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Applying Experiential Learning Theory in Teaching Parts Representation

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Abstract
The present paper aims to present aspects on applying the experiential learning theory in engineering education, in teaching technical drawing. The experiential learning theory describes the process of learning from the experience gained previously, in a cyclical way, involving four stages - experience, reflection, abstract conceptualization and experimentation, each stage being related to a certain learning style. The paper presents applications which explain the issues involved with applying the experiential learning theory in teaching technical drawing. It is presented a laboratory application designed for teaching the representation of parts – views and sections or sectional views.

Keywords
technical drawing, experiential learning, view, section

1. Introduction

Experiential learning theory represents one of the most important contemporary learning theories [1, 2] which describes the process of continuously learning from experience. The experiential learning theory concept was introduced by David Kolb, in 1984, and was applied by teachers and trainers working in different areas. The concept is indicated to be suitable for cases in which students are elder than 16 years [1-4]. The concept of the experiential learning process states that the knowledge is achieved by learning from experience, and it is valid for any stage in the educational process [3, 4].

The theory of experiential learning describes the process of learning as being a cyclical one, with four stages – experience, reflection, abstract conceptualization and experimentation. This process is cyclical due to the fact that the last stage in the current cycle of learning represents the first stage in the next cycle of learning. Figure 1 presents the four stages of the process of learning, as well as the four distinct learning styles, as described by Kolb [3, 4].

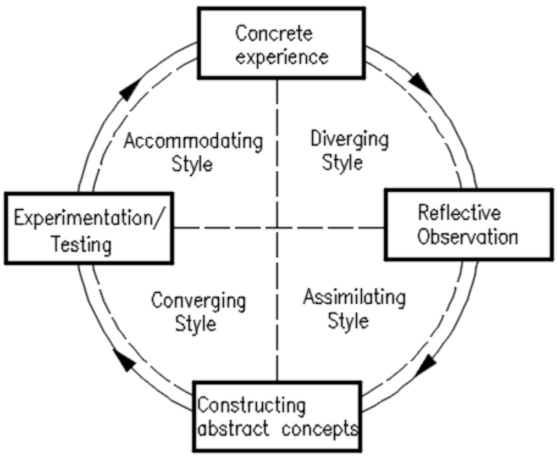


Fig. 1. The cycle of learning and the four learning styles, according to Kolb [3, 4]

Technical drawing is a very important subject in engineering education, it is considered to be a fundamental subject for the engineering studies. It provides the conditions for the development of the professional competencies related to operating with fundamental concepts from the field of engineering sciences, as well as for the designing of constructive solutions and of manufacturing technologies [5-7] and, a very important fact, it enables the development of the space sight abilities of the students attending the classes of an engineering program.

The original main idea of the paper presented is to use the principles of the experiential learning theory and, at the same time, the experience of the author in teaching graphical subjects, in order to design laboratory applications that would accompany the lecturers, providing conditions for the students to get the necessary skills and also a real interest in the subject.

2. Applying Experiential Learning Theory in Teaching Representation of Parts

In teaching technical drawing, one of the first chapters which is taught is the chapter presenting and defining the views, sectional views and sections [5-7]. At the moment when this chapter is taught, most of the students have not earned yet sufficient skills such as to choose the type of projections and the number of orthogonal projections needed for defining completely a certain part. In order to support the lecturers, specific books, didactical materials and posters are always used, but much more important are the applications, the laboratories, which need to be designed in order to provide the necessary skills for the students.

The objective of the laboratory applications presented in this paper is to support and complete the explanations given in the lecturers such as to reduce the effort of the students for understanding the basic elements of the graphical representation and modelling of the parts, to enable them to decide correctly what type of orthogonal projections are to be used for different types of parts and which is the minimum number of orthogonal projections needed for defining completely the parts.

The paper presents a laboratory designed for teaching representation of parts – views and sections/sectional views, laboratory which is constructed according to the experiential learning theory. The laboratory contains and passes through the four stages of the cycle of learning – concrete experience, reflection, abstract conceptualization and experimentation. In the previous laboratories students have learned that a part is to be represented in the minimum number of orthogonal projections required for describing completely the shape and dimensions of the part.

The first stage in the design of the laboratory, the stage of concrete experience, presents the issues which are to be considered when one needs to choose the way to represent a certain part. In the previous cycle of learning, associated with learning the projections arrangement, students have learned that a part is to be represented in the minimum number of orthogonal projections such as to describe completely the part in terms of shape and dimensions. At this point, they are taught that there is to be performed an analysis of the part to be drawn, such as to choose the main projection and then, the number of projections needed for defining the part (Figure 2).

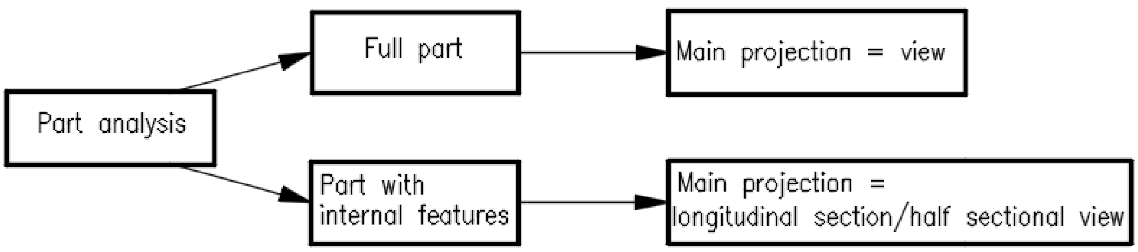


Fig. 2. Part analysis - stage of concrete experience

Depending on the shape of the part, the main projection can be a view, a longitudinal view, or a half-sectional view for symmetrical objects. In order to explain the way to choose the right projections, several parts of different shapes are considered (Figure 3).

The next stage in the cycle of learning is the stage of reflective observation, when students need to observe and analyse the shape of the parts considered and they also need to decide which are the types of projections appropriate for each part and how many projections are needed for each part.

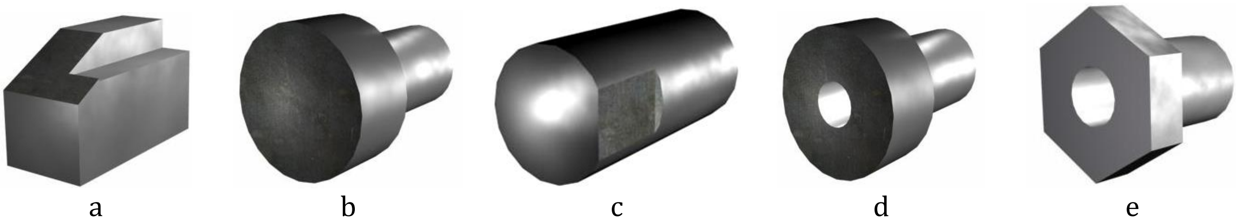


Fig. 3. Parts to be represented

The number of projections needed depend on the shape of the part: for prismatic parts (Figure 3, a), two projections are necessary to be represented (Figure 4), for cylindrical parts (Figure 3, b and d) one needs a single projection -view (Figure 5, a) or longitudinal section (Figure 6, a), and for cylindrical parts which have also plane surfaces (Figure 3, c and e) two projections are needed – views (Figure 5, b) or half sectional view plus a left-hand view (Figure 5, b). By understanding those issues, students pass to the stage of abstract conceptualization, in which they conceptualize the theory presented and they can construct the required projections for a part which is indicated.

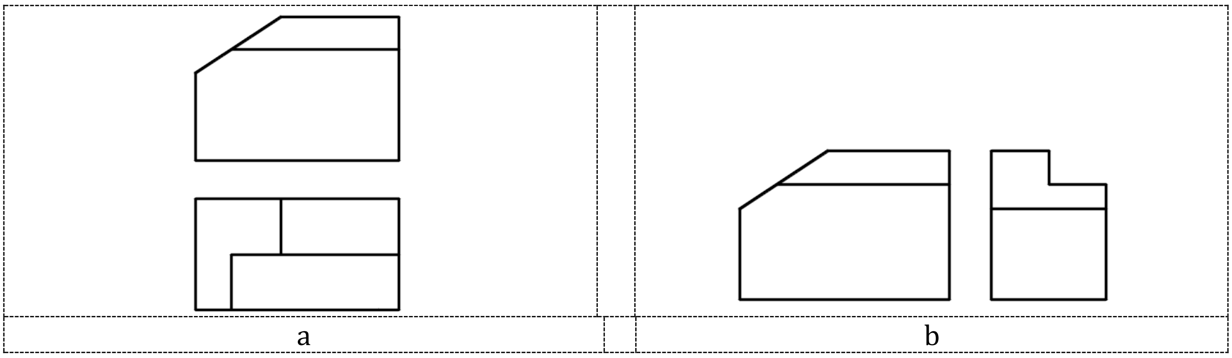


Fig. 4. Stage of abstract conceptualization- prismatic part: (a) the part is drawn in two projections, main view and top view; (b) the part is drawn in two projections, main view and left-hand view

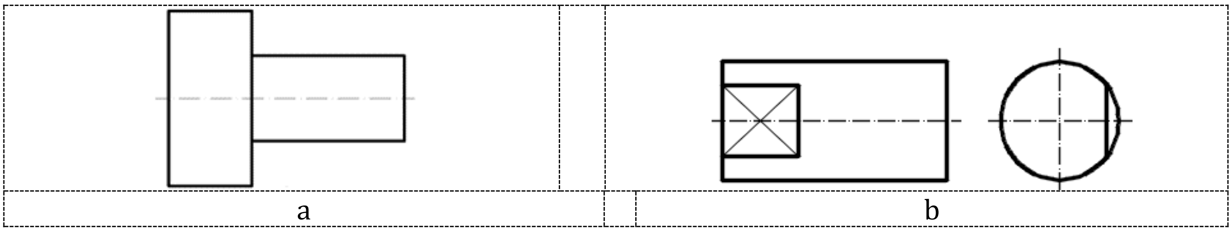


Fig. 5. Stage of abstract conceptualization - full parts: (a) the part is drawn in one projection - view; (b) part with plane faces - the part is drawn in two projections, main view and left-hand view

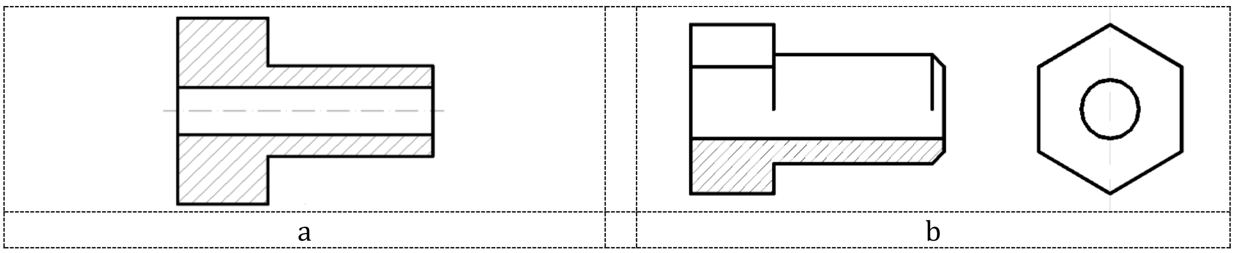
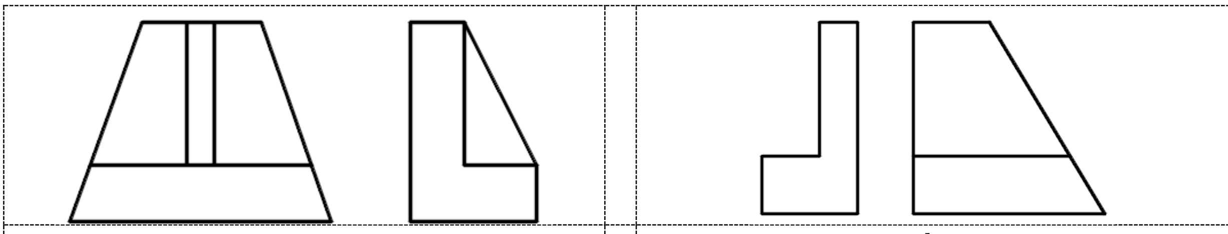


Fig. 6. Stage of abstract conceptualization- parts with internal features- (a) the part is drawn in one projection- section; (b) the part is drawn in two projections, half-sectional view and left-hand view

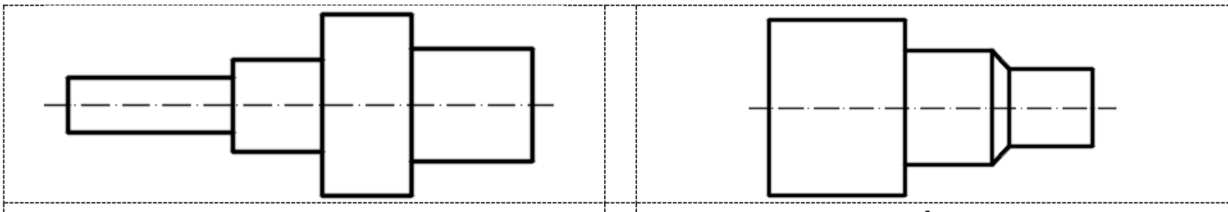
Figure 4, a and b present the projections required for describing completely the prismatic part in Figure 3, a. Figure 5, a and b present the projections needed for describing full cylindrical parts (Figure 3, b and c) and Figure 6, a and b the projections for the cylindrical parts with internal features in Figure 3, d and e.

The last stage of the cycle of learning, associated with the described laboratory, is the active experimentation stage. Students were asked to imagine different parts which can be set in the five categories presented: prismatic parts, full cylindrical parts, full cylindrical parts with plane surfaces, cylindrical parts with internal features and cylindrical parts with internal features and plane surfaces. They needed to represent the parts in the minimum number of projections, chosen according to the shape of the part considered. The figures below present some of those drawings made by the students. Fig. 7 presents the projections needed for defining two prismatic parts. In case of full cylindrical parts, one needs a single projection, view, to define the part (Figure 8), while in case the full cylindrical part has also plane surfaces, two projections, view and left-hand view, are needed (Figure 9). Cylindrical parts with internal features are to be represented in a single projection – longitudinal section (Figure 10).



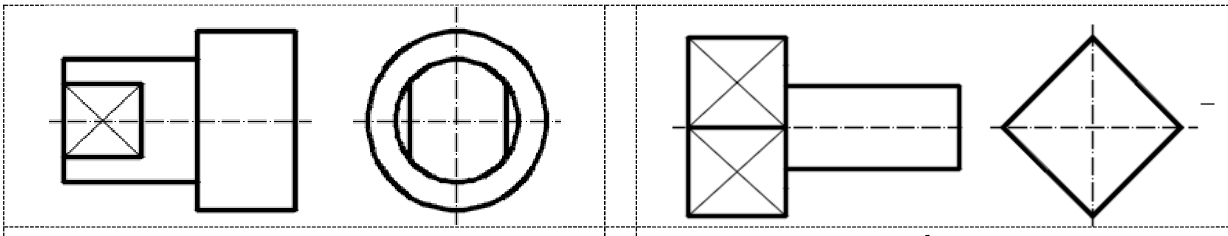
a b

Fig. 7. Stage of active experimentation – prismatic parts



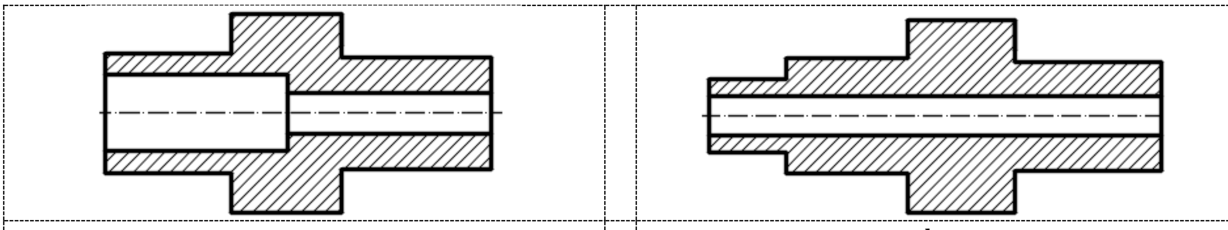
a b

Fig. 8. Stage of active experimentation – full cylindrical parts



a b

Fig. 9. Stage of active experimentation - full cylindrical parts with plane surfaces



a b

Fig. 10. Stage of active experimentation - cylindrical parts with internal features

Cylindrical parts with internal features and plane surfaces are to be represented in two projections, half-sectional view and left-hand view (Figure 11).

The drawings made by the students of two groups, 43 students, have been evaluated. The results, presented in Table 1, indicate a good understanding of the issues taught in the respective laboratory.

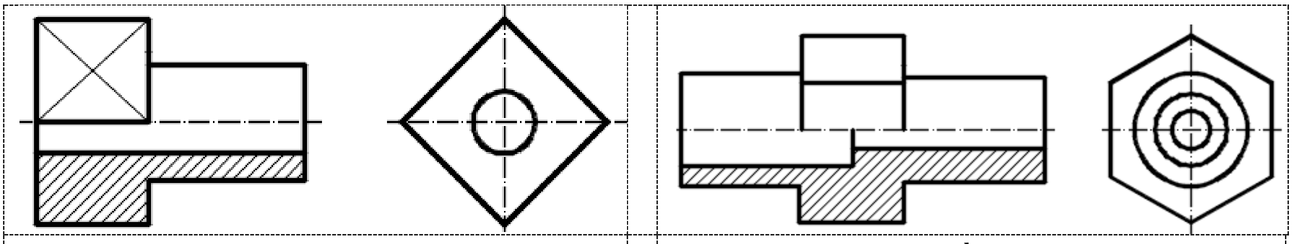


Fig. 11. Stage of active experimentation - cylindrical parts with internal features and plane surfaces

Table 1. Results obtained by the students in the active experimentation stage

Types of parts	Ratings			
	Not satisfactory	Satisfactory	Good	Very good
Prismatic parts	0	5	21	17
Full cylindrical parts	0	4	18	21
Full cylindrical parts with plane surfaces	1	8	23	11
Cylindrical parts: internal features	0	4	20	19
Cylindrical parts: internal features, plane surfaces	3	10	19	11

3. Conclusions

Experiential learning theory proves to be an important method to use to improve the knowledge of the students in the laboratory applications, since the results are considerably good. Although it is a challenge for the teacher to design the activity, laboratory or course, according to the experiential learning theory concepts, the results indicate that it is a method to be considered. By passing through each stage of the cycle of learning, students gain experience continuously, fundamental knowledge and a high creation capacity and, also, a very important fact, they get a real interest in the subject.

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