36

INTEGRATION OF DESIGN, MODELING AND VISUALIZATION IN SLOVENIAN PRIMARY EDUCATION

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Abstract

A human being perceives the world spatially, he detects and properly processes distances, size of objects, their shapes and all that is linked to our perceptions of the world. Humans' sensors provide the information about the world around and brain translates this information into thoughts, into ideas. The whole process is completely natural. In the past, due to technological limitations, the human attempted to generalize these ideas and convert them into a form so that he could "record" it on a flat medium, like on paper for example, and because of that he consequently had to develop the ability to "read" these records. The term spatial perception was introduced and after that it was established that not everyone has it. To possess spatial perception an abstract way of thinking and higher cognitive abilities are needed. This paper presents an integration of design, three dimensional (3D) modeling and visualization program SketchUp[1] in Design and technology curriculum into Slovenian primary schools. Emphasis is given to the analysis of the past and current condition and situation and on the incorporation of the program into the primary school curriculum. With the strategy assigned in such a way, the abilities that are connected with technological activities are strengthened, spatial intelligence is developed and assimilated. With such an approach two of the key European competences: 1. Mathematical competence and 2. Basic competences in science and technology and digital literacy, are acquired and reinforced.
Key words: *ability, competence, design and technology, SketchUp, spatial intelligence.*

Introduction

Before the change in the curriculum of Design and technology, in 2011 two dimensional (2D) technical drawing was a standard and three dimensional (3D) modeling and visualization were primarily presented only indirectly in the content of information technology (Papotnik et all, 2002), where students used the computer mainly as a tool for working and learning, rather than a tool for creating and developing new ideas in order to express these ideas as technical documentation. Technical documentation made in such a way, has been dealing mainly with how to convert real objects which are 3D onto paper, in short, how to convert them into 2D. To make this a set of standards and rules in technical drawing is used. Their task was to provide an unambiguous understanding of things that were drawn worldwide. Nowadays, technological development in computer science eliminates these problems. By using computer graphics a virtual reality can be created that is so realistic that even the experts have difficulty distinguishing between what is real and what virtual. Therefore, there is no longer any need to use old; outdated, methods of work and old methods of technical drawing in technical practice. In industrial practice it is already entirely normal to use three dimensional modeling thus causing an "urgent" need to introduce these methods also in all levels of education, in a word, at an elementary level (Aberšek, 2012).

1   *SketchUp is a registered trademark of Google Inc..*

Society demands that every student in the system of education and training is given the basic knowledge and skills which will form the basis for his further life and work. He must get a functional literacy, which is not only the ability to read, write, and compute but primarily the ability to solve basic problems later in his life and in his profession. Trends of 3D modeling and visualization show that the three dimensional world is becoming increasingly recognizable and is being used in schools, according to research done by various authors. (Large, Behesti, Breuleux, 1998; Hew, Cheung, 2010; Šafhalter, 2012).

Theoretical Framework: Advantages of 3D in the Learning Process

Authors like (Wiebe and Clark 1997; Bussey, et all, 2001; McCardle, 2002; Olkun, 2003) discuss the importance of physical and mental manipulation and representation in both 2D and 3D, to develop both the ability to solve spatial relation problems and spatial visualisation tasks. The value of manual technical drawing lies in the development of visualisation and manipulation of views in 2D and 3D. Field (2004) recognizes the difficulties learners have in moving from 2D drafting to 3D interactive solid models. All these authors stressed the importance of knowing basic of technical drawings before moving on to 3D. A survey performed by the Engineering Design Graphics Division of the American Society for Engineering Education concluded that the ability to create 3D solid models and the ability to sketch objects in the freehand mode were the two most important graphical communication outcomes for engineer students (Barr, 2004).

Multiple Intelligences

Intelligence is the ability or type of ability which allows an individual to solve problems that are relevant to the specific cultural environment (Gardner, 1995). According to Gardner, there are many types of intelligences. In the area of Design and technology it is very important to understand spatial intelligence. "The most important abilities for spatial intelligence are proper perception of the visual world, the implementation of the conversion or change of initial perceptions, re-creating aspects of their visual experiences, even in the absence of relevant physical stimulus" (Gardner, 1995, p. 208).

Components of spatial intelligence are developed in Design and technology by:

- Finding and presenting solutions, by sketching both components as a whole.
- Drawing objects in the perspective projection.
- Describing the origin of the image in the selected projection.

Students with more developed spatial intelligence can also learn visual intelligence. Teaching and learning Design and technologies should be supported by displaying images, photographs, sketches, drawings, models, scale models and structures (Papotnik, 2009). Using SketchUp can significantly contribute to the theoretical understanding of space and its laws according to research done by various authors (Martin-Dort, LuisSaorin, Contero, 2008; Kurtulus, Uygan, 2010; Šafhalter, 2012). It can also motivate pupils to explore, design and devote their free time to learning.

Key Competences for Lifelong Learning

The competences are defined as a combination of knowledge, skills and attitudes appropriate to the context. Key competences are those which all individuals need for personal

fulfillment and development, active citizenship, social inclusion and employment. The Reference framework sets out eight key competences, they are all considered equally important, because each of them can contribute to a successful life in a knowledge society. Many of the competences overlap and interlock: aspects essential to one domain will support competence in another. Competences in the fundamental basic skills of language, literacy, numeracy and in information and communication technologies (ICT) are an essential foundation for learning, and learning to learn supports all learning activities. There are a number of themes that are applied throughout the Reference Framework: critical thinking, creativity, initiative, problem solving, risk assessment, decision taking, and constructive management of feelings all play a role in the eight key competences (European parliament, 2006).

For the subject Design and technologies it can be said that all eight key competences overlap and complement throughout the content curriculum. By using the 3D modeling and visualization program SketchUp pupils can further develop and strengthen two key competences (Dolenc, 2012):

1. Mathematical competence and basic competences in science and technology.
2. Digital competence.

Integration of 3D Modeling and Visualization in Primary School

One of the most simple and user-friendly 3D programs for modeling and visualization, which has the ability to create 3D models (solid or sketch) is thought to be SketchUp. SketchUp allows us to draw both 2D drawing and 3D models. It uses an interface that is user friendly, is familiar with other drawing programs, and is based on surface modeling. Because of its iconic interface design it is particularly suitable for use in the educational process, especially in primary schools where its greatest advantage is simplicity and universality. SketchUp enables pupils to quickly learn how to draw their first model, understand the basic principles of 3D modeling and visualization and enhance spatial perception. Gained knowledge and skills can easily be transferred to a more demanding, more specific programs in further education or occupation.

Acquisition of Knowledge, Experience and Abilities

By using SketchUp pupils can transfer an idea or a real object into a virtual one into a virtual environment where it can be arbitrarily changed, revised or supplemented in order to be improved. By doing so in the context of progress and with the activity of drawing 3D models, they obtain information and conclusions which assist them in the further phases of planning and creating the product.

In product planning a spatial model is generated in a conceptual design which in addition to the visual part hides in the background all the necessary information about every single component of the product. Quality of implementation of the objectives and content, which are in a logical and meaningfully connected to the engineering, technical, physical, ergonomic, organizational and environmental problems as well as activities, is largely dependent on good design (Papotnik, 2009).

With the use of SketchUp the following abilities are especially being developed:

1. Abilities of observation, representation (proportions, figures and shapes), understanding of technical problems (correct and rapid perception of the structure and functions of the 3D model).

2. Determination of the relationships between parts and whole (interrelations between 3D models, similar in function but different in structure).
3. Constructive imagination (correct representation of the structure, function and production of a 3D model and subsequently the final product).
4. Constructive thinking (imaginative or mental modeling of a new product).

Integration of SketchUp into the Primary Schools Curriculum

With the renewal of the curriculum of Design and technology (Fakin et all, 2011) and the inclusion of 3D modeling and visualization as a standard of knowledge, we follow the latest trends in design procedure. Trends, where virtual reality is approaching reality and 3D technology is becoming a part of information technology just as pictures or movies were in the past. As Prensky was stated: "Digital immigrant instructors, who speak an outdated language (that of predigital age) are struggling to teach a population, that speaks an entirely new language" (Prensky, 2001, p. 4).

With the renewal of the curriculum of the Design and technology course in primary schools, 3D modeling and visualization has become one of the standards of achievement. The curriculum states: "Introduce the idea with a sketch, a product with technical documentation and the process with technological documentation (drawing in orthogonal and isometric projection, with a three dimensional model (3D)), with the words, examples, using models or other means" (Fakin et all, 2011, p. 13).

3D modeling was thus added in the curriculum in all classes in the set:

- Documentation, with the content of drawing or 3D modeling with computer graphic software (CAD, 3D).
- Computer and control, computer aided manufacturing, with the contents of drawing with computer graphics software (CAD, 3D).

In addition to a compulsory subject of Design and technology, the elective course Drawing in the geometry and technic was renewed. The aim of this course is to create skills, knowledge and attitudes in technical and information technology that define competences and form the basis for lifelong learning. With discovering and developing their own abilities, attitudes and interests the pupils are informing themselves, raising awareness and are being guided into appropriate occupations. Emphasis is placed on developing key competences which with the development of creativity, innovation and entrepreneurial individual, constitute part of the bases for the technical and technological development of society.

SketchUp also allows cross-curricular integration of Design and technology with other natural science subjects:

- Elective course Computing: Virtualization and visualization.
- Mathematics: Presentation of geometry and geometric objects in virtual space.
- Biology: Presentation of cells and the anatomy of animals and people in virtual space.
- Chemistry: Presentations of the structure of atoms, molecules and compounds in virtual space.

Using SketchUp is not limited to subjects of natural science; it can also be used in all subjects in primary schools, where for a better understanding of the subject matter the presentation in virtual space is needed (Dolenc, 2012).

The renovation of the curriculum of the course Design and technology and an elective course Drawing in the geometry and technic, caused a need for new knowledge among teachers of these subjects. At the Faculty of natural science and mathematics, department of technical education, which is responsible for training teacher of primary and secondary schools has therefore prepared two courses as a part of continuing education and training programs and qualification for teachers (and also for other professionals):

- 3D modeling with SketchUp and
- 3D modeling, computer aided design (CAD) and computer aided manufacturing (CAM).

In the light of the renovation of the curriculum a manual: "3D modeling and visualization with Google SketchUp" has been prepared (Dolenc, 2012). The manual provides detailed descriptions of the tools for drawing and visualization based on concrete examples and goes through everything you need to know about the program SketchUp, and how you can transfer the idea into virtual space. The manual is intended for absolute beginners, as well as for the most demanding users, since it covers many years of experience and practice, which can be seen in the book in a form of advices and warnings, which encompasses the essence of the program. The manual is a welcome novelty in the Slovenian market and it is the first book in Slovenian, which addresses the 3D modeling and visualization by using SketchUp.

Conclusion

In recent decades there have been significant changes in the field of technical documentation and visual creation. Traditional technical drawing has lost its supremacy not only in industry but also in school. It was substituted by technical modeling, which brought expressive and visual information closer to the way of human perception of such information. These modern trends in technical practice must also be followed by practice in schools. Many years ago schools began using different programs for spatial modeling. Programs that were applied there were usually pretentious and mainly user unfriendly. But today's also in general education such programs are necessary and must be user friendly. This needs to be done also because we need to keep pace with technological developments and provide the learner in the education and training with basic knowledge and skills which will form the basis for his further education, work and life.

The introduction of 3D modeling and visualization into the primary school curriculum Design and technology in students increases: spatial intelligence, developing observational skills, assessment of relationships between parts and whole, enhances constructive imagination and constructive thinking, encourages curiosity and positive attitudes towards science, contributes to better achievements in the field of substantive knowledge and ultimately draws closer the subjects of science and technology to the pupils, which suggests that these characteristics, abilities, qualities and acquired categories are of great benefit in enhancing the quality of personal, social and especially professional areas of life.

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