METHODOLOGIES IN PHYSICS EDUCATION

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Abstract

At the beginning of this new millennium, education is experiencing many changes. Data from International Bureau of Education, UNESCO, 2010/11, show that countries across Europe and world are applying a new structure of three years schooling of general secondary education. Reconstruction of social and political structure of education demands reconstruction of knowledge and curriculum developments. Reconstruction of physical knowledge affects either physical concepts or their teaching and learning. Our paper presentation aims to demonstrate several implementations of new methods in physics teaching and learning. Curriculum development, organized learning, and new technologies in physics education are some of the best examples to support new methods in teaching and learning. For instance, curriculum development is focusing on the need for methodologies. Among others, physics curriculum should include new methods in teaching and learning. Several authors are also considering the idea of introducing methodologies into their physical studies. Our physics curriculum of primary education introduces different methodologies to help teaching and learning. Organized learning is focusing on the need for efficient schemata in class activities. Suggestions from Finish Universities recommend implementations of simple schema belonging to generative experimentality in physics education. New technologies are focusing on the demand for perfecting methodologies through precision measurements. Applications of new technologies are meant to help teaching and learning of physics with virtual demos and on – line experiments. Theory and experiments are the best ways to gain physical wisdom. To this aim, good relationships between theory and experiment are continuously claimed by both communities of science and education. An assemble combination of curriculum topics, organized learning and new technologies have been the basis of our long – terms research study, aiming reconstruction of several issues in physics and education. Naturally, reconstruction of physical knowledge needs tools, scientific and pedagogical, theoretical and experimental. Social and political structure of education should provide teachers with all the necessary tools to improve the structure of physical knowledge. All these ideas and applications are brainstorming us to the most fascinating way, and also encouraging to seek for financial aids. To this aim, suggestions for multilateral projects should be taken in order to prepare a paradise future of successful education in physics.

Keywords: *reconstruction, education, methods, generative, experiments*

At the beginning of this new millennium, education is experiencing many changes, aiming to apply a new structure of three years schooling of general secondary education. Albania is also engaged to this new structure, making serious efforts in regard. These data are displayed in tables, analyzed, and used for graphing, Graph Figure 1.

Table 1 Countries applying three years of secondary education.

Country	Mathematics	Physics	Natural Sciences
Albania	10 hrs	4 hrs	10 hrs
Greece	8 – 11 hrs	4 – 6 hrs	3 – 5 hrs
Finland	21 crs	8 crs	10 crs
France	7 – 10 hrs	3 hrs	3 hrs
Russia	6 hrs	5 hrs	3 hrs
Japan	18 hrs	6 hrs	18 hrs
Brazil	10 hrs	7 hrs	13 hrs

Country	Mathematics	Physics	Natural Sciences
Italia	*21 – 22 hrs*	*13 hrs*	*13 – 22 hrs*
Austria	*7 – 10 hrs*	*7 – 10 hrs*	*10 – 15 hrs*
Turkey	*5 hrs*	*2 hrs*	*2 hrs*
Spain	*15 hrs*	*3 hrs*	*10 hrs*

Table 2 Countries applying the same previous secondary education.

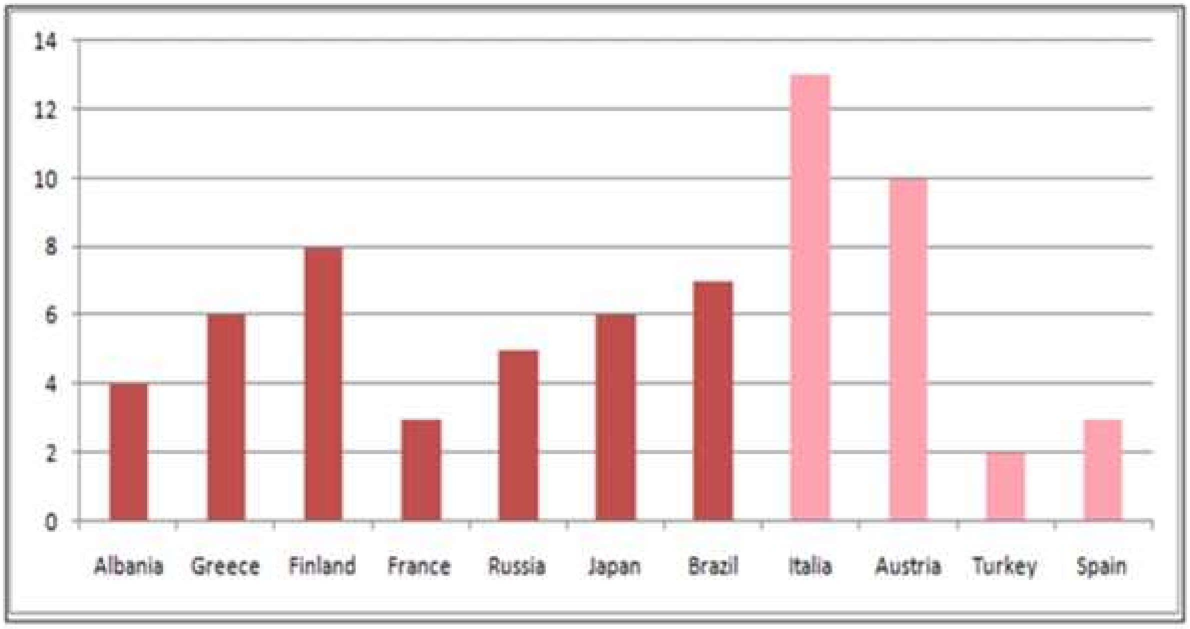

Figure 1

The new structure demands reconstruction of physical knowledge and also curriculum developments. In this framework, the new structure of physical knowledge affects either physical concepts or their teaching and learning. Our study aims to demonstrate several implementations of new methods in physics teaching and learning. Curriculum development, organized learning, and new technologies in physics education are some of the best examples to support new methods in teaching and learning.

For instance, curriculum development is focusing on the need for methodologies in education. Also, several authors are introducing methodologies into their physical studies. Considering that, physics curriculum should include new methods in teaching and learning, our physics curricula of primary education introduces different methodologies to help teaching and learning. Consequently, possibilities for introducing methodologies into physics curriculum of secondary education have been studied. Conference requirements upon including applied scientific methods is a good example in support, (ICRAE 2014).

Organized learning is focusing on the need for efficient schemata in class activities. Suggestions from Finish Universities recommend implementations of simple schema belonging to generative experimentality in physics education, (Mäntylä, 2006; Koponen & Mäntylä, 2010). Consequently, implementations of this schema into lab activities for teachers of secondary education have been studied. These studies were accomplished using generative experimentality, explanatory coherence and experiment, deductive coherence and modeling, (Koponen & Pekonen, 2010). Possibilities for associating methodologies to this schema have also been studied, to help both physics teachers and learners.

New technologies are focusing on the demand for perfecting methodologies through precision measurements, (Koponen & Pekonen, 2010). Applications of new technologies are meant to help teaching and learning of physics with virtual demos and on – line experiments.

To this aim, good relationships between theory and experiment are always claimed by scientists and teachers, to help students to gain physical wisdom. An assemble combination of curriculum topics, organized learning and new technologies have been the basis of our long – terms research study, aiming reconstruction of several issues in physics and education.

Naturally, social and political structure of education should help teachers with scientific, pedagogical, theoretical and experimental tools, to improve the structure of physical knowledge. All these ideas and applications are brainstorming us to the most fascinating way, and also encouraging to seek for financial aids. To this aim, suggestions for multilateral projects should be taken in order to prepare a paradise future of successful education in physics, (Alizoti, 2013).

Recommendations on methodologies in physics education

The introduction of methodologies in physics education is a long stated issue, involving both communities of physics scientists and physics teachers. Traditionally, presentations of scientific studies in physics should include applied scientific methods and methodology. On the other hand, presentations of educational studies should include applied pedagogic methods and methodology. However, educational diversities show that teaching works are not always loyal to such requirement, and teachers all know how much they would argue. Due to late developments in education and society, educational studies are finally being recognized to scientific levels. Actually, teaching is becoming a complex profession including education and specific matters, for example physics. From this perspective, new tendencies in physics education suggest for better arrangements between class activities and science!

Curriculum developments

Early research studies demonstrate the tendency for methodologies in educational studies. Examples can be cited either from international publications, (Research in Science Education in Europe, 1999), or from national publications (Kurrikula dhe Shkolla, Fizikë 3, 2003).
Curriculum Development from International Bureau of Education, UNESCO, 2010/11, has been claiming the reconstruction need for new curriculums in education, both primary and secondary. In response, Albania evolved to the new structure 9 + 3 of education with new curriculums. Team works between teaching partners, institutions and schools, have pawned the development of new curriculums in physics education. Consequently, visionary tables and instructional guidelines came to help the development of new curriculums.

The guideline for the development of new curriculums in our secondary education has been approved by Ministry of education. According to the guideline, (MASH & IZHA, 2010), teachers should prepare their specific daily plan of four blocks, including methodology.

Physics curriculum is based upon three traditional components, theory, exercises, experiments. Apart from these components, physics curriculum should include also methods of physics teaching, or learning. Physics curriculum of our primary education is a concrete example to support this tendency, (IKT, 2008). Among others, such new tendency in our education is meant to enable teachers to select appropriate methods for their class activities,

(Gjini, 2003; Misha, 2003). This tendency is also meant to help teachers with institutional demands and evaluation of teachers methods, (Dhoqina, 2003).
All these citings are mentioned to emphasize the need for methodologies in our physics curriculum of secondary education, in order to help teachers to achieve curriculum goals.

Organized learning

Actually, organized learning is focusing on the possibilities of successful learning using efficient class activities. Traditional and new ideas have strengthened the schemata tendency in modern psychology of education, (Elliot, Kratochwill, Littlefield & Travers). Suggestions from Finish Universities recommend some implementations of simple schema, belonging to generative experimentality in physics education, (Mäntylä, 2006).
Generative experimentality is based on the idea of generative justification of knowledge as first formulated by Newton, and Bacon. Although physicists preferences are chiefly toward empiricism, generative experimentality offers good possibilities for other, new and open ended ideas.

New technologies

New technologies of information are affecting physics and other sciences in several directions. SIC system or Sensor - Interface - Computer system is being implemented in all sciences, giving new insights and detailed information. Among others, SIC system and accessories are widely applied in medical care and treatments. In this way, applications of new technologies are trying to give a strong contribution to the demands for perfecting methodologies through precision measurements, (Koponen & Mäntylä, 2010).
From applied physics perspective, we are interested in the construction of SIC system and functionality. To this aim, we thought a good way to study the SIC system at work, focusing on measurements of physical quantities. On – line devices from Paravia – Italy and Vernier Software & Technology are used to study a large number of physical phenomena, according to physics curriculum of secondary education. From applied mathematics perspective, equations and formulas are presented to illustrate physical laws and phenomena. From applied informatics perspective, data collection, analyzes and display can be used, to provide both quality and quantity of physical information. Traditional tools are also utilized to verify SIC data, and draw conclusions. Our experimental research involved both professors and

students, giving us a chance to compare data over a wider area. From educational perspective, we are trying to make this knowledge available to anyone and for massive usage.

Method

An assemble combination of curriculum topics, organized learning and new technologies have been the basis of our long – terms research study, aiming reconstruction of several issues in physics and education.

Implementations of generative experimentality have been made in our class activities with teacher students, (Alizoti, Vila, Mulaj & Dhoqina, 2013). Our studies were accomplished using generative experimentality, explanatory coherence and experiment, deductive coherence and modeling, Figure 2.

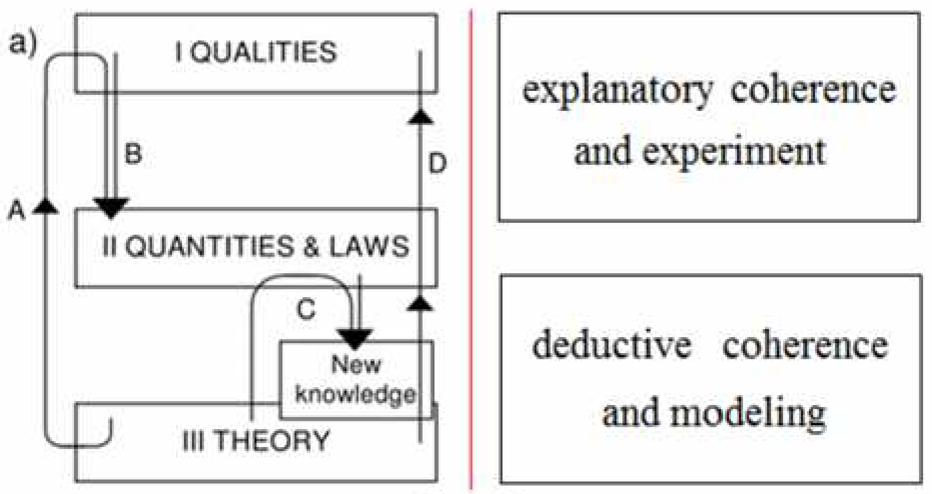

Figure 2

Participants

Three groups of students were given the task to study several topics in physics, from mechanics to optics, according to physics curriculum of secondary education.

Materials and Procedure

The students must study several topics in physics: (1) Mechanics, kinematics, dynamics, and statics; (2) Hydromechanics and Aeromechanics; (3) Thermodynamics and Ideal Gases; (4)

Electromagnetism, electricity and circuits; (5) Optics, mirrors and lenses. These topics are chosen according to physics curriculum of secondary education.

Coherence explanatory and experiment was used to explain physical qualities, length, mass, time, temperature, current, illumination, and others. Explanatory coherence and experiment was used to instruct students to work with experiments and proper means of measurements. Collected data helped students with qualities, quantities and physical laws. Tables and graphs of quantitative data helped students with data analyzes and physical laws.

Deductive coherence and modeling was used to instruct students to work with physical quantities and to calculate other physical qualities and quantities. They were also explained to use theoretical models and physical laws for these calculations.

Results

Students worked well in groups of five or six, as a team. Experiments, theory, and explanatory coherence enabled them to succeed with physical concepts. Students also acted as young teachers or novice experts. Discussions and debates took place while students were dealing with deductive coherence and modeling. Observations and deductions generated new physical concepts, and thence new physical knowledge. Classes worked with physical phenomena, measurements, quantities and laws, models and theories. Classes had several research methods, such as demonstrations, observations, opened interviews, and also open discussions. Experimental physical wisdom helped student to reach cognitivity and stimulate comprehension.

Classes had difficulties too and, sometimes, only two groups out of three were able to succeed the experiments, Table of Experimental Data.

Table Experimental Data

Group of Students	Achievements	Activity Time
First	Success	30 min
Second	Success	30 min
Third	Difficulties & Failure	30 min and more

In those cases, data from successful groups were used to deal with physical concepts, in class. Students acted well as teams of novice experts, trying also to focus on their future professional difficulties. It is common knowledge that, our future physics teachers will be following certain institutional rules with their profession and classes.

Observations showed that all experimental class activities were based on several methods. An assemble schema of these methods is shown below, Figure 3.

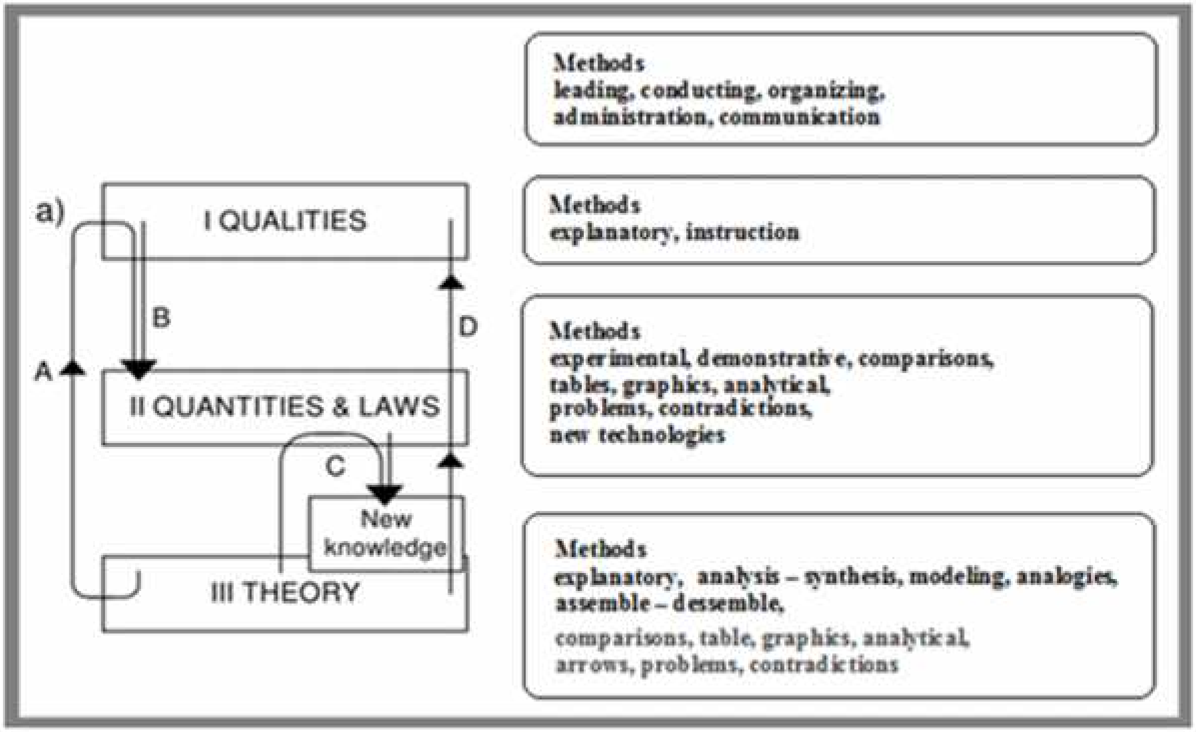

Figure 3

This approach offers a chance to associate the schema of generative experimentality with its proper schema of applied methods. From both schemas, it is easy to combine the sequences of generative experimentality with specific methods.

Discussions

Observations and discussions concluded that methodologies in physics education should evolve with respect to curriculum development, organized learning, and technological achievements. For this reason, our contribution is trying to extend the physics curriculum of secondary education with specific experimental activities and methods. International physics curriculums, such as Guide Curriculum, are referred to help with concrete examples.

With concern to International and European recommendations about experimental activities, an epistemological reconstruction in physics education can be developed around

(1) Demonstrative experiments.

(2) Simple experiments – one measurement one calculation.

(3) Experiments for lab class activities.

(4) Teacher – students conducted experiments.

In the framework of our national and international reconstructions, suggestions for multilateral projects should be taken in order to prepare a paradise future of successful education in physics, (Alizoti, 2013). Worldwide science and educational projects seem to be the general tendency to succeed with future challenges relate to globalization of the marketplace, rapid technological development and resulting demands for new competencies in the workforce, (Norwegian Project). These projects are to be planned to solve educational problems with concern to the new economy, flexible professionals and literate citizens, recruitments to science and technology. From physics education perspective, these projects should follow the traditional school physics and preparation for university, foresee new roles for secondary physics education, and have enough space for implementation of changes.

To accomplish such divine intentions, educational projects should start with curriculum developing, and continue with open ended ambitions. As Hunt states, curriculum developers can make it happen, through funding, assessment and training.

In conclusion, reconstruction of physical knowledge should follow six steps:

1) New curriculums should be developed.

2) New curriculums should have methodologies.

3) New curriculums should have experiments.

4) Generative experimentally can be used to help learning and teaching.

5) New technologies can be used to improve measurements and understandings.

6) Science and educational projects.

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