

Constructing an Educational Programme Based on Active Learning Strategies and its Impacts on Developing Pivotal Thinking Skills

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The present study aims to: 1. Construct an educational programme based on skills of active learning. 2. Identify the impact of the programme on pivotal thinking skills for a particular group of fifth year students of an applied branch in Physics. The study sample includes 56 students distributed over two equal sections (B, C). The two groups are equivalent in the variables that could affect the experiment's results. The researcher prepared a scale for pivotal thinking skills, which includes 105 items including eight main skills and 21 fifth scale secondary skills. After verifying the scale psychometric features, the experiment was applied to the two groups during the second course of the academic year (2017- 2018) and the results were analysed. The results show that there are significant differences in favour of the experimental group that adopted the pivotal thinking skills. In light of the results, the researcher puts forward some conclusions, recommendations, and suggestions.

Key words: *Educational programme, Active learning, Strategies of active learning, Pivotal thinking, Skills of pivotal thinking, and Physics of fifthth year applied branch.*

The Study Problem

The ability to think is an important educational goal that is included with all other educational goals. Scientists, thinkers, and philosophers have directed their attention to the different types of thinking. They have studied the nature of thinking, patterns and manifestations and how to develop thinking abilities for learners of different levels. Due to the researcher's experience, he observes that methods of teaching in most schools are unable to activate students' thinking to the level of pivotal thinking skills. This motivated the researcher to create a closed-type questionnaire for the teachers of physics and their students. The questionnaire includes the



following: 1. Is there any information about skills of pivotal thinking? 2. Do you have information about educational programmes? The teachers' answers for question one revealed that 85% replied in the negative. With regard to the students, 95% responded in the negative.

With regard to question 2, 75% of teachers responded in the negative and 85% of students responded in the negative. So, the problem is manifested by asking the following question: What is the impact of constructing an educational programme based on active learning strategies and its impact on pivotal thinking skills for the fifth year students of the applied branch in Physics?

The Importance of the Study

1. The importance of physics as one of the natural sciences that is related to students' lives, society and other sciences.
2. The importance of the fifth stage, since it prepares the students for sixth stage, which decides the student's future.
3. Attempts to use active learning strategies, which are modern strategies in the educational field that could develop pivotal thinking skills (Johnson & Johnson, 2008).
4. Demonstrates the knowledge of the researcher that there are certain educational programmes which are able to find a connection with physics topics, situations, and life applications happening in the student's environment.
5. The importance of pivotal thinking skills as being a tool of active thinking, which needs to be activated and taught to students (Peters, 2007).

The Study Goal

1. To build up an educational programme based on active learning strategies.
2. To detect the impact of the programme on developing pivotal thinking skills for fifth year students of an applied branch in physics.

The Study Hypothesis

To achieve the second goal of the study, the following hypothesis is formulated: There are no statistically significant differences at the level (0.05) among the means of differences of (pre and post) measures for the students of the experimental group and the control group on the scale of pivotal thinking skills.

The Study Limits

- ❖ Human limit: fifth preparatory stage students of applied branch.

- ❖ Spatial limit: morning preparatory schools that belong to the Al-Diwaniyah directorate of education.
- ❖ Time limit: the second course of the academic year (2017- 2018).
- ❖ Academic limit: the Physics textbook of the fifth preparatory stage of the applied branch (chapters, 7,8,9, and 10).

Definition of Terms

The Educational Programme is Defined By:

- ❖ (Al-khattat, Habeeb, & Mohammed, 2019) as “ the strategies used by the teacher in an education al situation to achieve high educational outcomes depending on the hypotheses of the programme in which the teacher’s and learner’s roles and the method are identified”.
- ❖ (Sternberg & Grigorenko, 1997) as an organised scheme of a group of topics, activities, and events that aim to acquire knowledge and develop skills in a specific period of time.

Defining the educational programme procedurally: “a group of steps and organised educational procedures based on active learning strategies that aim to develop pivotal thinking skills for the fifth stage students, scientific branch (the study sample) in physics”.

Active Learning is Defined by:

- ❖ (Johnson & Johnson, 2008) as “ a group of procedures and practices the teachers follow in the classroom in light of the goals set by the teachers, which include a group of means, activities, and methods that help to accomplish the goals”.

Definition of Active Learning Procedurally

“A group of practices and procedures the researcher performs to teach physics for the fifth scientific stage through preparing an appropriate class environment and engaging students in the learning process through educational activities that are prepared by the researcher for this purpose, and urging them to practice high thinking skills, which develop pivotal thinking skills”.

- ❖ Pivotal Thinking Skills:
- ❖ It is defined by (Marzano, et al., 1988) as “ a group of mental processes, which we call intelligence processes that handles the content of various processes, which are manifested through eight dimensions of secondary mental processes of twenty one skills”.

It is defined procedurally as: a group of eight main mental skills that include 21 secondary skills as shown below that can be calculated through the mark the student gets (the study sample) when they answer on the scale of pivotal skills of thinking in physics, which is prepared for this purpose (Sternberg, 1999).

- ❖ Pivotal skills of thinking: they are divided into eight main skills and 21 secondary skills including:

First: Concentration skill: it helps to gather the small pieces of available information then he/she works on prioritising some of them, and includes:

1. Defining problems skill (it works on clarifying confused or questionable situations by the learner).
2. Identifying goal skill: it aims to define the educational products that are expected to be achieved by the learner after experiencing the situation and scientific confused situation). (Marangudakis, 2006).

Second: Information gathering skill:

1. Observation skill (it means that the individual obtains information from the environment through employing one or more of his/her senses. It is considered his/her outlet to the outside world).
2. Skill of setting questions: includes clarifying issues and meanings through investigation and questions.

Third: Remembering skill (a group of activities that learners make to keep some information in their long term memory). This skill includes:

1. Encoding skill: (it is the link between small pieces of information to maintain in the long term memory).
2. Retrieval skill: (an organised process of saving information to retrieve it easily).

Fourth: Organisational Skills

1. Comparison skill: (it means identifying the similarities and differences of the content of information).
2. Classification skill: (it means gathering items and information according to common features, and categorising them into groups based on their characteristics).
3. Order: It means sorting things out in certain contexts.
4. Representation: It helps changing received information from the outer environment through certain relations among the different elements.

Fifth: Analysis Skills:

1. Identify traits and components.
2. Identify patterns and relations.
3. Define main ideas.
4. Specify mistakes (Davies, 2013).

Sixth: Generation skills: The ability to generate new ideas that did not previously exist, or it is the individual's ability to transfer the available information to reach new solutions. It includes:

1. Inference: It is one of the basic scientific methods to develop sciences over time and it aims to recognise the characteristics of unknown things through studying the characteristics of something known.
2. Prediction: Prediction is based on accurate observation and measurements, which leads us to reliable data. The student is usually trained to predict through using graphs.
3. Expansion: The learner's ability to provide more details, explanations, and information related to previous knowledge, with the aim of improving the learner's understanding process.

Seventh: Integration Skills With Two Secondary Skills:

1. Summarisation: It is the learner's ability to extract basic elements in a text through creating a set of coherent phrases that lead to a clear sense in the learner's mind.
2. Reconstructing: It is the ability to reconstruct information in a new form within an individual's cognitive structures (Bernardo, Zhang, & Callueng, 2002).

Eighth: Evaluation skills:

1. Standards building: The ability to build a mental or sensory representation of an idea or event. This skill may be used to describe the overlapping relationships of ideas and events.
2. Verification: The verification skill is defined as confirming the accuracy of the claims made on a case, and it is considered one of the highest scientific processes, which includes most of the scientific processes such as the collection of information by observation and measuring tools, hypotheses, controls, and discriminate variables then experimentation (Prince, 2004).

Seventh: Research procedures: this chapter includes the most important procedures of the study, which are appropriate for the study hypothesis and goals. They are:

First: Construction of the educational programme.

Second: Experimentation of the educational programme.

The following is the details of these procedures:

First: Construction of the educational programme: To achieve the first goal of the study, the researcher has reviewed the literature of constructing programmes and previous studies, noticing that the adopted basics consist of three stages:

❖ **The first stage: Planning, consisting of:**

1. Analysis step: The analysis step represents the basis to build educational programs, in which the main paths and basic needs are identified. It encompasses:
 - 1.1 Analysis of educational reality: the researcher depends on field analysis through verification with respect to teachers' skills. He finds that there is no adequate attention paid to planning for teaching or during teaching physics (Danish, Hauer, & D'Augelli, 1980).
 - 1.2 Identify students' characteristics: the researcher identifies these characteristics during his interview with the study sample and their records (Al-Khattat et al., 2019).
 - 1.3 Students' views for their educational needs: To verify this step, a questionnaire is prepared for this purpose and includes 15 items, which tackles the most difficult aspects of learning physics. It is verified by presenting them to several arbitrators and specialised scholars, who unanimously agree on these items. The questionnaire consisted of four fields, each one has 15 items, as per Table 1, which are applied on the survey sample of 50 students of the sixth stage (applied branch) because they studied physics last year.

Table 1: Questionnaire Fields

No.	Field	items	No.	Field	items
1	Methods of teaching field	(1-5)	3	Educational aids field	(12-13)
2	Field of the scientific content	(6-11)	4	Methods of evaluation field	(14-15)

The researcher considers these difficulties as needs for the sample, so they should be included in the educational programme:

1. Employing diverse and interesting methods of teaching.
2. Organising the educational content to fit the students' levels.
3. Formulating graded questions of difficulty.

4. Employing laboratories, systems, and educational aids to teach physics.

1.4 Identify the educational needs from the teachers' point of view:

A sample is presented to the teachers of physics of 15 teachers distributed to ten secondary and preparatory schools. They were presented to a group of experts and arbitrators, who agreed on them. Then, the answers were analysed and used to identify the most important educational needs that related to students' study of physics to be observed in the prepared program as the following:

1. Observe the differences of students' levels.
2. Provide educational activities to stimulate students' thinking and enable them to learn skills.
3. Use diverse methods of teaching (Muslim, Tahir, Rudiq & Jawad, 2019).
4. The need to develop achievement tests that measure different mental abilities.
5. Encourage students to participate in scientific discussions and their interactions in the lesson (Alzamili & Mohammed, 2019).

2. Designing Step: The final drafting of the programme elements can be achieved through the following steps:

2.1 Introducing the Goals of the Educational Programme

After studying the general goals of teaching physics to the fifth grade, applied branch students, the programme educational goals were formulated and presented to a number of arbitrators to express their opinions regarding representing the programme. According to their observations and suggestions, some goals were modified and reformulated to reach the final version (Laverde, Cifuentes, & Rodriguez, 2007).

2.2 Identify and organise the educational materials: The educational material was identified as a physics textbook for the fifth stage, applied branch, the second course, which includes four chapters according to the plan of the Ministry of Education, as shown in Table 2 below:

Table 2: Educational Material for Fifth Year Physics/ Applied Branch

Chapter	Chapter title	Pages	Chapter	Chapter title	Pages
7 th	Circular and rotational motion	(131-157)	9 th	Electric current	(195- 228)
8 th	Seismic, wave and sound movement	(158- 194)	10 th	magnetic	(229- 248)

The class is taught by five lessons per week, and the content is organised from easy to difficult in accordance with the students' abilities and their mental levels. Moreover, it includes physical knowledge, experience, activities, educational aids and teaching methods that can develop the pivotal skills of thinking; the main ones and the secondary ones.

2.3 Formulation of behavioural purposes: A number of observable and measurable behavioural purposes are formulated concerning 156 behavioural purposes, including the following levels: (remembering, comprehension, application, analysis, synthesis, and calendar) (Adams, 2015). They are presented to a number of experts and arbitrators to reflect their views regarding the items and their relevance to the study material. Some items are modified according to the arbitrators advice and opinions (Mohammed, 2017).

2.4 Preparation of Programme Requirement: it means the availability of procedures and organisation that facilitate the implementation of the programme and contribute to achieve the programme goals according to the following:

- Preparing the teacher's guide of the programme: through using the literature and theoretical background that includes (goals of the programme guide, thinking, thinking patterns, levels of thinking, pivotal thinking, pivotal thinking skills, stages of learning pivotal thinking skills).
- Preparing the educational environment (physical and psychological) can be done by choosing the shape and size of the classroom and the order of the students' seating and the arrangement of the equipment and educational aids and the arrangement of the laboratory. In addition, a positive psychological atmosphere can affect the learning of students and the relations of cooperative work among them in terms of establishing a positive place or laboratory in respect to light, colour, heat and presentation methods, which provides a sense of safety for students and teacher (Crawford, 2004).
- Preparing educational activities: The activities that are related to how to learn pivotal thinking skills are prepared so as to be appropriate to the programme goals in the following manner:
 1. Individual or collective activities are achieved through preparation of work in small groups of students that follow different learning methods in addition to feedback, conversations and discussions among the students after applying each skill.
 2. Using collective and individual experiences to explore physical information.
 3. The researcher asked students several questions and each student had to answer in written form and then circulate the answers among the students for correction and give the correct answer.

Moreover, there are extracurricular activities practiced by students that relate to appropriate teaching methods selection, such as preparing school bulletins and writing lessons in addition to employing other tools and devices from daily life to implement these experiments.

- Selection of educational aids:
 1. Choosing coloured markers to clarify the scientific posters.
 2. Using data to display diagrams and graphs.
 3. Using pictures to present topics.
- Choosing appropriate teaching strategies: A number of strategies for active learning have been selected in accordance with students' abilities, content, and learning the pivotal thinking skills as shown in the Table 3 below:

Table 3. Strategies Related to the Active Learning and Pivotal Thinking Skills

Chapter	Content	Main Skill	Secondary Skill	Strategy
7 th	Circular & rotational movement	Concentration, info, collection, remembering	Problems definition, defining goals, observation, drafting questions, encoding and recalling	Info. Gap, reciprocal teaching
8 th	Vibratory and wave motion and sound	Organisation and analysis	Comparison, classification, order, representation, identify traits and contents, identify patterns and relations, identify main ideas, and identify mistakes	Reciprocal questions and thinking strength
9 th	Electrical current	Generation and integration	Inference, prediction, expansion summarisation and reconstruction	Academic debates
10 th	magnetic	evaluation	Standards building and verification	Reciprocal teaching and info. gap

Strategies have been presented together with the study material to several experts and arbitrators to evaluate the programme.

- Writing study plans: there are 45 plans of teaching that will be used during the experiment.
- Test construction: the following tests are prepared:

- Pre - evaluation: the researcher prepares a test of previous physical information, where he applies it to the two groups before the beginning of the experiment.
- Constructive evaluation: The researcher prepares oral and written tests at the end of each course to ensure the students' comprehension.
- Final evaluation (concluding): A scale of pivotal thinking skills is prepared to apply after the completion of teaching (Scheerens, Glas, Thomas, & Thomas, 2003).

❖ **Second phase: Implementation, including:**

1. Implementation of school plans: the school plans are implemented for each topic according to previously identified strategies as shown in Table 3.
2. Educational activities: different activities are used to relate topics according to the situations, events, and biological applications that existed in the student's environment.
3. Implement education: the researcher prepares the required tools, and brings some other tools from the outside environment to the school. This step is done through:
 - Asking students of the experimental group the question related to the lesson.
 - Inviting students to the lesson and connect the lesson to tangible concepts.
 - Ask students to make appropriate activities and write down the results.
 - Free and organised discussion with appropriate interpretations and appropriate reinforcement.
 - Ask students to find suitable interpretations of new situations and scientific attitudes and applications derived from the environment to ensure the transmission of the learning effect.

❖ **Third phase: Evaluation: Three types of evaluations are adopted:**

- Program preliminary evaluation: It represents a set of procedures and approaches that the researcher prepared before implementing the program through presenting the programme to experts in physics and teaching methods. The arbitrators have agreed on its validity after modifying some items.
- Programme constructive evaluation (experimental and exploratory): The initial version of the educational program is applied to a sample of 26 students. The researcher himself taught the programme to ensure the validity and time required to teach the subject in addition to the suitability of the activities.
- The final evaluation of the programme is the scope of achieving the programme goals that are represented by the scale of the pivotal thinking skills in physics (Brown, 2002).

Second: Programme experimentation including:

1. Experimental design: the design of partial control is adopted for two equivalent groups of pre-test and post-test that measures pivotal thinking skills of students as shown in the Table 4 below:

Table 4. Experimental Design

Group	Equivalence	Independent variable	Dependent variable	(pre and post) Measurement
Experimental	<ul style="list-style-type: none"> - Age - Intelligence test - Study achievement 	Educational programme based on active learning	Pivotal thinking skills	Scale of pivotal thinking skills
Control	<ul style="list-style-type: none"> - Test of previous physical info. - Scale of pivotal thinking skills 	Regular method		

2. Identify the study population and the sample: it includes all the students of fifth year (applied branch) in the morning preparatory government schools of the directorate of Education in Al-Diwaniyah for the academic year (2018-2017).
3. Selection of the study sample: Al-Diwaniyah preparatory school for boys is selected in a random method. The sample consists of three sections for the fifth year (applied branch); section (B) is chosen to be the experimental group and section (C) is chosen to be the control group (Table 5):

Table 5: Study Sample

School	Section	Group	Number of Students		
			Before elimination	Failed	After elimination
Al-Diwaniyah preparatory school	B	experimental	30	2	28
	C	control	31	3	28

4. Identify equivalence procedures

Equivalence procedures have been verified in some variables as: age in months, intelligence, previous achievement of the first course, test of previous information, and scale of pivotal thinking skills that the researcher prepared in addition to the results that refer to the equivalence of the two groups (Goba, Balfour, & Nkambule, 2011) as shown in Table 6:

Table 6: Equivalence Results

Variable	Group	No.	Mean	Standard deviation	Freedom degree	T-test		Significance
						calculated	tabular	
Age	experimental	28	203	6,14	54	0.29	2.02	insignificant
	control	28	202,5	6,4				
intelligence	experimental	28	33,89	8,84		0.73		
	control	28	35,68	9,44				
previous physical information	experimental	28	13,04	2,61		1.001		
	control	28						
previous achievement of the first course	experimental	28	12,32	2,72		0.35		
	control	28						
scale of pivotal thinking skills	experimental	28	68,86	16,27	1.03			
	control	28	67,11	13,16				
			385,68	94,85				
			359,57	94,92				

Preparing the study tool: The scale of pivotal thinking skills is built according to the following steps:

1. Determining the scale goal, which is to measure the pivotal thinking skills of the fifth year students of (applied branch).
2. Revising the scales, where the researcher studied a number of scales.
3. Defining the concept of pivotal thinking depending on the definition of (Quine, 1999).
4. Identifying the scope of the scale depending on the definition, which are eight main skills and 21 sub-skills.
5. The relative importance of pivotal thinking skills, where the experts have unanimously agreed that they have the same importance.
6. Drafting the scale items in its initial version of 147 items that represent 21 sub - skills, and prepare the alternative answers in addition to scoring method.
7. Scale validity can be confirmed through two ways:

A- Face validity: the scale in its initial version of 147 items for the specialists and arbitrators, and 42 items are deleted. Therefore, the scale includes 105 items (Holden, 2010).

B- Construct validity: this type of validity is the most accepted one (Clark & Watson, 1995). After applying the scale on the study sample of 100 students, some indicators that refer to it are described as the following:

- Items Discrimination coefficient: Depending on the T - test of two independent samples to examine the differences between the means of the scores of maximum and minimum

groups for each item. When comparing the two groups, it shows that the calculated value of (t) is higher than the value of tabular (t) by (2.01) . It means that there are differences among the maximum and minimum scores of the students of the two groups (Masters, 1988). Based on this result, all items are distinct as shown in Appendix 1.

- The relation of the item score with the total score of the field. The correlation coefficient is about (0.33 - 0.57) as shown in Appendix 2 that is greater than the tabular value (0.19).
 - The relation of the item score with the total scale score that belongs to it. The correlation coefficient is about (0.38 - 0.67) at the level (0.05) and freedom degree (98) as shown in Appendix 3.
 - The relation of the field score to the total scale score after applying Pearson's correlation coefficient to measure the values of the correlation coefficients between the field score and the total score of the scale. It is shown that the values of the correlation coefficient is about (0.72-0.88) and all are statistically significant as revealed in Appendix 4. The researcher uses Alpha Cronbach to measure the reliability coefficient of the scale, which is (0.84). So, the scale is ready to be applied in its final version to the two research groups that include 105 items distributed on sub-skills, where each sub-skill has five items as seen in Appendix 5.
5. Procedures of Experiment Application: The actual implementation of the experiment in teaching is based on the prepared educational programme on Monday (26/2/2018), which continued to Thursday (26/4/2018).
 6. Applying Research Tool: The researcher applied the scale on Thursday (3/5/ 2018), and answers are corrected based on the model answers, then results are entered into Excel to calculate, analyse, and interpret them statistically using SPSS²³.

Review and Results Interpretation

1. Results interpretation: The paper has two purposes:
 - The first goal is verified after several procedures during construction of the programme, which is mentioned earlier in the theoretical aspects and the steps of constructing the educational programme.
 - The second goal: To verify the study null hypothesis, (T. test) is used for two independent samples as shown in Table 7:

Table 7: The Two Groups on the Scale of Pivotal Thinking Skills (pre and post)

Variable	Group	No.	Mean of differences	Freedom degree	T-test		Significance at (0.05)
					calculated	tabular	
Pivotal thinking skills scale	experimental	2828	94,43	54	4.896	2.02	significant
	control		28,18				

2. Results Explanation: The study results revealed the superiority of the students of the experimental group who are taught according to the prepared educational program on the control group in the field of developing pivotal thinking skills. The differences between the scores mean of the two groups are significant and in favour of the experimental group. The researcher attributed this result to the following reasons:
 1. The strategies followed in teaching are appropriate to the students' abilities and the content of the educational material that depended on active learning, where it included organised and sequential teaching stages that are applicable within the class.
 2. The programme gave the chance to employ not only basic mental processes such as observation and recall ...etc., but higher mental skills (compound) as inference, evaluation, imagination, flexibility...etc., that have been learned by employing them in daily teaching plans, which in turn has helped to develop the pivotal thinking skills.
 3. Teaching methods followed in schools depended on the student's memorisation of the subject rather than thinking deeply. The student in schools maintains the level of knowledge (automated memorisation), which leads the student to lose his/ her interest in the abilities and skills that are associated with other knowledge levels as application, analysis, synthesis and evaluation.
 4. There is a clear harmony between thinking pivotal skills and the characteristics related to active learning since both focus on higher thinking levels.
 5. This dominance can be attributed to the connection between the theoretical and practical aspects of the program. Without active learning represented in methods, activities, thinking maps, and teaching plans that are used to clarify this, students are unable to master pivotal thinking skills.
 6. Communication, dialogue, and discussions that are provided by the program within the classroom, through the strategies followed in teaching and presentations and methods, which increased the chances to develop the pivotal thinking skills of the experimental group students.

Conclusions

The researcher has reached the following conclusions:

1. The necessity to adopt active learning to construct educational programmes since it develops thinking skills.
2. This programme has a positive impact on developing pivotal thinking skills in physics for fifth year/ applied branch.



Recommendations

1. Focus on the educational programmes since they include stages related to the students' needs.
2. Depend on the active learning in teaching physics in the preparatory stage because it achieves good results and it is an essential tool of active thinking that increases the students' independence.
3. The inclusion of physics curriculum with pivotal thinking skills and developing them through engaging students in thinking - stimulated thinking.
4. Publish a guide on how to teach these skills for all educational institutions.

Suggestions

1. Conduct other studies to experiment with prepared educational programmes on other variables like achievement, scientific debate... etc.
2. Conduct other studies to teach other subjects like mathematics, chemistry and biology using the prepared programme.
3. Develop other studies to experiment with the educational programme at other stages like intermediate and university stages.

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