Influence of Learning Styles on Conceptual Learning of Physics

Teresita Marín-Suárez and Hugo Alarcón

Several studies have reported the influence of scientific reasoning on the conceptual learning of students in courses developed with methodologies that promote active learning. Given that learning styles may also influence conceptual learning of physics, it has been conducted a correlational study which uses two different approaches of Learning Styles, the Honey-Alonso [1] and Felder-Silverman [1] models. This qualitative study was performed in groups using the methodology of modeling [3,4] in a course of introductory mechanics in college. To assess the conceptual learning, the Force and Motion Conceptual Evaluation (FMCE) test was used. The results confirm the strong dependence of learning styles on conceptual learning of Physics.

Abstract

The student learning can occur in many ways: watching and listening, thinking and acting, reasoning logically and intuitively, memorizing and visualizing, and drawing analogies or creating mathematical models. On the other hand, teaching methods also vary depending on the preferences of the instructor. Some of them teach by lecturing; some make experimental demonstrations or promote the discussion among students; others focus on problem-solving. Each one of these methods assesses the compatibility of their style with the instructor's teaching style governing their learning in the classroom [2]. There are also inconsistencies between standard models of the learning styles and traditional teaching styles of their professors.

Introduction

As Alonso has studied the dependence of scientific reasoning on the conceptual learning in courses taught with modeling instruction [8], it could be interesting to consider the Theory of Learning Styles in order to complement the understanding of the learning process for concepts in Physics. Hence the key problem in this study is to identify precisely the degree of influence that may have the learning style of students on their learning of Physics.

Theoretical Framework

LEARNING STYLES

Among the available models of Learning Styles (LS) those proposed by Felder and Silverman [2] and one from Alonso, Gallego and Honey [1] have been chosen.

Honey-Alonso Model

Honey and Mumford designed an 80-questions based test that provided a broad overview of learning styles [1]. The styles they discovered in their questionnaire are in terms of four phases of a cyclical process of learning.

- Active: People welcome new challenges. They consider and face challenges with determination, open mind, without skepticism.
- Reflective: They are observers, information gatherers, and meticulous facts analysts for decision-making.
- Theoretical: Looking for logic in every situation, they try to explain everything with logic and complex theories. They present a logically structured thinking and tend to be perfectionists.
- Pragmatic: Interested in the practical application of ideas, they act immediately in situations which are of interest. Fast and practical decision-making, realistic and a little impatient.

Felder-Silverman Model

The model that Felder and Silverman [2] propose classifies students using a scale to rank preferences of receiving information and processing information.

- Sensing-Intuitive: Selective learners like facts, data, and experimentation. They solve problems through standard methods and do not like "surprises". Intuitive prefers principles, theories and innovation before repetition.
- Active-Reflective: Active learners feel more comfortable with active experimentation instead reflective observation like reflective learners. Active will not learn much in situations that require silence and reflection and reflective do not learn well if they are denied the opportunity to think about the information presented to them.
- Sequential-Global: students learn material either sequentially understanding the material as soon as they get it or globally understanding the material in a few weeks unable to solve simple problems or show a rudimentary understanding until they finally "get it".

Modeling Instruction and Scientific Reasoning

Modeling Instruction is a methodology for teaching physics based in the modeling theory given by Hestenes [3,4]. The methodology is characterized by the combination of systematic discussion on the modeling process and the techniques required to solve problems. The selection of proper problems to work in teams is an important part of the methodology. It has been reported recently the results about the first implementation of the Force and Motion Conceptual Evaluation (FMCE) of the Learning Styles in some courses at Tecnológico de Monterrey, which showed a strong positive correlation between the scientific reasoning and the conceptual learning of students.

Methodology and Experiment Design

The CHAEA test [5] consists of in four measurements from 0 to 20 indicating the preference for each dimension. The learning style profile is shown in a regular polygon with four axes that represent the dimensions of the model. This graph is constructed by projecting the scores in the axes of the 2D model, thus the sum represents the axis point where the polygon vertex is located. Once mapped the 4 points the polygon, which is the learning style profile, may be built.

The Force and Motion Conceptual Evaluation test (FMCE) is one of the most popular surveys to assess the knowledge state of the students [10]. For this study, the FMCE was applied as a pre- and post-test. The pre-test was taken at the beginning of the semester while the post-test was taken near the end. To assess the conceptual learning it has been considered the difference between the post and pre tests.

To compute the degree of explanation given by these learning styles we used a multiple regression analysis with variables Delta FMCE, Visual-Verbal, Active-Reflective, which were significant in bivariate correlation analysis.

Contextual Framework

The CHAEA test [5] results consist of in four measurements from 0 to 20 indicating the preference for each dimension. The learning style profile is shown in a regular polygon with four axes that represent the dimensions of the model. This graph is constructed by projecting the scores in the axes of the 2D model, thus the sum represents the axis point where the polygon vertex is located. Once mapped the 4 points the polygon, which is the learning style profile, may be built.

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There were 58 students, from a total of 76 enrolled in the courses that used the modeling methodology, that have taken all the surveys, both test of learning styles and the pre and post FMCE.

Results and discussion

Table 1. Honey-Alonso Learning Styles results

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>5</td>
<td>1.76</td>
</tr>
<tr>
<td>Reflective</td>
<td>6</td>
<td>1.26</td>
</tr>
<tr>
<td>Theoretical</td>
<td>12</td>
<td>3.88</td>
</tr>
<tr>
<td>Pragmatic</td>
<td>12.5</td>
<td>2.88</td>
</tr>
</tbody>
</table>

Table 3. Correlation coefficients for conceptual learning and Learning Styles

<table>
<thead>
<tr>
<th>Model of Styles</th>
<th>Data FMCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILIQ</td>
<td>Act-Ref</td>
</tr>
<tr>
<td>Sensing-Intuitive</td>
<td>-0.34</td>
</tr>
<tr>
<td>Secuencial-Global</td>
<td>-0.07</td>
</tr>
<tr>
<td>CHAEA</td>
<td>Act</td>
</tr>
<tr>
<td>Visual-Verbal</td>
<td>Ref</td>
</tr>
<tr>
<td>Pragmatic</td>
<td>Int</td>
</tr>
</tbody>
</table>

Best model found considered the three learning styles Activo-Reflectivo (Honey-Alonso) and Visual-Verbal (Felder-Silverman) with a value of R² = .306.

Conclusions

- Students have shown a preference for theoretical and reflective dimensions, describing a cautious and analytical reasoning in learning.
- According to the Felder-Silverman model, groups are mostly verbal, global, slightly reflective and not so intuitive.
- The dimension that proved to be the most balanced was Active-Reflective where students seem slightly more reflective.
- There is work to be done to increase the Honey-Alonso Active dimension considering that one of the aims of the instructor is to promote this type of learning.
- More work is needed with the Visual-Verbal students. They have a high dependence on a verbal learning style, mainly identified with lectures.
- The negative correlation between the Active-Reflective and the FMCE shows that students have more difficulties for conceptual understanding since they are less active.
- Active students according to Felder-Silverman model are more involved in learning and therefore had a better conceptual understanding. Something similar happens with the Visual-Verbal dimension.
- Finally, while it is not possible to assess the conceptual styles of these students can be predicted by 30.6% if it is known their preference levels in the Active-Reflective, Visual-Verbal and pragmatic styles.

References

1. C. Alonso, D. Gallego and P. Honey “Los estilos de aprendizaje: Nuevas aplicaciones” (Instituto de Investigaciones en Ciencias de la Educación, Madrid 1999.)
6. H. Alonso and J. de la Garza “Influencia del aprendizaje y el método de enseñanza en la adquisición de conocimientos en física universitaria” (Comunicación presentada en la conferencia ‘Taller de Investigación’. Mexico 2007.)

Tableau 4. Criterios de evaluación del aprendizaje y los estilos de aprendizaje

<table>
<thead>
<tr>
<th>Variable</th>
<th>Valor</th>
<th>Desvia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activo-Reflectivo</td>
<td>0.321</td>
<td>0.054</td>
</tr>
<tr>
<td>Sensing-Intuitive</td>
<td>0.321</td>
<td>0.054</td>
</tr>
<tr>
<td>Secuencial-Global</td>
<td>0.321</td>
<td>0.054</td>
</tr>
<tr>
<td>CHAEA</td>
<td>Activo</td>
<td>0.321</td>
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<tr>
<td>Visual-Verbal</td>
<td>Reflect</td>
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</tr>
<tr>
<td>Pragmatic</td>
<td>Int</td>
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Acknowledgments

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