and performed either an Independent Samples T-Test (Table 5) or a Mann-Whitney U test (Table 6). The post-tests were administered at the end of the semester.

Table 4. Normality test (Shapiro-Wilk).

	W	p
The Magnetic Field post-test	0.966	0.474
Electromagnetic Induction post-test	0.971	0.604
Electromagnetic Waves post-test	0.886	0.005

Note: A low p-value suggests a violation of the assumption of normality.

Table 4 displays the results of the Normality Test (Shapiro-Wilk) for the post-test responses. Similar to the pre-test analysis, we observed that a low p-value suggests a violation of the normality assumption. Consequently, we opted to utilize a T-Test to analyze the post-test responses related to the magnetic field and electromagnetic induction, and a Mann-Whitney U test to assess the responses regarding electromagnetic waves.

Table 5. Independent samples t-test.

		Statistic	df	p
The Magnetic Field post-test	Student's t	-1.11	26.0	0.279
Electromagnetic Induction post-test	Student's t	1.05	26.0	0.305

Table 6. Independent samples T-test.

		Statistic	df	p
Electromagnetic Waves post-test	Student's t	-1.112	26.0	0.912
	Mann-Whitney U	85.0		1.000

Table 5 presents the results of the Independent Samples T-Test for the post-test responses of the magnetic field and electromagnetic induction. No significant difference was found between the control and experimental groups in these areas. Likewise, Table 6 shows that the Mann-Whitney U test for the post-test responses concerning electromagnetic waves also revealed no significant difference between the groups.

Summing up, we can say that the results indicate that there were no significant differences in the quality of knowledge between the control group and the experimental group, both at the pre- and post-examination.

The second study question was to investigate the influence of gender on the effectiveness of the two teaching approaches in the field of physics didactics. Just like the initial research question, the questions before and after the test included three main topics: the magnetic field, electromagnetic induction and electromagnetic waves. The study included both a control group and an experimental group.

Table 7. Normality test (Shapiro-Wilk).

	W	p
The Magnetic Field pre-test	0.960	0.110
Electromagnetic Induction pre-test	0.876	0.005
Electromagnetic Waves pre-test	0.907	0.022

Note: A low p-value suggests a violation of the assumption of normality.

To evaluate the equality of knowledge quality between these groups based on gender, we conducted a one-way Normality Test (Table 7) and utilized either an Independent Samples T-Test (Table 8) or a Mann-Whitney U test (Table 9) to compare the pre-test results of the two groups.

Table 8. Independent Samples T-Test.

		Statistic	df	p
The Magnetic Field pre-test	Student's t	0.935	24.0	0.359
Electromagnetic Waves pre-test	Student's t	-0.707	24.0	0.486

Table 9. Independent Samples T-Test.

		Statistic	p
The Magnetic Field pre-test	Mann-Whitney U	75.0	0.955

Table 7 (gender table) presents the results of the Normality Test (Shapiro-Wilk), which assesses the assumption of normality specifically for gender-related data. We determined that the T-Test is suitable for analyzing the pre-test responses related to the magnetic field and electromagnetic waves, while the Mann-Whitney U test is appropriate for evaluating the responses pertaining to electromagnetic induction.

Table 8 displays the results of the Independent Samples T-Test for the pre-test responses of the magnetic field and electromagnetic waves, comparing the performance of male and female students. However, the Mann-Whitney U test conducted for the pre-test responses concerning electromagnetic induction revealed no significant difference between male and female students (Table 9).

Furthermore, we also conducted post-tests based on gender, administering the same tests to assess the knowledge and understanding of the key topics. We conducted a Normality Test (Table 10) and performed a t-test (Table 11) to compare the post-test results of male and female students.

Table 10. Normality Test (Shapiro-Wilk).

	W	p
The Magnetic Field post-test	0.960	0.353
Electromagnetic Induction post-test	0.971	0.605
Electromagnetic Waves post-test	0.950	0.199

Note: A low p-value suggests a violation of the assumption of normality.

Table 10 presents the results of the Normality Test (Shapiro-Wilk) for the post-test responses based on gender. We observed a violation of the normality assumption, indicating that the distribution of the data was not normal. Consequently, we used a non-parametric Mann-Whitney U test to assess the responses regarding the magnetic field, electromagnetic induction, and electromagnetic waves.

Table 11. Independent Samples T-Test.

		Statistic	df	p
The Magnetic Field post-test	Student's t	0.253	26.0	0.802
Electromagnetic Induction post-test	Student's t	-1.189	26.0	0.245
Electromagnetic Waves post-test	Student's t	-1.117	26.0	0.274

Table 11 shows the results of the Mann-Whitney U test for the post-test responses, comparing the performance of male and female students. The findings reveal no significant difference between gender and the results of the key topics.

In summary, the results indicate that there was no significant difference in knowledge quality between male and female students for both the pre-test and post-test assessments in relation to the effectiveness of the two teaching methods.

For the third research question, which aims to explore the implications of different teaching methods on undergraduate physics students' GPA as reflected in their pre-test and post-test scores, the results are outlined as follows.

The investigation begins with a Normality Test to determine if the pre-test and post-test scores were normally distributed. The results:

Table 12. Normality test (Shapiro-Wilk).

	W	p
The Magnetic Field pre-test	0.932	0.068
Electromagnetic Induction pre-test	0.890	0.007
Electromagnetic Waves pre-test	0.902	0.013

Note: A low p-value suggests a violation of the assumption of normality.

A low p-value ($p < 0.05$) indicates a violation of normality, which was the case for Electromagnetic Induction and Electromagnetic Waves pre-test scores. This warranted the use of non-parametric testing methods.

For the Electromagnetic Induction pre-test, a Mann-Whitney U was conducted due to the deviation from normality:

Table 13. Independent samples t-test.

		Statistic	p
Electromagnetic Induction pre-test	Mann-Whitney U	85.0	0.698

This result signifies that there was no significant difference between groups for the GPA scores from the Electromagnetic Induction pre-tests.

Moving to the post-test results:

Table 14. Normality test (Shapiro-Wilk).

	W	p
The Magnetic Field post-test	0.944	0.163
Electromagnetic Induction post-test	0.937	0.111
Electromagnetic Waves post-test	0.878	0.005

Once again, non-parametric testing was pertinent for the Electromagnetic Waves post-test scores due to a significant violation of the normality assumption.

The subsequent analysis utilized the Independent Samples T-Test, the results of which are presented in the following tables:

Table 15. Independent samples T-test

		Statistic	df	p
The Magnetic Field post-test	Student's t	0.00927	24.0	0.993
Electromagnetic Induction post-test	Student's t	-0.99613	24.0	0.329

The T-test results from Table 15 did not show any statistically significant difference between groups for the GPA scores of The Magnetic Field and Electromagnetic Induction post-tests. The p-values were well above the significance threshold of 0.05, indicating that the teaching methods did not lead to different outcomes in these areas of physics education when considering the GPA.

However, for the Electromagnetic Waves topic, where the post-test scores were not normally distributed, a Mann-Whitney U test was conducted:

Table 16. Independent samples t-test.

		Statistic	p
Electromagnetic Waves post-test	Mann-Whitney U	80.0	0.913

This Mann-Whitney U test result also indicates no significant difference between the student groups' GPA in the context of the Electromagnetic Waves post-tests.

When these results are summarized, it becomes obvious that there was no noticeable difference between the two teaching strategies in the GPA for each of the three main physics topics that were determined by the results before and after the test. Through pre- and post-test tests, each approach allowed students to achieve the same level of understanding and academic performance, regardless of the learning strategy used. This shows that variables other than learning style can have a greater impact on the GPA of physics students.

DISCUSSION AND CONCLUSION

According to the Results of the Study, there Were No Noticeable Changes in the Quality of Knowledge of the Experimental and Control Groups between the Assessments before and after Testing.

Our study found no evidence to support the claims of Fraser et al. (2014), as well as Pivarchi and Raganova (2017) that students' knowledge and assimilation of ideas in physics can improve over time if they are assigned tasks of varying complexity. This means that the results of our study could be influenced by other factors besides the complexity of the task.

Our study did not reveal a significant difference in the quality of knowledge between groups who received tasks of varying complexity, which contradicts previous studies such as Etkina and Van Heuvelen (2007), Larkin and Reif (1979), Hsu et al. (2004), Vygotsky (1978), Hake (1998) and Heller et al.(1992), which emphasize the benefits of gradually increasing the complexity of tasks and putting complex tasks in a meaningful context.

These results are particularly noteworthy in the light of extensive research confirming the positive results of increasingly complex activities. As suggested by Heller et al. (1992), Larkin and Reif (1979), Heik (1998), Etkina and Van Heuvelen (2007), further studies of these results — especially on samples of undergraduate students such as those given in our study - can provide important information about the complex consequences of completing assignments. difficulty in student performance.

Thus, despite the fact that our study did not find evidence to support the hypothesis that the complexity of tasks significantly affects the quality of knowledge, additional research is needed to determine whether a large number of tasks of varying degrees of complexity can improve student academic performance, especially in the context of undergraduate studies.

Our results showed that even with the pre-test and post-test assessment, there is no statistically significant difference in the quality of knowledge between male and female students. This result is similar to those obtained in previous studies (Balta & Asikainen, 2019; Zohar & Sela, 2003; Haeruddin, Kamaluddin, Kade, & Pabianan, 2022). In addition, findings (Good, Memories and Singh, 2022) noticed that female physics students have better problem-solving strategies than men when compared with problem-solving strategies. This is an interesting result that should be studied more carefully in large samples, since several studies on solving mathematical problems show that men are better at solving problems than women (Gallagher et al., 2000).

During our study of the impact of task complexity on the average student score at the end of the semester, there was no noticeable difference in academic performance between those who completed a large number of graded difficulty tasks and those who completed a small number of complex tasks. These results show that in terms of student academic development as measured by GPA, neither of these two different teaching philosophies has significantly improved student academic performance.

Our results are consistent with earlier studies conducted on this topic. Researchers' attention has shifted to understanding how different teaching approaches affect students' academic achievement, in particular their GPA at the end of the semester (McDermott & Redish, 1999). For example, Ryan et al. (2016) provide evidence in favor of individual problem-solving training as a method of improving student achievement, suggesting that a small number of complex tasks can have a significant impact on final grades. This is consistent with research that demonstrates how actively solving complex problems improves learning ability and memory, which, in turn, has a beneficial effect on students' final grades (McDermott, 2001). However, our study shows that differences in how teaching tactics affect students' GPA at the end of the semester may not have a significant impact on their final undergraduate physics grades.

In conclusion, more research is needed to explore other factors that may affect student academic success, even though our work contributes to the ongoing discussion of optimal physics teaching strategies. Teachers who continue to explore and refine their teaching strategies can strive to create a more productive learning environment that promotes student success.

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