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Teaching Integrated Math with Physics through the Topics of Functions, Graphs and Free Fall

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Abstract:

Integrated teaching is currently one of the key teaching trends in Vietnam. Integrated teaching shows a clear advantage that is connecting the knowledge, experiences, and abilities of learners together. Students have to mobilize their own knowledge and promote their own qualities, so this teaching method helps students remember longer and apply better. Teaching integrated math with physics through the topics of functions, graphs and free fall in Vietnam is still a new topic and no one has researched it yet. Our article focuses on researching perspectives on integrated teaching, teaching methods that integrate math with physics through the topics of functions, graphs, and free-fall in practice. The results of the article show that students show interest in this interdisciplinary teaching method. Students develop math and physics solving skills through math and physics problems and know how to exploit and expand their knowledge with or without the help of teachers.

Keywords: Integrated teaching, functions, graphs, free fall, connections.

1. INTRODUCTION

Integrated teaching is a teaching method that mobilizes knowledge in many different subjects to solve a problem or teaching situation that requires connection and interrelatedness in some aspects. Integrated teaching must be interactive in nature. Integration can be the connection between theoretical knowledge with practice and between mathematics and other subjects.

According to Xavier Roegiers, integration includes four types. The first is the internal integration of a subject (intra-subject integration). The internal integration of a subject (intra-subject integration) is the use of knowledge and content of the subject itself to solve, exploit and develop the problems that the subject offers. The material also commented, "The "intra-subject" perspective focuses on the content of the subject. This view aims to maintain and affirm the independent existence of separate disciplines." Intra-subject integration includes the following forms: intra-subject integration in arithmetic; intra-subject integration in algebra; intra-subject integration in calculus; intra-subject integration in geometry. The second is multidisciplinary integration. Multidisciplinary integration is the point of view of research, presentation, and development of cases, topics, and contents in different disciplines. In this view, subjects continue to be approached individually and only meet at certain points in the research process, so the subjects present knowledge specific to each subject, with little interaction about knowledge, content, and methods. The third is interdisciplinary integration. Interdisciplinary integration is a view in which we propose situations and topics that can only be reasonably approached through the illumination of many disciplines, emphasizing the connection of disciplines, and making them more integrated to solve a given situation, so learning processes will not be discussed in isolation but must be linked together around the problems to be solved. The document categorizes the types of interdisciplinary integration, including Math - Information integration, Math - Physics integration, and Math, Information, and Physics integration. Finally, there is cross-disciplinary integration. Cross-disciplinary integration is the main point of view of developing skills that students can use in all subjects, in all situations, etc. collectively known as transdisciplinary skills, including cognitive skills, repetition skills, manual skills, behavioral skills, and self-development skills.

In this article, we focus on answering the following questions:

1. What is the perspective of integration?

2. How does the teaching method integrate Math with Physics through the topics of functions, graphs, and free-fall?

2. LITERATURE REVIEW

2.1. Perspectives on integration

According to Nguyen Ngoc Giang (2019) in the book "Integrating Math, Information and Physics", "Integrating an object or phenomenon of a subject is that the subject connects things and phenomena with related things and phenomena, as well as connections in the thing and phenomenon themselves to form a unified and useful block in a certain context". The document also gives features of integration such as: first, integration is subjective; second, the integration is related and associative; third, integrations are useful combinations; fourth, integration shows introversion as well as extroversion; finally, integration forms a unified whole and is always in a certain context.

According to Nguyen Phuong Chi et al (2018) in the article "Teaching mathematics at the high school level in an integrated way", Humphreys et al (1981) define that "integrated learning is the method in which children explore knowledge across disparate but related disciplines in some respect in their learning environments".

In the work "Introducing integrated teaching and comparison with traditional teaching in undergraduate medical curriculum: A pilot study", Mausumi Basu et al (2015) define "Integrated teaching as the organization of teaching problems according to a way of interweaving or unifying subjects that are regularly taught in separate courses or departments. It is simply a bridge between knowledge and practice."

In the work "Integrated teaching for the purpose of developing students' ability to apply knowledge" by Ha Thi Lan Huong (2015), the author gives a view on integrated teaching "in order to form and develop in students the necessary competencies, including the ability to apply knowledge to effectively solve practical situations. It also means to ensure that each student knows how to apply the knowledge learned in school to new, difficult, and unexpected situations; thereby becoming a responsible citizen, a capable worker... Thus, integrated teaching will maximize the growth and personal development of each student, helping them to succeed in the role of the head of the family, the citizen, the future worker".

In the work "Integrated, interdisciplinary teaching and curriculum development" by Nguyen Van Cuong (2017), "Integrated teaching is a teaching perspective in which teaching content is linked between different fields of science or subjects, associated with practical, complex topics. Integrated teaching aims to develop the ability to apply knowledge from different fields of science and subjects in connection to solving complex practical situations. Integrated teaching content requires complex teaching methods".

According to "Integrated teaching training materials in junior high schools and high schools" (Pedagogical University Publishing House, 2014), "Integrated teaching in the narrow sense is the introduction of content issues of many disciplines into a single curriculum in which scientific concepts are addressed in a unified spirit and method".

2.2. Illustrated examples of integrated teaching of Maths with Physics through the topics of functions, graphs and free fall

Example 1

Two points A and C have a vertical distance of 500m, point C is on the ground. At the same time, the first body is free-falling from A and the second is thrown vertically up from C with speed v_0. *Take* $g = 10m/s^2$.

a) Find v_0 *so that the two bodies meet at B with a height of 180m.*

b) Calculate the maximum height reached by the second object.

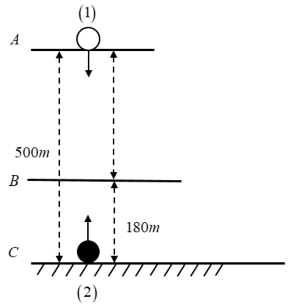

Figure 1. Free fall motion problem
(Source: Author)

Teacher's activities	Student activities
Step 1: Search for Physics content that is suitable for knowledge of Functions and graphs in grade 10	
Is the problem free-fall motion in the Ox or Oy direction? Where do we choose the origin? Where does the positive direction come from?	The problem is free-fall motion in the Oy direction. Select the origin at point C on the ground. Positive direction is up.
Then what is the coordinate equation of the object?	The coordinate equation of the object has the form: $y = y_0 + v_0 t + \frac{1}{2} g t^2$, where v_0 is the initial velocity of the object; t is the time it takes the object to move; y_0 is the distance from the origin to the original position of the object.
What is the formula for the speed of an object?	The formula for the object's velocity is $v = v_0 + gt$, where v_0 is the object's initial velocity; t is the time taken by the object to move
What is the relationship formula between velocity, acceleration and displacement?	The formula for the relationship between velocity, acceleration and displacement is $v^2 - v_0^2 = 2g.\Delta y$, where v_0 is the initial velocity of the object; Δy is the displacement, the path of the object.
Is it possible to use knowledge of functions and graphs to solve this problem?	Yes, it is.
Step 2: Apply knowledge on the topic of Functions and graphs to solve math problems	
Identify the known factors.	Known factors: - For the first object: initial velocity is $v_{01} = 0\,m/s;\ y_{01} = 500\,m$. - For the second object: initial velocity is $v_{02} = v_0\,m/s;\ y_{02} = 0\,m$.
a) Find v_0 so that the two bodies meet at B with a height of 180m.	The equation of motion for the first object is:

	$y_1 = y_{01} + v_{01}t - \frac{1}{2}gt^2$ $\Leftrightarrow y_1 = 500 - \frac{1}{2}gt^2 \quad (1)$. The equation of motion for the second object is: $y_2 = y_{02} + v_{02}t - \frac{1}{2}gt^2$ $\Leftrightarrow y_2 = v_0 t - \frac{1}{2}gt^2 \quad (2)$. For two objects to meet at B with a height of 180m, then $y_1 = y_2 = 180$. From (1) we have: $180 = 500 - \frac{1}{2}.10t^2$ $\Leftrightarrow t^2 = 64 \Rightarrow t = 8\ (s)$. From (2) we have: $180 = v_0.8 - \frac{1}{2}.10.64$ $\Leftrightarrow v_0 = 62,5\ (m/s)$
- What is the motion of the second object thrown from *B*? - When an object is at its maximum height, what is its velocity at that point?	- The second object thrown from *B* is in uniform deceleration. - When the object is at the maximum height, the object stops and then falls down. The velocity of the object is then 0.
b) With V_0 in question a), calculate the maximum height reached by the second object.	When the second object reaches its maximum height, then its velocity is zero, or $v_2 = 0$. According to the relationship formula between speed, acceleration and displacement we have: $v_2^2 - v_{02}^2 = -2g.\Delta y$ $\Leftrightarrow -v_{02}^2 = -2.10.(y_{max} - y_{02})$ $\Leftrightarrow y_{max} = \frac{v_{02}^2}{20} = \frac{62,5^2}{20} = 195,3125\ (m)$ $\approx 195,3\ (m)$
Step 3: Draw conclusions	
Conclusion of the problem?	a) With $v_0 = 62,5 m/s$, the two bodies meet at *B* with a height of 180m. b) With $v_0 = 62,5 m/s$, the maximum height achieved by the second object is 195.3m.
Step 4: Dig deep into the problem (if any)	
The teacher asks the students to find another way to solve the problem using the graph method. It is recommended to use graphing software such as GeoGebra to find the time when two cars meet.	Students listen and absorb ideas.

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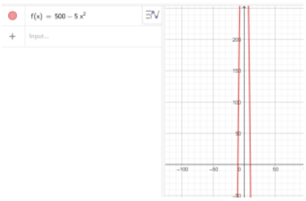
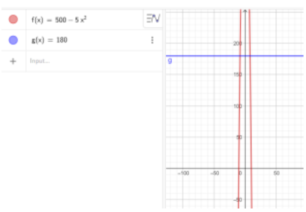
The teacher builds the shape and draws on GeoGebra software a graph showing two cars meeting at *B* with a height of 180m.

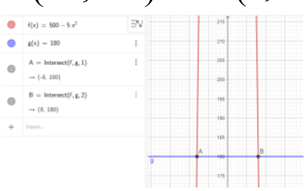
- Step 1: Draw the graph of the function $f(x) = 500 - 5x^2$.



- Step 2: On the same coordinate plane above, draw the graph of the function $g(x) = 180$



- Step 3: Determine the coordinates of the intersection of the two graphs as $A(-8;180)$ and $B(8;180)$.



- Step 4: Eliminate point *A* because its coordinates are negative, get point *B*. From there determine the value of x_0 (corresponding to t_0 in the problem). Replace the value of x_0 you just found into $180 = v_0 x - 5x^2$ to find the velocity v_0 of the second object you want to find.

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<td>The teacher gives a general problem.</td>
<td>Students read and analyze the problem.</td>
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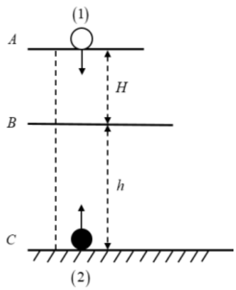
Problem 1: (Le Van Vinh, 2018) An object falls freely from *A* at a height (*H* = *h*). The second object is launched vertically with velocity v_0 from the ground at *C*. The two bodies start moving at the same time. Calculate v_0 so that the two bodies meet at *B* of height *h*. What is the maximum height the second object reaches? Consider the special case when $H = h$.  **Figure 2.** General problem of free fall motion (Source: Le Van Vinh, 2018)	
Solve the above general problem.	The problem is about free-fall motion in the Oy direction. Select the origin at point C on the ground. The positive direction is up. The equation of motion of the first body is: $y_1 = (H + h) - \frac{1}{2}gt^2 \quad (1)$ The equation of motion of the second body is: $y_2 = v_0 t - \frac{1}{2}gt^2 \quad (2)$ For two bodies to meet at B with height h, $y_1 = y_2 = h$ From (1) we have: $h = (H + h) - \frac{1}{2}gt^2$ $\Rightarrow t = \sqrt{\frac{2H}{g}} \quad (3)$ From (2) we have: $h = v_0 t - \frac{1}{2}gt^2 \Rightarrow v_0 = \frac{h}{t} + \frac{1}{2}gt \quad (4)$ Substituting (3) into (4) we get: $v_0 = \frac{h}{\sqrt{\frac{2H}{g}}} + \frac{1}{2}g.\sqrt{\frac{2H}{g}}$ $= h.\sqrt{\frac{g}{2H}} + \frac{1}{2}\sqrt{2gH}$

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<td>$$= \frac{H+h}{2H}\sqrt{2gH}$$
When the second object reaches its maximum height, then the velocity of the object is 0, or $v_2 = 0$.
According to the relationship formula between speed, acceleration, and displacement, we have:
$v_2^2 - v_0^2 = -2g.\Delta y \quad (5)$
Substituting $v_2 = 0$ into (5), we get:
$$h_{\max} = \frac{v_0^2}{2g} = \frac{\left(\frac{H+h}{2H}\sqrt{2gH}\right)^2}{2g} = \frac{(H+h)^2}{4H}$$
When H = h then:
$$v_0 = \frac{h+h}{2h}\sqrt{2gh} = \sqrt{2gh}$$
$$h_{\max} = \frac{(h+h)^2}{4h} = h$$
So in order for two bodies to meet at B, the second object must be thrown up with a velocity $v_0 = \frac{H+h}{2H}\sqrt{2gH}$ and the maximum height it can reach is $h_{\max} = \frac{(H+h)^2}{4H}$.</td>
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<td>**Deeply research the problem**: The teacher gives the problem:
Problem 2: Two points *A* and *C* have a vertical distance of 500*m* apart, point *C* is on the ground. The first body falls freely from *A* and after 2 seconds the second is thrown vertically up from C with speed v_0. Take $g = 10m/s^2$. Find v_0 and t_0 so that the two bodies meet at *B* with a height of *h* = 180*m* and also the maximum height of the second object.</td>
<td>Students read, analyze and solve the problem.</td>
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Example 2 (based on Nguyen Phu Dong, 2018)

An elevator is moving upward with an acceleration of $2m/s^2$. When the elevator has a speed of 3.6*m/s*, an object falls from the ceiling of the elevator. The elevator ceiling is *h* = 2.94*m* from the floor. Calculate in the reference frame attached to the ground:

a) Falling time.
b) The displacement of the object.

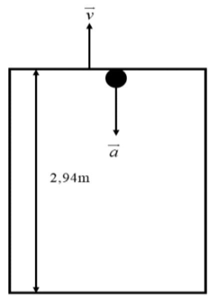
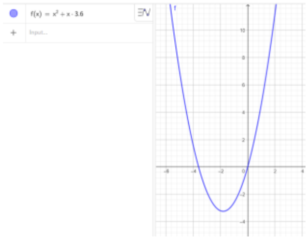
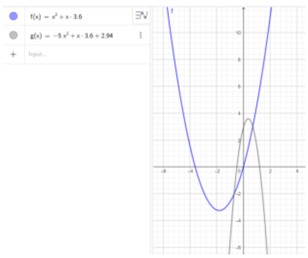
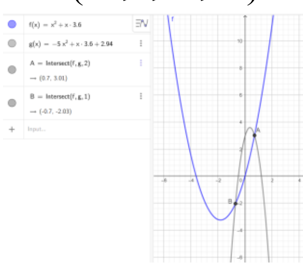


Figure 3. Elevator motion and free-fall problem
(Source: Author)

Teacher's activities	Student activities
Step 1: Find the Physics content that is suitable for the knowledge of Functions and graphs in grade 10	
Is the problem free-fall motion in the Ox or Oy direction? Choose a reference system attached to the ground, where is the origin? Where is the positive direction? When is the origin of time?	The problem is free-fall motion in the Oy direction. Choose a reference system attached to the ground, the origin at O at the elevator floor. The positive direction is up. The origin of time is when the object begins to fall.
Then what is the coordinate equation of the object?	The coordinate equation of the object has the form: $y = y_0 + v_0 t + \frac{1}{2}at^2$, where v_0 is the initial velocity of the object; a is the acceleration of the motion; t is the duration of the motion; y_0 is the distance from the origin to the original position of the object.
Is it possible to use knowledge of functions and graphs to solve this problem?	Yes, it is.
Step 2: Apply knowledge of the topics of Functions and graphs to solve the problem	
Identify known factors.	Known factors: - For the elevator floor: acceleration $a = 2\,\mathrm{m/s^2}$; initial velocity $v_1 = 3{,}6\,\mathrm{m/s}$; $y_{01} = 0\,\mathrm{m}$. - For the falling object: acceleration $g = -10\,\mathrm{m/s^2}$; initial velocity $v_2 = 3{,}6\,\mathrm{m/s}$; $y_{02} = 2{,}94\,\mathrm{m}$.
Identify the elements to look for.	- Falling time of the object. - The displacement of the object. - Distance traveled.
How is the falling time of an object calculated?	The time to fall of an object is calculated from the moment the object begins to fall until the object

	hits the floor of the elevator.
a) Determine the time taken by the object to fall.	Select the reference frame attached to the ground; the origin at point O at the elevator floor; positive direction upward; The origin of time is when the object begins to fall. Then: - For the elevator floor: $y_1 = y_{01} + v_{01}t + \frac{1}{2}a_1t^2 \Leftrightarrow y_1 = 3,6t + t^2$ - For the falling object: $y_2 = y_{02} + v_{02}t + \frac{1}{2}a_2t^2$ $\Leftrightarrow y_2 = 2,94 + 3,6t - 5t^2$ When the object hits the floor of the elevator, then: $y_1 = y_2$ $\Leftrightarrow 3,6t + t^2 = 2,94 + 3,6t - 5t^2$ $\Leftrightarrow 6t^2 - 2,94 = 0$ $\Leftrightarrow \left[\begin{array}{l} t = 0,7 \\ t = -0,7 \end{array}\right.$ Remove the answer $t = -0,7$ because $t < 0$. Get the answer $t = 0,7$.
How is the displacement of an object calculated?	The displacement of the object is the distance between the initial position and the position of the object when it touches the floor of the elevator.
b) Calculate the displacement of the object.	The displacement of the object: $\Delta y = \lvert y - y_0 \rvert$ $= \lvert 2,94 + 3,6t - 5t^2 - (2,94 + 3,6t_0 - 5t_0^2) \rvert$ Substituting $t = 0,7; t_0 = 0$, we get: $\Delta y = 0,07(\mathrm{m})$.
Step 3: Draw conclusions	
Conclusion of the problem?	a) The time to fall of the object is $0,7\,\mathrm{s}$. b) The displacement of the object is $0,07\,\mathrm{m}$.
Step 4: Dig deeper into the problem (if any)	
The teacher asks the students to find another way to solve the problem using the graph method. It is recommended to use graphing software such as GeoGebra to find the time when two cars meet. The teacher builds the shape and draws on GeoGebra software a graph showing two cars meeting at *B* with a height of 180m. - Step 1: Draw a graph of the function $f(x) = x^2 + 3,6x$.	Students listen and absorb ideas.

 - Step 2: On the same coordinate plane above, draw the graph of the function $g(x) = -5x^2 + 3,6x + 2,94$.  - Step 3: Determine the coordinates of the intersection of two graphs $A(0,7;3,01)$ and $B(-0,7;-2,03)$.  Step 4: Eliminate point *B* due to negative coordinates, get point *A*. From there determine the value of x_0 (corresponding to t_0 in the problem).	
Deeply research the problem: The teacher gives the problem: **Problem 3**: An elevator is moving upward with an acceleration of $4m/s^2$. When the elevator has a speed of 2.5m/s, an object falls from the ceiling of the elevator. The elevator ceiling is h=4.48m from the floor. Calculate in the frame of reference attached to the ground: a) Falling time. b) The displacement of the object.	Students read, analyze and solve the problem.

Example 3

An object A falls freely from a height of 80 m. At the same time, object B is thrown straight down from a height of $320m$ with an initial velocity of v_0. Two objects hit the ground at the same time. Take $g = 10m/s^2$. Find v_0.

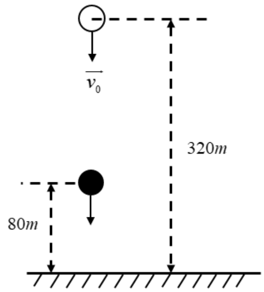
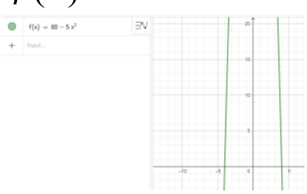
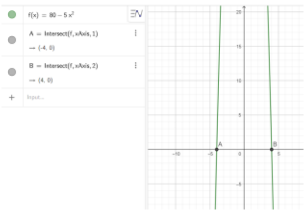
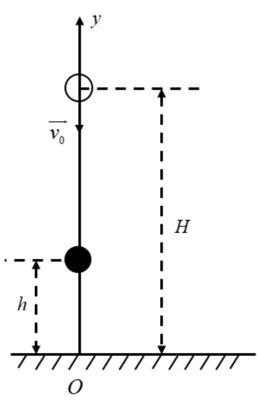


Figure 4. Motion problem of a free-falling and a straight-throwing body

(Source: Author)

Teacher's activities	Student activities
Step 1: Find the Physics content that is suitable for the knowledge of Functions and graphs in grade 10	
Where do we choose the origin? Where is the positive direction? When is the origin of time?	Select the origin at point O on the ground. The positive direction is up. The origin of time is the moment when two objects begin to move.
Then what is the equation of motion of the object?	The equation of motion of the body has the form: $y = y_0 + v_0 t + \frac{1}{2} g t^2$, where v_0 is the initial velocity of the object; t is the duration of the motion; x_0 is the distance from the origin to the original position of the object.
Is it possible to use knowledge of functions and graphs to solve this problem?	Yes, it is.
Step 2: Apply knowledge of the topics of Functions and graphs to solve the math problem	
Identify known factors.	Known factors: - For object A: initial velocity $v_{01} = 0\,\mathrm{m/s}$; $y_{01} = 80\,\mathrm{m}$. - For object B: initial velocity $v_{02} = -v_0\,\mathrm{m/s}$; $y_{02} = 320\,\mathrm{m}$.
Determine what to look for.	The initial velocity v_0 of the second object.
Find the initial velocity v_0 of the second body.	Select the origin at point O on the ground. The positive direction is up. The origin of time is the moment when two objects begin to move. The equation of motion for object A is:

	$y_1 = y_{01} + v_{01}t + \frac{1}{2}gt^2$ $\Leftrightarrow y_1 = 80 - 5t^2 \quad (1)$ The equation of motion for object *B* is: $y_2 = y_{02} + v_{02}t + \frac{1}{2}gt^2$ $\Leftrightarrow y_2 = 320 - v_0 t - 5t^2 \quad (2)$ When object *A* hits the ground, $y_1 = 0$ $\Leftrightarrow 0 = 80 - 5t^2 \Leftrightarrow \left[\begin{array}{l} t = 4 \\ t = -4 \end{array}\right.$ Remove the answer $t = -4$ because $t < 0$. Get the answer $t = 4\ (s)$. When object *B* hits the ground, $y_2 = 0$ $\Leftrightarrow 0 = 320 - v_0 t - 5t^2$ Substituting $t = 4$ into the equation, we get: $320 - v_0.4 - 5.4^2 = 0 \Leftrightarrow v_0 = 60\ (m/s)$
Step 3: Draw a conclusion	
Conclusion of the problem?	So the initial velocity of object *B* is $v_0 = 60\,\text{m/s}$.
Step 4: Deepen the problem (if any)	
The teacher asks the students to find another way to solve the problem using the graph method. It is recommended to use graphing software such as GeoGebra software to find when object *A* hits the ground. The teacher builds shapes and draws on GeoGebra graphing software to find the time when object *A* hits the ground. Step 1: Draw the graph of the function $f(x) = 80 - 5x^2$.  Step 2: Determine that the coordinates of the intersection of $f(x)$ with the horizontal axis are $A(-4;0)$ and	Students listen and absorb ideas.

$B(4;0)$.  Step 3: Eliminate point *A* due to negative coordinates, get point *B*. From there determine the value of x_0 (corresponding to t_0 in the problem). Substitute the value x_0 you just found into the equation $0 = 320 - v_0 t - 5t^2$ to find the velocity v_0 of the second object you want to find.	
The teacher gives a general problem. **Problem 4**: (Nguyen Phu Dong, 2018) *An object falls freely from a height h. At the same time another object is thrown straight down from a height H (H > h) with an initial velocity of* v_0. *Two objects hit the ground at the same time. Find* v_0.  **Figure 5**. A general problem of the motion of a free-falling object and a straight-throwing object (Source: Nguyen Phu Dong, 2018)	Students read and analyze the problem.
Solve the above general problem.	Select the origin at point *O* on the ground. The positive direction is up. The origin of time is the moment when two objects begin to move.

	Let the body falling freely from a height h be the first, and the object dropped from a height H the second. Then: The equation of motion of the first body is: $y_1 = h - \frac{1}{2}gt^2 \quad (1)$ The equation of motion of the second body is: $y_2 = H - v_0 t - \frac{1}{2}gt^2 \quad (2)$ When the first object hits the ground, $y_1 = 0$ From (1) we have: $h - \frac{1}{2}gt^2 = 0$ $\Longrightarrow t = \sqrt{\frac{2h}{g}} \quad (3)$ When the second object hits the ground, $y_2 = 0$. From (2) we have: $0 = H - v_0 t - \frac{1}{2}gt^2$ $\Longrightarrow H = v_0 t + \frac{1}{2}gt^2 \quad (4)$ Substituting (3) into (4) we get: $H = v_0.\sqrt{\frac{2h}{g}} + \frac{1}{2}g.\frac{2h}{g} = v_0.\sqrt{\frac{2h}{g}} + h$ $\Longrightarrow v_0 = (H-h).\sqrt{\frac{g}{2h}} = \frac{H-h}{2h}.\sqrt{2gh}$ So the initial velocity at which the second object is thrown is $v_0 = \frac{H-h}{2h}.\sqrt{2gh}$ with $(H > h)$.
Deeply research the problem: The teacher gives the problem: **Problem 5**: *An object A falls freely from a height of* 320*m*. *At the same time, object B is thrown straight down from a height of* 480*m* *with an initial velocity of* V_0. *Two objects hit the ground at the same time. Take* $g = 10m/s^2$. *Find* V_0.	Students read, analyze and solve the problem.

3. ORGANIZATION OF PEDAGOGICAL EXPERIMENTS

3.1. Time and experimental subjects

With the consent of the Board of Directors of Dong Nai Pedagogical Practice High School, Bien Hoa city, Dong Nai province, we were allowed to conduct pedagogical experiments to test and evaluate the research results. We have conducted a fact-finding of the student's situation and the status of integrated teaching.

- Time to conduct the experiment: From February 7, 2022 to March 30, 2022.
- Location: Dong Nai Pedagogical Practice High School, Bien Hoa City, Dong Nai Province.
- Content: According to the basic curriculum for the academic year 2021 - 2022.
- Control class: 10A5, including 38 students. Math teacher: Le Mai Thanh Dung, Physics teacher: Trinh Thi Phuong Thao. The class is studying according to the basic textbook program.
- Experimental class: 10A4, including 38 students. Math teacher: Le Mai Thanh Dung. Physics teacher: Ngo Nguyen Hoang Nhat. The class is studying according to the basic textbook program.
- We designed the experimental lesson plan and implemented the teaching content of the lesson "Practice on the topic of uniform rectilinear motion", and "Practice on the topic of free fall" for both classes. For the experimental class, teachers will teach according to lesson plans that integrate math with physics. For the control class, the teacher will teach according to the program distribution. The given math and physics problems must ensure the following contents:

+ Clearly define the key knowledge and skills to be achieved.

+ The pedagogical situations given must be suitable to the capacity and level of the students, paying attention to fostering the students' integrative ability.

+ In accordance with the actual conditions of the school in terms of time, facilities, and ensuring the achievement of the set goals.

3.2. Quantitative assessment

To test the feasibility and evaluate the effectiveness of the cases, we gave the experimental class and the control class a 45-minute test with essay form. Quantitative analysis is based on test results.

Table 3.1. The frequency distribution table of the average score of the 45-minute test after the experiment of the experimental and control classes
(Source: Author)

		Class		Total
		Control	Experimental	
Average scores	5.0	1	0	1
	5.5	2	0	2
	6.0	3	0	3
	6.5	4	3	7
	7.0	5	6	11
	7.5	7	7	14
	8.0	6	8	14
	8.5	4	5	9
	9.0	3	4	7
	9.5	2	3	5
	10.0	1	2	3
Total		38	38	76

We conduct the test of normal distribution for the sample set of the mean scores of math in the first semester of the experimental and control classes. Our results are shown in the following graph:

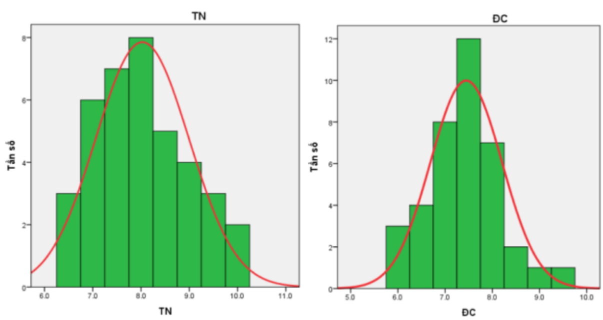


Figure 6. Distribution of 45-minute physics test scores of experimental and control classes
(Source: Author)

We notice that the distribution graph is bell-shaped (Figure 6). Distributions of this form are called "Normal distributions". So we continue to study this sample.

From table 3.11, we obtain the graph of the frequency distribution of math scores of two experimental and control classes in the first semester of the school year 2021 - 2022 as follows:

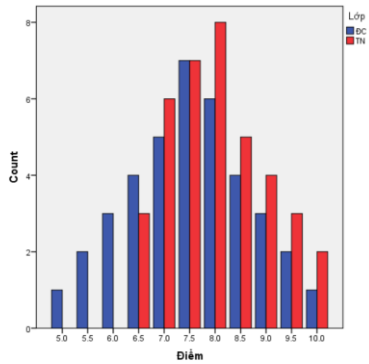


Figure 7. **Graph showing the frequency distribution of 45-minute post-experiment physics test scores of experimental and control classes**
(Source: Author)

From chart 7, it can be seen that the heights of the score columns and the distribution of scores of the two classes do not have much difference. The scores of the experimental class range from 6.5 to 10 points and mainly from 7.0 to 9.0 points. The scores of the control class range from 5.0 to 10 points and most of them are in the range of 6.5 - 8.5 points.

Table 3.2. Table of specific parameters of statistics about the average score of the 45-minute post-experiment physics test of two classes
(Source: Author)

	Class	**Mean**	**Variance**	**Standard Deviation**
Scores	Experimental	8.026	.932	.9653
	Control	7.513	1.425	1.1939

From Table 3.2, we have:

- The average score of the 45-minute test of the experimental class in the first semester is 8,026 points.
- The average score of the 45-minute test of the control class in the first semester is 7,513 points.
- The standard deviation and variance of the control class are higher than those of the experimental class, showing that the dispersion of scores around the mean of the control class is higher than that of the experimental class. We conduct a T-test (Table 3.2) to accurately assess the difference or equivalence between the mean scores of the two classes. We test the following two hypotheses with significance level $\alpha = 0,05$.

H_0: "The average score of the 45-minute physics test of the experimental class and the control class is similar".

H_1 : "The average score of the 45-minute physics test of the experimental class is higher than that of the control class".

Table 3.3. The average T-test table of the average score of the 45-minute physics test of the experimental and control classes in SPSS
(Source: Author)

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Điểm	Equal variances assumed	1.238	.269	2.060	74	.043	.5132	.2491	.0169	1.0094
	Equal variances not assumed			2.060	70.889	.043	.5132	.2491	.0165	1.0098

Reading table 3.3, we have the following results:

- Levene test has the value $Sig. = 0,269 > \alpha = 0,05$, so the variance of the two classes, although there is a slight difference, should be considered equivalent, using the results of the Independent sample T-test for the case that the equal variances are assumed.
- According to Independent sample T-test, we have $Sig.(2 - tailed) = 0,043 < \alpha = 0,05$, so hypothesis H0 is rejected, hypothesis H1 is accepted. Therefore, the mean score of the experimental class is higher than that of the control class at the 5% level of significance.

Thus, by the test method between classes with similar academic abilities, we found that the experimental class, after being taught with an experimental lesson plan that integrates math with physics, has better test results and better performance of students in the learning process in a positive direction. It can be seen that the experimental situations applied to the experimental class are completely feasible and achieve certain effectiveness in teaching.

4. CONCLUSION

Integrated teaching is a modern teaching method that promotes the qualities and capabilities of learners. Learners through integrated teaching develop their own potential, knowledge, and experience. Integrated teaching has many different types of teaching. They are the teaching methods of intra-subject, inter-subject, cross-subject, and multi-subject integration. In integrated teaching methods, interdisciplinary integrated teaching is often interested. In interdisciplinary integration, the interdisciplinary integration of math and physics is often encountered in practice. Because the nature of many physics problems is mathematics, these problems are good "raw materials" for interdisciplinary teaching methods. Among the topics, the topic of functions, graphs, and free-fall are topics that clearly show the advantages of interdisciplinary teaching. The article has examined perspectives on integrated teaching as well as proposed a teaching method that integrates mathematics and physics through the topic of functions, graphs, and free fall.

REFERENCES

1. Xavier Roegiers. (1996). *Integrated pedagogy or how to develop competencies at school*. Education Publishing House.
2. Nguyen Ngoc Giang. (2019). *Integration of Math, Information, and Physics*. Hanoi National University Publishing House
3. Nguyen Phuong Chi, Ngo Thi Tu Quyen, Nguyen Thi Hong Phuong. (2018). *Teaching Mathematics at the High school level in an integrated way.* Vietnam Journal of Education. 21–27.
4. Basu, M., Das, P. & Chowdhury, G. (2015). *Introducing integrated teaching and comparison with traditional teaching in undergraduate medical curriculum: A pilot study.* Medical Journal of Dr. D.Y. Patil University, 431–438. https://doi.org/10.4103/0975-2870.160778
5. Ha Thi Lan Huong. (2015). *Integrated teaching for the purpose of developing students' ability to apply knowledge.* Pedagogical Research Institute, University of Pedagogy.
6. Nguyen Van Cuong. (2017). *Integrated, interdisciplinary teaching and curriculum development.* H.N.U.E Journal of Science. 20–26.
7. Ministry of Education and Training. (2014). *Training materials on Integrated Teaching in middle and high schools.* Pedagogical University Publishing House.