The Effectiveness of a Suggested Program Based on Van Hiele Theory on Developing Solving Physics Problems Skills of Third Year Secondary School Students, Scientific Section

An M.A. Proposal

By

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Abstract

Physics is a vital subject as it includes modern concepts, inventions and growing theories. It seeks to achieve multiple and diverse goals. This makes it a reason behind the development of the societies. Physics, with its content, its methods of treatment and its objective and empirical teaching, is considered a fertile ground for the acquisition and the development of the different thinking skills. Physics is not found without thinking and no thinking without problems.

In the light of this development, education has an important responsibility after the educational process has become one of its urgent necessities. It is necessary to take into consideration the contemporary means and teaching methods to meet the purpose of these requirements and to keep the pace with the continuous scientific and technical progress. They are able to adapt successfully to the rapid changes that are imposed on the society. They are also able to develop the learners’ skills, enhance their motivation, probe their energies and enrich their ideas. Education also aims at establishing a parallel, an integrated and comprehensive preparation in all the spiritual, mental, physical and social aspects so as not to have a side overshadows on another. This is also to have beneficial members for themselves and for their community and who are happy in their lives.

Researchers called for the need to change the curriculum as it became not able to keep the pace with this development and its requirements. In spite of the importance of physics and the role that could be played by it, the reality of

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physics curriculum and its traditional teaching methods can not achieve the bright targets adopted by the educational institutions. As the traditional method is criticized strongly in the curriculum construction.

One of the learning theories that have adopted the geometric thinking levels is Van Hiele theory that is developed by Pierre Marie Van Hiele, who is a Dutch math teacher, and his wife Diana Van Hiele Geldof after numerous experiments in the secondary schools in Netherlands. The researcher has distributed the students according to their knowledge of the geometric engineering, into five levels. This distribution came to be a solution to the difficulties experienced by the students when the continuous attempts of the continuous explanation fail. (Howse, Tashana D.; Howse, Mark E., 2014, 305 – 313).

Van Hiele theory is based on the idea that learning is a process that is not connected, but there are leaps in the learning curve. This means that there are separate and different thinking levels. Hence, Van Hiele and his wife saw that there is a need for a scalable levels of the geometric thinking characteristics( Fuys, et al, 1988).

These levels are numbered by Van Hiele from 0 – 4 (Usiskin, 1982) as follows:

Level (0): Identifying the shape or the optical aspects. In this level, the students judges the geometric shape from its general appearance. He/she distinguishes it as a whole. He/she doesn’t know anything about the characteristics. When applying this to the physics problems, the students can identify the parameters.

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of the problem and recognize electric circuit of the physics problem without addressing the relationships involved in it.

Level (1) : The analytical or the descriptive level. In this level, the student analyses the geometric shape in terms of its components and the relationship between these components. Also, he/she analyses the data issued to discover the relationship between them.

Level (2) : The ordinal or the relational or the informal deduction level. In this level, the student arranges the shapes and the relations logically. He/she also uses a simple deduction. Also, he/she can categorize the shapes hierarchically by analyzing its characteristics and doing informal discussions. When applying this to the physics problems, the students can identify the laws that connect these relationships.

Level (3) : The formal deduction level in which the student accommodates the importance of the deduction. In this level, the student builds theories in the assumptions system. He/she distinguishes between the unknown elements, definitions and the assumptions. In the physics problems, the student chooses the appropriate law for solving the physics problems.

Level (4) : The abstraction or the meta-mathematical or the axiomatic level. In this level, the student can make an abstract conclusion which enables him to understand. In this level, the student identifies the

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mathematical system in a formal way more than the characteristics that are known before by him/her. He/she can analyze the conclusions from the assumptions and the definitions. He/she also can learn through the introduction of new axioms depending on the geometric system. In the physics problems, the student transfers the symbols found in the law into the numbers that are found in the problem: converting it into the mathematical form.

Thus, Van Hiele theory with its levels can be applied in designing a suggested program to overcome the difficulties of solving the physics problems. That’s because of the great similarity between the geometric problems, and their different ideas, and the physics problems; the study topic. Physics problems contain shapes, circles, graphs, laws and theories that are similar to the geometric problems to a great extent. This is due to the large and the integrated connection between physics and mathematics in particular.

The problem of the study:

Due to the low level of the students in physics and the lack of solving the physics problems in particular, the researcher tries to use the suggested program based on Van Hiele theory in developing the following:

- Third year secondary stage students’ achievement (scientific section) in the cognitive side for the topics of "Electromagnetic and Electric Current" unit.
- Third year secondary stage students’ acquisition (scientific section) of the physics problems solving skills mentioned in the topics of the unit.

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The main question can be displayed as follows:

What is the effect of a suggested program based on Van Hiele theory on physics problems solving skills for secondary stage students in the "Electromagnetic and Electric Current" unit?

The main question can be divided into the following sub-questions:

1- What are the physics problems solving skills required for the secondary year stage students?

2- What is the format of the suggested program according to Van Hiele theory on physics problems solving skills of the “Electromagnetic and Electric Current” unit for third year secondary stage students (scientific section)?

3- What is the effect of applying the suggested program based on Van Hiele theory on developing the physics problems solving skills in the “Electromagnetic and Electric Current” unit?

The importance of the study:

The current study is important for:

1- Directing the teachers to use the modern and effective methods in teaching the “Electromagnetic and Electric Current” unit.

2- Defining Van Hiele levels or the necessary steps for the transition from one thinking skill to another for the teachers.

3- Benefiting the researchers for conducting similar researches in other subjects that require thinking.

4- Benefiting physics curriculum designers in re-arranging the content of the "Electromagnetic and Electric Current" unit in

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physics according to Van Hiele theory. The problem solving skills of the "Electromagnetic and Electric Current" unit.

**The study aims:**

The current study aims at identifying the effect of using a suggested program based on Van Hiele theory on developing the physics problems solving skills in the "Electromagnetic and Electric Current" unit for third year secondary stage students (scientific section).

**Limitations of the study:**

The current study is limited to the following:

1- 1-A sample of third year secondary stage students, scientific section enrolled in the Secondary School for Girls in Fayoum in the first semester 2014/2015 A.D.

2- "Electromagnetic and Electric Current" unit in physics for the general third year secondary stage which includes:
   a- Chapter one : electric current and Ohm's law (three lessons).
   b- Chapter two : the magnetic effect of the electric current (four lessons).
   c- Chapter three : electrical measuring devices (three lessons).
   d- The scientific concepts mentioned in the "Electromagnetic and Electric Current" unit.
   e- Physics problems solving skills mentioned in the unit.

This unit has been chosen for its importance and for including a large amount of problems, concepts, skills. Also, it requires thinking in the requires skills for answering the problems of the "Electromagnetic and Electric Current" unit.

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Materials and Tools of the Study:

The researcher has designed the following material and tools for the study:

1- The educational materials:
   a- The suggested program for teaching the "Electromagnetic and Electric Current" unit in physics for third year secondary stage, scientific section. It includes the student's book.
   b- The student's book is prepared by the researcher.
   c- Teacher's guide is prepared by the researcher.

2- The measurement tool:
   - Physics problems solving skills test for the "Electromagnetic and Electric Current" unit.

The Study Method:

1- The researcher used the descriptive approach in the theoretical framework to describe, diagnose, deal with the various aspects and collect the necessary data with an analysis of the phenomena under study. This is to determine the skills that should be developed the skills in the construction of the study tools.

2- The study used the quasi-experimental design to test its hypotheses.

The study procedures:

1- To answer the first question which is "What are the physics problem solving skills in the "Electromagnetic and Electric Current" unit required for the secondary stage students?" through:

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Preparing a list of these skills and displaying this preliminary list to a group of jury members to define the suitable skills for the third year secondary stage students to solve the physics problems.

2- To answer the second question which is "What is the suggested program format to teach "Electromagnetic and Electric Current " unit in the curriculum of the third year secondary stage students , scientific section, according to Van Hiele theory on the achievement and development of solving skills of the unit problems ?" through :

- Determining the aims of the problems .
- Organising the content based on Van Hiele theory .
- Determining teaching strategies .
- Determining teaching activities.
- Determining evaluation questions.
- Preparing program Scenario and how to process it.
- Writing the instructions of using the program.
- Preparing the final form of the program and displaying it to the jury members.

3- To answer the third question which is" What is the effect of using the suggested program based on Van Hiele theory on developing the skills of solving the physics problems?", the researcher did the following:

1- Preparing the physics problems solving skills test for third year general secondary stage , scientific section in the "Electromagnetic and Electric Current " unit. Then, it is presented to a group of jury members and modified in the light of their opinions. It is also adjusted scientifically .

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2- A pre-test is carried out on the study sample.
3- A post-skills test is applied.
4- A statistical processing is made as before to answer the fourth question.

**The study hypothesis:**
The current study tries to test the following hypotheses:
- There are no statistically significant differences between the mean scores of the students "the study sample" in the pre-post skills test of the problems in the "Electromagnetic and Electric Current" unit.

**Results of the study:**

There are no statistically significant differences between the students mean scores in the pre-post application of the problem solving skills test.

Table (8) shows the mean scores of the pre-post application of the skills test, the standard deviation of both ones and the T-test value.

Table (8): the mean scores of the pre-post application of the skills test.

<table>
<thead>
<tr>
<th>Application</th>
<th>Average</th>
<th>Standard deviation</th>
<th>Participants' number</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-</td>
<td>38.87</td>
<td>6.642</td>
<td>30</td>
<td>33.422</td>
</tr>
<tr>
<td>Post-</td>
<td>87.67</td>
<td>2.682</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

It is shown from the previous table:

T-value = 33.422 is more than its value in the table with the free degree (29) and with statistical significance (0.05) which equals (2.045). Thus, it is statistically significant and the null

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hypothesis is rejected and the alternative hypothesis which shows that there are statistically significant differences between the mean scores of the pre-post application of the physics solving problems.

The calculation of Eta square = 0.9747 and this size effect is so high. This shows that the effect of the program on developing the physics solving skills was high.

**The study recommendations:**

Based on the results of the study, the researcher recommends the following:

1- Training the physics teachers in the secondary schools on Van Hiele theory levels. That is to help their students to facilitate physics problems solving. This helps in the reduction of their complaints in this regard.

2- Formulating the answers for the physics problems in the school books according to Van Hiele theory levels and what corresponds it in solving the physics problems by determining the data of the problem and what is required by the student. Then, the student writes the law for answering the problem according to the data and according to what is required. Then, he/she starts answering the problem and ends by making sure of the validity of the solution.

3- Coordinating between the curriculum size and the number of the physics classes by the designers of the curriculum. This is to enable the student to follow the previous levels in solving the problems or increasing the number of the

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physics classes in the school timetable to achieve the same purpose.

4- Training the secondary stage physics teachers continuously, sustainably and effectively to achieve the desired goals of teaching physics for the secondary stage.

5- Paying attention to the school book regarding its scientific content and format to be relied upon by the students and not to have many sources to be followed by the students outside the school. That is to have a convincing and a sufficient school book, unique in its explanation, its presentation method and its materials for the students.

The study suggestions:
The researcher suggests carrying out the following research studies:

1- The effectiveness of using Van Hiele theory levels on developing Chemistry problems solving skills in the secondary stage.

2- The effectiveness of a program based on brain theory on developing physics problems solving skills.

3- The integration between the mathematics and the physics curricula and its effectiveness on developing the physics problems solving skills.

4- Teaching the physics curriculum for the first and second secondary stages as a complementary subject over the year instead of teaching it in one semester either the first or the second of the year. As this does not provide an opportunity for the students to benefit from the inappropriate time for understanding and applying the subject.

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5- Training the teachers on the new teaching methods as it links physics with the actual reality.
6- Re-using the practical notebook for each student starting from the secondary stage (first, second and the third years) until the student masters the practical side and practices how to illustrate the lesson graphically.

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