through avenues such as affirmative action policies and practices, more accessible mentoring and socialization processes and a range of training opportunities and/or courses. Radical feminists contend that more basic solutions are needed rather than simply revising current political, legal and educational policies and practices. BLACKMORE (1989, p. 123) argues that "the concept of leadership needs to be re-examined in order to transform its current "masculinist" bias, which emphasizes control, hierarchy and individualism".

At a time when our educational system is in the midst of major upheaval and transformation, we cannot ignore or subordinate the talents of any who are within the educational community. The leadership of the 21st century must not depend on a "good old boys" network nor the "good old girls", but the "good old people" system dedicated to quality education for all learners. As Francis Hesselbein notes, "in the end, it is the quality and character of the individual that defines the performance of great leaders".

BIBLIOGRAPHY

BLACKMORE, J., Educational leadership: A feminist critique, in J. Smyth (Ed.), *Critical perspectives on educational leadership* (pp. 93-129). London: the Falmer Press, 1989.

BLACKMORE, J., Breaking out from a masculinist politics of education. In Limerick B. & Lingard B. (Eds.), *Gender and changing educational management* (pp. 44-56), Rydalmere, NSW: Hodder Education. 1995.

BURTON, C., Merit and gender: Organisations and the mobilization of masculine bias. *Australian Journal of Social Studies*, **22**, 424-435, 1987

DAVIES, E.G., *Women's education and careers: The hidden agenda.* M. Ed. Studies thesis. University of Tasmania. 1994.

FUNK, C., *The female executive in school administration: Profiles, pluses and problems.* ERIC microfiche, ED 285282, 1986.

GOLD, ANNE, Women and educational Management, paper presented at the European union-funded conference, "*Gender Equity for 2000 and beyond*", Dublin, Ireland, October 21-23, 1996.

GUPTON, S.L. and SLICK, G.A., *Highly successful women administrators.* Thousand Oaks, CA: Corwin Press, 1996.

HOLTKAMP, L.A., Crossing Borders: An Analysis of the Characteristics and Attributes of Female Public School Principals. *Advancing in Leadership Journal*. Retrieved February 10, 2005 from http://www.advancingwomen.com/awl/winter2002/holtkamp.html, 2002.

HYLE, A.E., Barriers to Change: Reflections on an Experience. Paper presented at *The Annual Meeting of The American Educational Research Association.* San Francisco, CA, April 20-24, 1992, ERIC microfiche, ED 351162, 1992.

JACOBS, B., *The role of staff development in the promotion of women to the position of secondary school principals.* M. Ed. thesis, University of South Australia, 1994.

MORRISON, A.M.; WHITE, R. & VAN VELSOR, E., *Breaking the glass ceiling: Can women reach the top of America's corporations?* Reading, MA: Addison-Wesley, 1987.

NICOLL, C., *Gender constructs of educational management in Queensland secondary schools: a critical feminist review.* M. Ed. Adm. thesis, University of Queensland, 1992.

RANDALL, S., Not advancing equally: women in educational management in Australia. Paper presented at *The Annual Council of Europe International Conference on Equal Advances in Education Management*, Vienna, Australia, 3-6 December 1990, ERIC microfiche, ED 371468, 1994.

SCUTT, J., *Women and the law: Commentary and materials.* Melbourne: Law Book Co., 1990.

SHAKESHAFT, C., *Women in educational administration.* Newbury Park: Sage, 1987.

TROEN, V. & BOLES, K., Leadership from the classroom: Women teachers as a Key to school Reform Paper presented at *The Annual Meeting of The American Educational Research Association.* San Francisco, CA, April 20-24, 1992, ERIC microfiche, ED 348771, 1992.

The use of the concept map and the mathematics' teaching for the investigation and evaluation of the prospective teachers' attitudes towards physics

SARANTOS PSYCHARIS, AIKATERINI KASSIMATI

Greek Pedagogical Institute -Deputy Counselor for Evaluation and University of Aegean, Department of Pedagogy
psycharis@Rhodes.Aegean.gr, kkas@pi-schools.gr

Abstract

This paper presents some of the results that have come out of the use of the concept map that the students of the Pedagogic Department of the Aegean University face in relation to the Science of Physics (S.P.).The purpose of the research was to identify the students' primary attitudes about the concepts of S.P. and to investigate the newly formed attitudes about the subject of S.P. after the teaching of the Mathematical concepts that are needed in S.P. by the Physics. Teacher. The concept map was used as the tool for the research.

Key words: *evaluation, physics, mathematics, heat, prospective teachers.*

INTRODUCTION

1. Concept Mapping

A concept map is a visual tool for representing knowledge relationships and structures and has been used as a didactic and pedagogical tool to help students "learn more meaningfully" and form a "conceptual understanding of the subject" (NOVAK, 1990 & MWAKAPENDA & ADLER, 2002).

Concept maps have been also used for assessment of students' knowledge structure and its implementation in science education (NOVAK, 1990). Research shows that understanding a subject domain, included in the science curriculum, is associated with a concise and complete set of relations among the different concepts of the specific domain (NOVAK, 1998; NOVAK & GOWIN, 1984; NOVAK, GOWIN, & JOHANSEN, 1983). The close scrutiny of these relations may help the evaluation of both the students and the course itself.

Concept maps are represented by network diagrams in which the various concepts are nodes and the relationships (associations) between concepts are links. The concepts are essentially nouns and the relationships between them are verbs.

The lines are drawn between pairs of concepts to represent the kind of relationships between the different concepts while the linking words (labels) on the lines indicate the way (nature) the pairs of concepts are related. The proposition is defined as the set of the two nodes and the linking word between the two nodes and this is the fundamental unit of the concept map (RUIZ-PRIMO & SHAVELSON, 1996).

Research (JONASSEN *et al*., 1998) has shown that concept mapping is a measure of structural knowledge, that is, that there may be a relationship between what is actually known by the learner and the external representation of this knowledge as a concept map Consequently a concept is a representation of how key concepts in a domain are mentally organized/ structured by students.

There are mainly two concept mapping techniques.

The "Construct-A-Map From Scratch" and the "Fill-in-the-Map".

Both techniques have as main purpose to evaluate the knowledge structure of the students but they differ on the constraints (directedness) they impose on a student in eliciting her representation of structural knowledge (SURBER, 1984). Research on concept maps has focused on how the various concept mapping techniques affect the representation and interpretation of a student's knowledge structure. (MARÍA ARACELI RUIZ-PRIMO *et al*., 2001).

Construct-A-Map From Scratch. In this method the assessor provides information to the student and asks him/her to construct a hierarchical or non-hierarchical map. Students' response to this requirement by constructing a map, in their attempt to correlate all the concepts that concern a particular domain (MARÍA ARACELI RUIZ-PRIMO *et al.*, 2001).

Fill-in-the-Map. In this method students are provided with a concept map where some of the concepts or the linking words have been empty and

students are obliged to fill in the blank nodes and/or the empty links (Anderson & Huang, 1989).

Using this method student's fill in the blanks and their answers are evaluated as correct or incorrect. This method has advantages and disadvantages. The advantage of the method is that is easy for administration, scoring, storing in a database etc. and the main disadvantage is that it imposes a structure on a student's knowledge.

2. Physics and Mathematics

Research has shown that Physics and Mathematics are interrelated and the integration emanates from the fact that solving physics problems requires mathematical skills (Carin, A.A., 1997).Another crucial result of the research is that the use of Mathematics in Physics can give an impulse in the knowledge of certain concepts of Physics.

Usually students at the Pedagogical Departments, most of whom have not attended high level Physics at the last two years of High School, find difficulties to solve problems in physics which involve mathematical problems.

Moreover, most of them agree that they prefer Physics questions without mathematical problems because in their opinion they are less difficult (Lavaly, 1990).

The use of mathematical terms in the P.S. problems causes fear to the students of the university departments that prepare teachers for the primary education sector (Lavaly, 1990) and when they fail, they often tend to blame the mathematical problems which are included in the S.P. problems. For this reason, we have decided to use Mathematics in S.P. in two levels.

In the first level, we touch upon simple mathematical operations and in the framework of units' conversion or of finding the order of size of physical quantities, or solving simple algebraic equation etc. whereas in the second level, we touch upon more abstract mathematical operators such as the derivative and the integral which can be used for example either to calculate the rate of change of physical quantities or to calculate the total amount of change of a physical quantity.

In the case of the Pedagogical department students, the Physics teacher avoided strict definitions of mathematical concepts and focused on their natural meaning while the students were aware of the fact that the Mathematics they were being taught would be used in P.S. Moreover, during the use of Mathematics in the P.S. problems and concepts, the P.S. teacher made a specific reference on the Mathematics that he had taught in order for the students to feel more confident.

3. Design of the study

The study involved 33 first-year students from the University of the Aegean, which come from the Scientific, the Technological and the Theoretical Orientations of studies[1]. The subject of the module relates to the didactics of Physics and is scheduled for three hours per week for a total duration of twelve to thirteen weeks.

The course consisted of mechanics and heat and was taught in the first year of their studies.

In the first week, during the first teaching hour, the teacher taught the basic principles of the concept mapping method and during the second and third hour he developed two concept maps that regarded concepts of Mechanics. During this process the teacher taught his students some thematic areas in the traditional way and then towards the end of his lecture he designed two concept maps on his own, using both of the concept mapping methods (concept mapping from scratch and fill in method).

In the second week, during the first teaching hour he discussed his students questions regarding the use of the concepts he had taught and the concept mapping by means of their use with them, he continued to teach Mechanics through the introduction of new concepts and then he developed two more maps (using both methods), including the previously taught concepts. During the teaching process he began to use mathematical terms but he avoided mentioning abstract mathematical operators in this stage but he focused on the use of algebraic operations, on how to draw a suitable diagram with appropriate labels and scales, to construct table listing the quantities given and the quantities to be found, to solve the equation for the unknown variable in symbolic form, to use the appropriate units into the equation, to estimate the order of a physical quantity and to obtain a numerical value for the unknown.

Besides, he used only one relation in the concept map by means of the fill in method which needed a mathematical operation In this way he wanted to guide his students towards the finding of a mathematical relation between two concepts. The relation he used concerned the one between the momentum and the forces that cause the change in momentum.

In the third week, during the first two hours he taught new concepts of Mechanics and the third hour he asked his students to develop concepts maps themselves using both methods and all the concepts that the had been taught during the previous weeks. The teacher had made sure, when he used the fill in method, to have certain links that needed Mathematical knowledge. The teacher had taught the Mathematics that the students needed but they did not go beyond the use of powers, unit conversion and calculation of variables by solving equations.

In the fourth week, during the first two hours he taught his students more abstract mathematical operators such as the derivative and the integral and his teaching focused on the natural meaning of these mathematical terms. In the third hour he implemented these mathematical concepts on the concepts of physics that he had taught during the previous weeks, such as the concept of force, the calculation of distances through the use of integrals etc.

The fifth week was devoted to problem solving through the use of mathematical terms that the teacher had taught and during the process he kept emphasizing on the mathematical concepts he was using, in order to convey a sense of confidence to his students.

In the sixth week he asked the students themselves to solve problems in class by using the mathematical concepts taught.

In the seventh week he used the concept map method to identify the pre-existed attitudes of the students on the concepts which concerned heat. During that week he used both methods of the concept mapping. In the eighth week, he analyzed the answers given, with his students, and in the next two weeks he devoted his teaching on aspects related to heat. In the eleventh week he performed experiments on heat. In the twelfth week, he gave to his students three concepts maps to fill in. The first of them concerned heat and the scratch method was used while the second concerned heat as well but this time the fill in method was used with special emphasis not only the solution of equations but to the use of the derivative and the integral.

The third map concerned both of the thematic units and focused on the interrelation between Mechanics and Heat, such as the calculation of gas work, the kinetic energy of the molecules etc.

4. Findings

The study involved three quite differently positioned groups of University students both in terms of the orientation of studies selected in order to be admitted to the Pedagogic Department. Participation in the research was purely voluntary and the research was planned to involve 33 students. The study involved 33 students of the Pedagogical Department of the University of the Aegean that come from the Scientific orientation (N=7), the Technological orientation (N=10) and the Theoretical orientation (N=16), and attend the subject "Children's Views on the Concepts of Physical Sciences".

Prospective teachers have had experiences about teaching and learning in science concepts related to mechanics and heat phenomena as students in secondary education.

All the prospective teachers had attended lessons on heat in lower secondary school while those that had selected the Scientific and Technological orientations had been taught a significant part of the heat engines and kinetic theory of gases in the second year of the upper secondary school.

Usually the evaluation of the concept mapping technique (through both of the concept mapping methods) goes through by counting the presence of hierarchy levels, propositions, links and cross-links (Ruiz-Primo & Shavelson, 1996).

Data are presented in Tables 1-4.

Table 1. concept map on heat with the scratch method

The evaluation we have carried out, has been accomplished through the use of "correct" as a characterization for the students' answers which contained the right verb or the proper hierarchy or the proper link. The second category was characterized as "incorrect" when the hierarchy or the link was not right and in the last one we have classified answers considered as irrelevant.

Scientific orientation	Correct N=4	Incorrect /Partially correct N=2	Irrelevant N=1

[1] Educational Research Centre & Ministry of Education and Religious Affairs, The Greek Education System: facts and figures.

Technological orientation	Correct N=3	Incorrect /Partially correct N=6	Irrelevant N=1
Theoretical orientation	Correct N=1	Incorrect /Partially correct N=5	Irrelevant N=10

Table 2. Concept map on heat with the scratch method

Using the concept mapping, the evaluation is implemented on counting the number of linked concept pairs (WHITE & GUNSTONE, 1992), the number of linking phrases used, the number of concepts used or omitted. In our research we counted the Number of linking phrases used.

Table 2.

	Number of linking phrases used
Scientific orientation	30
Technological orientation	22
Theoretical orientation	12

Through the use of the fill in method, we estimated the number of mathematical terms used in the case where heat and in the case where mechanics and heat together are included

Table 3. Concept map on heat with the fill-in method

Fill in with emphasis on Mathematics

	Number of mathematical terms used out of 15 needed
Scientific orientation	13
Technological orientation	6
Theoretical orientation	3

Table 4. Concept map on mechanics and heat with the fill-in method

Heat and Mechanics

Scientific orientation	Correct N=2	Incorrect /Partially correct N=4	Irrelevant N=1
Technological Orientation	Correct N=2	Incorrect /Partially correct N=5	Irrelevant N=3
Theoretical orientation	Correct N=1	Incorrect /Partially correct N=2	Irrelevant N=13

CONCLUSIONS

The above research has several restrictions and constitutes a first attempt of the use of concept mapping and of the recording the attitudes of the students as well as its use as a tool for the teaching of Physics to students of the Pedagogical Department. One of the restrictions relate to the fact that it has only been used in the Pedagogical Department of the Aegean University but it is going to be extended to other Pedagogical Departments as well. Specific criteria should also be used regarding the reliability and validity of the test and this constitutes the theme of the research we are contacting at present.

The results reveal a deficiency as far as the students' knowledge on Physical Sciences issues is concerned; moreover, the situation appears to be even worse when the use of mathematical concepts is required in the P.S. It also becomes fairly apparent that the Scientific Orientation students perform better but still their results are not so good when concepts interrelating is required. In contrast, their performance seems to be very good as far as the usage of mathematics is concerned. When they were asked to interrelate heat with Mechanics (Table 4) though, their performance decreased significantly, a fact revealing the students' inability to form a unified understanding of the Physical Sciences as an entity.

The teaching of Mathematics appears to have changed the students' attitude towards the use of them in Physical Sciences. 80% of the students coming from the Theoretical Orientation have answered that they have overcome their fear for the use of mathematics in P.S. to a significant degree, while this percentage rose to 90% for the Technological and to almost 100% for the Scientific orientation students. The students also expressed their willingness to repeat the whole process for the rest of the Physics' thematic units, attributing their poor results to their lack of familiarity with the concept mapping method.

This is in accordance to the research made by (WEBB, 1973). His research showed that if the teaching of mathematics and of physics is correlated (that is no mathematical concept is met in the learning of physics that has not already been explicitly treated), and a good relationship between mathematics and science developed (WEBB, 1973), then fear of mathematics in physics can be dispelled.

Despite the fact that scores from concept mapping may indicate the extent to which a student is able to make connections between concepts in a subject, there is a discussion if the scoring procedure reduces some of the richness and detail of information contained in a concept map" (NOVAK & MUSONDA, 1991).

BIBLIOGRAPHY

AMOS K., LAVALY, Do students find physics easier to learn without mathematical problems? Phys Educ **25**, 1990.

ANDERSON, T.H., & HUANG, S-C.C., On using concept maps to assess the comprehension effects of reading expository text. Technical Report No. 483. Urbana-Champaign: Center for the Studying of Reading, University of Illinois at Urbana-Champaign (ERIC Document Reproduction Service No ED 310 368), 1989.

CARIN, A.A., Teaching Modern Science, Merril, Prentice Hall, New Jersey, 1997.

JONASSEN, D.H.; REEVES, T. & HONG, N. "Concept mapping as cognitive learning and assessment tools**",** *Journal of Interactive Learning Research*, 8, 289-308, 1998.

RUIZ-PRIMO, MARÍA ARACELI, SCHULTZ, SUSAN E., MIN LI, AND SHAVELSON, RICHARD J., Comparison of the Reliability and Validity of Scores from Two Concept-Mapping Techniques. *Journal of Research in Science Teaching* **38** [2], 2001.

MWAKAPENDA, W. & ADLER, J., "Do I still remember?": Using concept mapping to explore student understanding of key concepts in secondary mathematics. In C. Malcolm & C. Lubisi (Eds.), *Proceedings of the 10th Annual Conference of the Southern African Association for Research in Mathematics Science and Technology Education* (Part II, pp. 60- 67). Durban: University of Natal, 2002.

NOVAK, J.D. & MUSONDA, D., A twelve-year longitudinal study of science concept learning. *American Educational Research Journal,* **28** [1], 1991.

NOVAK, J.D., Concept mapping: A useful tool for science education. *Journal of Research in Science Teaching,* **27** [10], 1990.

NOVAK, J.D.; GOWIN, D.R. & JOHANSEN, G.T., The use of concept mapping and knowledge with junior high school science students. *Science Education,* **67** [5], 1983.

NOVAK, J.D., Learning, creating, and using knowledge. Concept maps as facilitative tools in school and corporations. Mahwah, NJ: Lawrence Erlbaum, 1998.

NOVAK, J.D. & GOWIN, D.R., Learning how to learn. New York: Cambridge University Press, 1984.

RUIZ-PRIMO, M. & SHAVELSON, R., Problems and issues in the use of concept maps in science assessment. *Journal of Research in Science Teaching,* **33** [6], 1996.

SURBER, J.R., Mapping as a testing and diagnostic device. In C.D. Holley & D.F. Dansereau (Eds.), Spatial learning strategies: Techniques, applications, and related issues (Orlando: Academic Press, 1984.

WEBB N.G.F., Developing a good relationship between Mathematics and Science *Sch Sci Rev* **54,** 44-49, 1973.

WHITE, R. & GUNSTONE, R., *Probing understanding*. London: The Falmer Press, 1992.