opción

Revista de Antropología, Ciencias de la Comunicación y de la Información, Filosofía, Lingüística y Semiótica, Problemas del Desarrollo, la Ciencia y la Tecnología

Modeling for computer graphics study in terms of fundamentalization of information science

Baidrakhmanova G.A.[1]

[1]Abay Kazakh National Pedagogical University, Almaty, Republic of Kazakhstan
gulnaztai83@mail.ru

Issabayeva D.N.[2]

[2]Abay Kazakh National Pedagogical University, Almaty, Republic of Kazakhstan
daraja_78@mail.ru

Rakhimzhanova L.B.[3]

[3]Al-Farabi Kazakh National University, Almaty, Kazakhstan
lyazatr72@mail.ru

Sultangaliyeva L.[4]

[4]K.Zhubanov Aktobe Regional State University, Aktobe, Republic of Kazakhstan
lida-1967.s@mail.ru

Suleimenova G.[5]

[5]K.Zhubanov Aktobe Regional State University, Aktobe, Republic of Kazakhstan
guljanat_sj@mail.ru

Abstract

The research objective consists of consideration and application of a technique for teaching computer graphics by means of information model creation via the method of computer graphics study by means of information models. The results of the pedagogical

experiment prove the reliability and effectiveness of the technique connected with computer information modeling in the process of computer graphics teaching. In conclusion, the fundamentalization of education, the course of information science particularly must be constructed from a phenomenon of information processes to methods of their study by means of information models, using computer as a tool to control the information processes.

Keywords: Fundamentalization, Education, Computer, Graphics, Information.

Modelado para el estudio de gráficos por computadora en términos de fundamentalización de la ciencia de la información

Resumen

El objetivo de la investigación consiste en considerar y aplicar una técnica para enseñar gráficos de computadora mediante la creación de modelos de información a través del método de estudio de gráficos de computadora mediante modelos de información. Los resultados del experimento pedagógico demuestran la confiabilidad y efectividad de la técnica conectada con el modelado de información computarizada en el proceso de enseñanza de gráficos computacionales. En conclusión, la fundamentalización de la educación, el curso de la ciencia de la información en particular, debe construirse a partir de un fenómeno de los procesos de información a los métodos de su estudio mediante modelos de información, utilizando la computadora como una herramienta para controlar los procesos de información.

Palabras clave: Fundamentalización, Educación, Computación, Gráficos, Información.

1. INTRODUCTION

The fundamentalization of education is one of the priorities in scientific and pedagogical investigations. Grinshkun (2009) defines the fundamental nature of education as an orientation of content of education on methodologically significant, system knowledge,

invariant elements of human culture promoting the development and realization of creative potential of the learner. It provides qualitatively new level of his intellectual, emotional and moral culture, creating the internal need for self-development and self-education throughout all human life, adapting personality for changing social, economic, information and technological conditions. Well-known position interprets the fundamental nature of education as a profound training of learners within the frame of a particular instruction; it is so-called education deep into.

There is another interpretation of fundamental nature of education – it is a versatile humanitarian and natural - scientific education based on mastering fundamental knowledge; it is so-called education in breadth. This position identifies the fundamentality as a combination of the factual, ideological and methodological aspects of a subject study on a scientific basis (Laptev, 2002). According to scientists Ryzhova (2000) the development of education fundamentality in the field of information science comes down to a mathematization of teaching content of information science and development of a formal component of activity; the central concepts of such course are the computer and an algorithm. Lednev (1991) construct the information science course from a phenomenon of information processes to methods of their study by means of information models, using the computer as a tool to control the information processes.

The field of computer graphics teaching Kheyfets (2017) emphasizes the problems of the current introductory courses of computer graphics; the lack of connection between theory and practice thereby, the author's software for its overcoming is suggested. Now in pedagogical higher education institutions of Kazakhstan there is no consensus about fundamental bases of information science, the course of information science has a problem of choice, which bears serious methodological danger in teaching future teachers of information science. Will future teachers of information science study the mathematical discipline analyzing the structuring, researching of mathematical methods, models, and the computer for automation of numerical information processing or will they study information processes in a broad sense?

2. METHODOLOGY

For objective and evidential reliability of the pedagogical hypothesis, the pedagogical experiment in two steps was conducted: the ascertaining and learning experiments. Experimental learning was provided at four schools of Almaty during (2015-2018) years. Students were divided into experimental and control groups. The purpose of the ascertaining experiment was to analyze a condition of practical knowledge and abilities of students in the field of computer graphics.

30 pupils and teachers of information science participated in experiment.

The purpose of the learning experiment (the second stage) was to check the efficiency of the developed system of tasks, and the technique to use information modeling in computer graphics. The reliability of experimental learning was checked by a comparative method of teaching material assimilation by pupils of control and experimental groups and probabilistic method – criterion[2] . Control tests, the results of which had the qualitative analysis, were carried out for this purpose. Each student got 30 questions in 3 options. The method – criterion ☐ is widely used in pedagogical research /17/ for comparison of objects distribution in two sets according to the condition of some property on the basis of changes on a scale of names of this property in two independent selections of the considered sets.

The meaning of the criterion χ^2 statistician for the comparison of control work results is calculated by a formula:

$$\chi^2 = \frac{1}{l_1 l_2} \sum_{i=1}^{k} \left[\frac{(l_1 R_{2i} - l_2 R_{1i})^2}{R_{1i} + R_{2i}} \right],$$

l_1- the number of the checked works in the first sampling;

l_2- the number of the checked works in the second sampling;

R_{1i} the number of relative assessment of i-category in the first sampling;

R_{2i} the number of relative assessment of i-category in the second sampling.

If $\chi^2 > \chi^2_{kr}$, then the difference between two distributions is significant; if $\chi^2 < \chi^2_{kr}$, the difference is insignificant.

We randomly chose 40 works (test answers) in control and experimental groups. The first sampling gives test answers of the students of control groups, the second - experimental ones. Results of tests are presented in table 1.

Table 1

Relative assessment	Control groups	Experimental groups
R≤50%	10	1
50%<R≤70%	19	6
70&<R≤80%	7	14
80%>R	4	19

Taking into account that in the considered case $l_1=l_2$, it is possible to use a formula:

$$\chi^2 = \sum_{i=1}^{k}\left[\frac{(R_{2i} - R_{1i})^2}{R_{1i} + R_{2i}}\right],$$

There are the same designations, as in the previous formula. Then we have:

$$\chi^2 = \frac{(10-1)^2}{10+1} + \frac{(19-6)^2}{19+6} + \frac{(7-14)^2}{7+14} + \frac{(4-19)^2}{4+19} \approx 26,23$$

Table shows that compliance to three degrees of freedom χ_{kr}^2 at 95% probability level - 7.81. If 26,23>7,81 it would be possible to reject a null hypothesis and consider that there are essential differences in results of the control testing in experimental and control groups.

3. RESULTS AND DISCUSSION

We state a fact that modern foreground spheres of information science at school are information processes and information technologies, but the most perspective course should include the development of a fundamental triad – information processes, modeling and formalization and information bases of management. The information and computer modeling within the frame of information science course is an object of many researchers in domestic and foreign practice. Richard (2005) pointed out that scientific works about the development of the model and modeling concepts were more (M & M) in comparison with works devoted to the problem solution; instead of being anxious about texts writing in textbooks and development of the standardized tests, authors are focused on (simulation) solution of problems in a wild nature.

Loucas (2015) represents the new language of visual programming based on a logo - ViMAP - and the sequence of the teaching activities connected with programming and modeling developed for support of seamless integration between programming and kinematics. Vanessa et al. (2013) did the three-stage test of usability of the instrument of the modeling designed to support the detailed understanding by students the effects of climate change for ecosystems. The process of designing included the repetition of the existing technology of modeling used by professional scientists as an instrument of teaching intended for students of high schools.

Helen (2006) considered the changing of the assessment's role of the students by the teacher through the support of mathematical arguments of the pupils in the context of a new problem of modeling the data analysis. The author says that for the understanding of mathematical content in modeling, the teacher needs to act a new role, in close interaction with students. Teacher has to be focused on listening and observation of the student's ideas and ask questions for understanding and explanation. Misongkim (2015) develops interactive, fascinating and informal teaching activities called Embodied Modeling-Mediated Activities (EMMA) to support a deep analysis by Singapore students of astronomy, and the ability of teachers to use information and communication technologies, including instruments of multimodal modeling (Ibrahim, 2007).

Scott (2008) investigates an inductive approach for automatic creation of self-efficiency models (effective physiological data), which can be used to inform the pedagogical solutions for forecasting of self-realization level of the student. Scott (2008) successfully applied the mathematical modeling in order to satisfy various mathematical and informative requirements of the gifted students, who had excellent learning capability and persistence in mathematics. Nitza (1999) developed and implemented a new educational environment The Computerized Molecular Modelling (CMM) for teaching and training in Israeli higher education institutions, which could illustrate and investigate the phenomena of chemistry and could easily create the

molecules of any size and color in several styles of representation, bright animation of threedimensional paradigms.

Kathleen (2001) offers the pedagogical strategy to support all types of students in studying of the central scientific practice of model quantitative thinking, having analyzed the thesaurus of five couples of senior students when they were making the quantitative ecological models on the basement of STELLA software. For the productivity of modeling, it is necessary: (a) to be focused on model exit to compare with model input and individual relations in creation and review of the model, (b) to study the nature and effects of dependences and feedback in comparison with their creation as properties of complex systems. It is necessary to (c) use the variables in comparison with constants for representation of continuous and periodic functions.

The research of Kathleen (2001) helps the teacher or the clever trainer to understand the situations with information sharing where the groups of students cooperate remotely. The research shows how the probabilistic method of machine teaching can be used for modeling and analysis of interactive knowledge exchange. It is for hidden Markov models and multidimensional scaling in the analysis and assessment of the sequences of the coded interaction of online students. These methods of the analysis were used for training of a system to distinguish dynamically (1) when pupils have trouble with studying of new concepts, which they share with each other, and (2) why they have problems. In the process of computer graphics acquiring, it is necessary to construct the information model of the

figure before its designing, i.e. to purposefully select information of an object, which reflects the most essential properties of it.

The tasks for creation appeared during the antique period and were connected with practical requirements. They train the mind, learn to use it in a complex structure, and develop a non-standard approach for problem-solving. From the very beginning, it is pointed out that the graphics object possesses a form, the size, proportions and color, and then the concept of construction, installation of an object and elements is provided. For the creation of the graphics image, the flat or volumetric object can be moved, replicated, edited, turned, reflected and changed in sizes and proportions. We will present stages of computer information modeling in the form of the flowchart (figure 1).
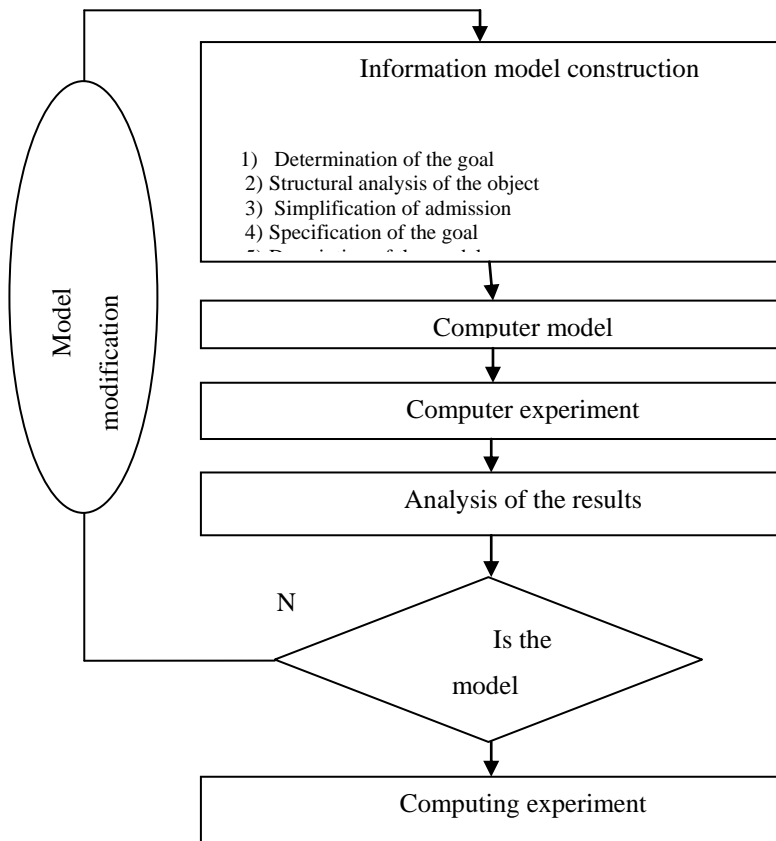
Figure 1: The stages of computer information modeling

The method of modeling has the cyclic features, for each model, all stages of methodological modeling are repeated, and the computing stage assumes the recurrence of a check and calculation of the constructed model for different parameters, for obtaining new results or testing of the constructed model in various situations. In addition, the modeling is modern and not quite developed teaching method as it

meets all requirements of the modern trends in the didactic theory for the development of thinking and intellectual activity of the student: the method of undelivered tasks, the solution of non-stationary tasks and the acceptability of teaching. The examples of tasks demonstrate the stages of computer information modeling with the graphics editor.

The bicycle is the two-wheeled construction consisting of two wheels connected by a frame for a seat and helm, adjuster from helm to pedals, wheels connecting rods for a chain.

Figure 2: Parts of the bicycle

- Simplification of admission

• Wheels have the oval form consisting of a cylindrical surface, in the middle, there is a polygon for support of spokes.

• The frame has cylindrical surfaces.

• The adjuster has cylinders; one of them has a polygon connector.

• The seat has the connected n – triangles.

• The helm has cylinders connected by means of the connectors, polygons closing cylinders.

• Pedals have the form of the connected cylinders narrowed in the middle and the edges have the rings and n-triangles.

• Connecting rods have cylinders with a concentric hole connected by the bridge.

• All sizes must be selected on the basement of statistical data of the bicycle.

- Specification of the goal and the description of the model

Draw a graphic object - the bicycle, using geometrical figures of a certain size, such as polygon, cylinder, and oval.

3 stage. Computer modeling

1) The use of the graphics editor 3DS Max.

Here we will consider only the fragments of the painting program for bicycle adjuster, wheels, pedals and helm. Bicycle adjuster. In Create - Geometry we create a new cylinder with a radius of 2.5, with the height of 7, with the following segments of height: 4, segments of cover: 1, sides: 12 and we place it by means of the tool Select and Move (figure 3).
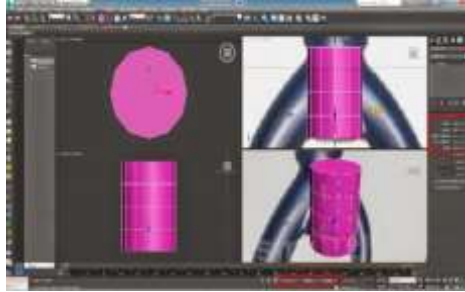
Figure 3: Use of a cylinder figure

The cyclicity of model creation shows that students not always, but in most of the cases, build the wrong connection between cylinders. Pupils just join figures, or take a joint point for a circle. After several attempts, it is necessary to explain that a junction of cylinders is an 8-triangle with a certain radius. With the help of to create, to create forms we will make the n-triangle with a radius of 2.1 and 8 sides, and then we connect the following cylinder (figure 5).

Figure 4: Point of cylinders' crossing

We add another cylinder with the help of Select and Turn on, and then we will turn both times with identical quantity-30 on axis Z.

Let us make additional copies, using the Select and Move tool directly down. Let us pass into a perspective window, and in the mode of the edge choice, we will select 4 edges. Using the Select and Move tool and holding Shift, we will copy them on axis Z on 1.876. The narrowed end of adjuster can be made by means of the planer on X. As a result, we will get a bicycle adjuster (figure 5).

Figure 5: Bicycle adjuster

Wheels. In Creation, geometry chooses the Cylinder. Change height segments on 1, cover segments on 5 and the sides on 32. In the keyboard leave X, Y and Z up to 0, change radius on 30, height on 3 and click Create (figure 6). After the creation of the Cylinder clicks the right button of the mouse, then select Transform in->; Transform into editing.
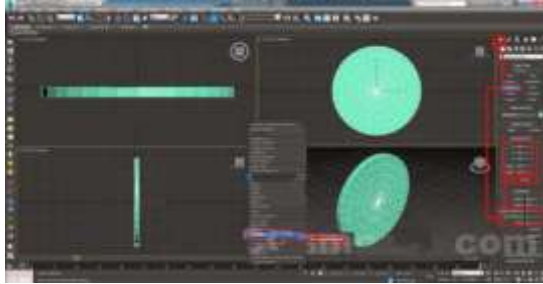
Figure 6: Bicycle wheel

We allocate the necessary polygon and delete superfluous things, and then we transform it for the creation of the halls for spokes. With the help of Create, form makes a new NGon with 8 sides and 3.5 radius, having clicked and moved it on the screen. Use the Choose and Move tool to allocate NGON, as it is in figure 7. Now, using the Cut tool, create 8 new edges, by 4 from each side.
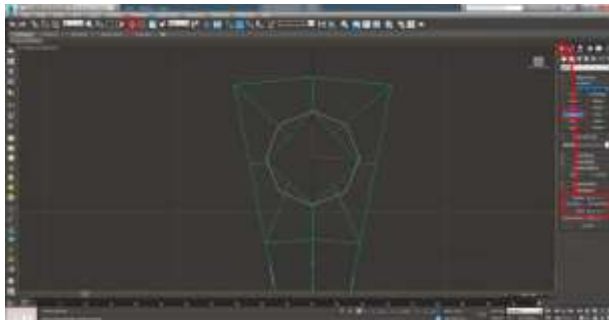

Figure 7: Polygon for bicycle spokes

Figure 8: Center of bicycle spokes

Holding the SHIFT button, turn an object by 22.5 degrees on axis Y. Choose the type of an object Copy, 15 copies and click OK. Activate the Attach tool and click choosing other 15 objects to fasten them together.
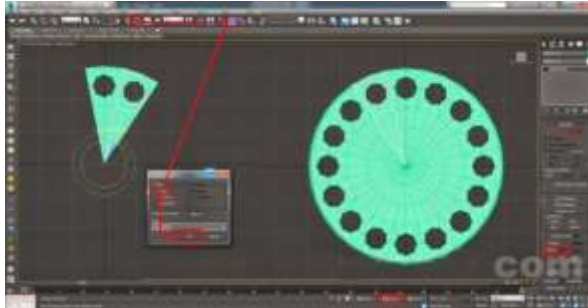

Figure 9: Copy of an object of a wheel

2) We use graphics editors such as Paint or Corel Draw.

First, we will show a bicycle contour, its main lines. We have to have two oval wheels connected by a frame, a base for the seat and the helm. We will outline the ovals of the wheel, and make them wider.

We will show the contour of the helm by a smooth line. We will outline a base for the seat and give the shape. From the seat, we have one more line down; then we draw a front star and pedals. We draw the thickness of rubber. Over a back wheel, the wing is located. Now we are focused on frame and adjuster. We will shape the seat, showing the sub-seat pintle. Then we have a helm: there are handles and steering column. Now the details would be the center of our attention. We do not have a wheel rim with the nipple yet. We draw cartridges on a back wheel and a chain. The holes will be depicted on the star. The pedals will get the volume and handles will have – the strips. The seat will have the line separating its side. We are approaching the goal gradually. What we need is a box for the chain spokes of the wheels. Now you can draw the bicycle on the screen of the computer.
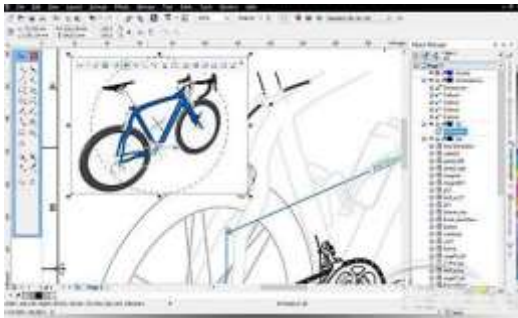

Figure 10: Corel Draw Bicycle

4 stage. The results analysis.

The modeling of the bicycle took into account all parts and their sizes and distance between objects; all of them have similarities with a real object.

5 stage. Computer experiment

It is possible to experiment with a bicycle, to add it to the program for animation of objects.

It is important to show by means of such tasks that the modeling has the cyclic feature. It means that the stages of modeling are repeated for each model, and experimental stage with computer model suggests the recurrence of the check of the constructed information model for different parameters for obtaining new research results in various situations.

4. CONCLUSION

Therefore, the results of the pedagogical experiment prove the reliability and effectiveness of the technique connected with computer information modeling in the process of computer graphics teaching. The skill of the teacher is to select such tasks, which help school students to define correctly the modeling goals. Ultimate goals of teaching to the model are defined by the significant changes in the theory and practice of pedagogical science connected with altering the content of the technologies in teaching, promoting qualitatively new format of learning for future members of the information society for

whom the innovative thinking and cognitive interest will become the vital necessity. During the research the following results are obtained:

1.The approaches for the identification of the education fundamentalization concept are analyzed. During teaching computer graphics within the frame of information science course and training future teachers of information science in pedagogical higher education institutions as a way of development of fundamentalization of education, the method of information models was applied, using computer as a tool to control the information processes;

2.The technique of teaching computer graphic information modeling is developed;

3.The complex of educational and applied research tasks of modeling of computer graphic objects is developed;

4.The pedagogical experiment at school was conducted in order to approbate and obtain effective results of the testing method.

The fundamentalization of education, the course of information science particularly must be constructed from a phenomenon of information processes to methods of their study by means of information models, using the computer as a tool to control the information processes. It means to study computer graphics in the course of information science on the basement of geometrical information models, using graphics editors in computer modeling.

REFERENCES

GRINSHKUN, V., & LEVCHENKO, I. 2009. **School information science in the context of education fundamentalization**. The Herald of Peoples' Friendship University of Russia, the series of Education Informatization. No 1. pp. 55-64. Russia.

HELEN, M. 2006. **Middle grade teachers' learning through students' engagement with modeling tasks**. Journal of Mathematics Teacher Education. Vol. 9, pp. 5–32 DOI 10.1007/s10857-006-9004-x. Germany.

IBRAHIM, A. 2007. **Mediated Modeling in Science Education**. Science & Education. Vol. 16, pp. 653–697. DOI 10.1007/s11191-006-9004-3. Germany.

KATHLEEN, H. 2001. **Cognitive Comparisons of Students' Systems Modeling in Ecology**. Journal of Science Education and Technology. Vol. 10, N° 4. Germany.

KHEYFETS, V. 2017. **The use of 3D modeling when constructing and analyzing perspective projections and shadows is considered**. ICCATS 2017 IOP Publishing IOP Conf. Series: Materials Science and Engineering. 262 012104 doi:10.1088/1757-899X/262/1/012104. Russia.

LAPTEV, V. 2002. **The concept of fundamentalization of education in the field of information science and its implementation in pedagogical higher education institution**. News of Herzen State Pedagogical University of Russia. Psychology and pedagogical sciences (psychology, pedagogics, theory and technique of teaching): Scientific journal. Vol. 2, N° 3: 124 – 135. Saint Petersburg. Russia.

LEDNEV, V. 1991. **Content of education: entity, structure, perspectives**. Moscow: Higher school. Russia.

LOUCAS, T. 2005. **Examining Learning through Modeling in K-6 Science Education**. J Sci Educ Technol. 24:192–215 DOI 10.1007/s10956-014-9533-5. Germany.

MISONGKIM, K. 2015. **Empowering Prospective Teachers to Become Active Sense-Makers: Multimodal Modeling of the Seasons**. J Sci Educ Technol. Vol. 24, pp. 610–627. DOI 10.1007/s10956-015-9550-z. Germany.

NITZA, D. 1999. **High-School Chemistry Students' Performance and Gender Differences in a Computerized Molecular Modeling Learning Environment**. Journal of Science Education and Technology. Vol. 8, N° 4. Germany.

RICHARD, L. 2005. **Indiana University Lyn D. [English, Queensland University of Technology]**. Trends in the Evolution of Models & Modeling Perspectives on Mathematical Learning and Problem Solving, Analyses. ZDM. Vol. 37, N° 6. Russia.

RYZHOVA, N. 2000. **The development of a methodical system of fundamental teaching of future teachers of information science in a subject field**. Abstract of the thesis of Doctor of Pedagogical Sciences. Saint Petersburg. Russia.

SCOTT, W. 2008. **Modeling self-efficacy in intelligent tutoring systems: An inductive approach**. User Model User-Adap Inter. Vol. 18, pp. 81–123. DOI 10.1007/s11257-007-9040-y. Germany.

VANESSA, L., PETERS, N., & BUTLER, S. 2013. **Evaluating the Usability of a Professional Modeling Tool Repurposed for Middle School Learning**. J Sci Educ Technol. Vol. 22, pp. 681–696. DOI 10.1007/s10956-012-9422-8. Germany.

UNIVERSIDAD DEL ZULIA