

Learning Styles: An Overview of Concepts and Research Tools and Introduction of Our Research Design in Physics Education Field

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Abstract. This contribution summarises the main approaches to learning styles and their definition. The characteristics of the learning style and several related terms are clarified. An overview of existing tools for learning styles research, such as MSLQ or LSI questionnaires is also presented. The dimensions these tools focus on are specified and the differences between them are illustrated with several examples of actual questionnaire items. The design of our scheduled research in physics education field is introduced.

Introduction

Nowadays there is a developing trend to respect the different needs of individual pupils. The theory of learning styles maps the differences in how the pupils learn new things but it has been discussed especially in pedagogy or in didactics of arts. We suppose that for physics education it would be beneficial to find out if there is some learning style preferable because learning of natural sciences may include its particular specificities [1]. It could allow teachers to choose appropriate methodical tools to provide a good physics learning environment to different types of students and to improve the effectiveness of physics education. Moreover it is also a chance to increase the motivation of students to learn physics because of their greater success in physics if we take their learning styles into account.

The main approaches and terms

In the literature there are several different approaches to learning styles and their definition. They differ in a number of topological variables. Learning styles have been in the focus of such a vast number of researchers, especially in psychology but also in pedagogy, that there exists a variety of definitions, interpretations and models related to this topic. We introduce some of them to illustrate the ambiguity and to set the boundaries of our own research.

Learning style models

The plurality of learning style models is particularly evident from Table 1, which is taken from [2]. As it shows, there are different aspects and processes involved in the definition of learning style depending on the author of the appropriate model.

Learning style definitions

Based on the learning style models there are several definitions of the term learning style itself. Hartley provides the following definition: “Learning styles are the ways in which individuals characteristically approach different learning tasks” [3]. Sarasin describes learning styles rather as some predispositions: “Learning style is the preference or predisposition of an individual to perceive and process information in a particular way or combination of ways” [4]. James and Gardner include also the learning conditions in their definition of learning style: “Learning style is a complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store, and recall what they are attempting to learn” [5].

Classification systems of the learning styles

There are many classification systems of learning styles. Some of them are based on neurological and neuropsychological research, others describe the ways how individuals perceive, organise and process the information.

The four-modalities classification distinguishes between four groups of learners: the visual, the auditory, the kinaesthetic and the tactile. The representatives of these groups have different/ diverse

Table 1. Taxonomy of learning style models [2].

Model	Curry (1987)				Riding and Cheema (1991) Wholist-analytic	Rayner and Riding (1997)		
	Instructional preference	Social interaction	Information processing	Cognitive personality		Personality centred	Cognitive centred	Learning centred
Witkin (1962) Field-dependence/independence				●	●		●	
Kagan (1965) Impulsivity-reflexivity				●	●		●	
Holzman and Klein (1954) Leveller-sharpener				●	●		●	
Pask (1972) Holist-serialist				●	●		●	
Pavio (1971) Verbaliser-visualiser				●	●		●	
Gregorc (1982) Style delineator				●	●		●	
Kauffmann (1979) Assimilator-explorer				●	●		●	
Kirton (1994) Adaption-innovation				●	●		●	
Allinson and Hayes (1996) Intuition-analysis				●	●		●	
Kolb (1984) ELM			●					●
Honey and Mumford (1992) LSQ			●					●
Vermunt (1994) LSI			●					●
Entwistle & Tait (1995) Surface-deep			●					●
Biggs et al. (2001) SPQ			●					●
Schmeck et al. (1991) ILP			●					●
Hunt, Butler, Noy, and Rosser (1978) Conceptual level			●					●
Dunn, Dunn, and Price (1989) LSI	●	●						●
Reichmann and Grasha (1974) Styles of learning interaction model	●	●						●
Ramirez and Castenada (1974) Child rating form	●	●		●				●
Reinert (1976) ELSIE				●				●
Hill (1976) Cognitive Style Interest Inventory				●				●
Letteri (1980) Learner types				●				●
Keefe and Monks (1986) Learning style profile	●	●		●				●

sensory modality preferences during their learning process. Visual learners prefer to stimulate their vision by some written texts, graphs or pictures, while kinaesthetic and tactile learners learn their best if they can touch objects used for learning, manipulate with them, play some motion games and move.

Field-dependency classification indicates that field dependent learners distinguish particular components of the task with difficulty and they are not able to find a figure in a complicated field usually, while field independent individuals identify the details easily because they perceive the components separately from the field.

Classification based on hemispheric dominance divides learners in two groups: left-brain and right-brain dominated. During the learning process both hemispheres are active but each of them processes the information in a different way. The left hemisphere is considered to be the centre of analytical, logical and systematic processes, while the right hemisphere is said to be rather holistic, intuitive and imaginative.

Ambiguity in/tolerance classification describes how learners work with some information that disagree with their existing knowledge and concepts.

We can also deal with learners reactions and approaches to finding solutions of a given problem. Impulsive learners proceed fast but they are not accurate in contrast to reflective learners who spend more time analysing the problem and usually reach a more accurate solution.

Key terms delimitation

The variety of learning style models and the ambiguity of related definitions of the learning style affect definitions of other terms used in learning styles research. For our own research especially the terms “learning style” and “cognitive style” are important so we focus on their delimitation. The two mentioned terms are really close to each other and there are four main possibilities of their relation. According to Curry [6], Dunn, Dunn and Price [7] and also Mareš [8] we accept the idea that the concept of the learning style is wider and that it exceeds cognition. The cognitive style is only one part of the learning style then. This idea is illustrated by Figure 1.

We understand the cognitive style as a mostly inborn and only hardly suggestible part of the learning style. Some other specific differences between these two terms are shown in Table 2.

Hereafter and for the purpose of our research the learning style is read as a characteristic that has a number of components and is defined according to Keefe as: “the composite of characteristic cognitive, affective and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment” [9].

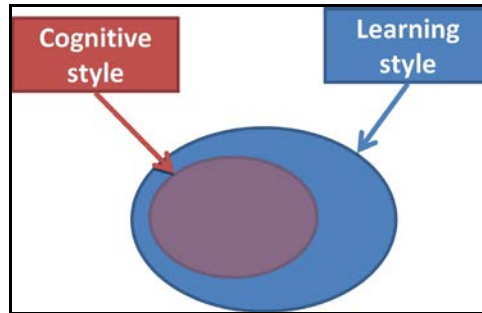


Figure 1. Relation between learning style and cognitive style.

Table 2. Learning style and cognitive style comparison. Translated from [8].

	Cognitive Style	Learning Style
Origin	mostly inborn	mostly obtained
Activation	mostly spontaneous	initially spont., later conscious
Content dependency	minimal	stronger
Situation dependency	average	strong
Outer suggestibility	little	potentially strong
Inner suggestibility	little	potentially strong

The cognitive style is the term that we use for fairly fixed characteristic of an individual to describe his/her typical or habitual mode of problem solving, thinking, perceiving and remembering. We incline to Riding, Glass and Douglas, who define cognitive styles as “static and relatively in-built features of the individual” [10].

We also distinguish the “learning strategy” in our terminology as a strategy that students adopt while studying. A learning strategy means some particular method. It is an obtained behaviour of how the learner approaches the task. In accordance with Hartly [3]: “Different strategies can be selected by learners to deal with different tasks. Learning styles might be more automatic than learning strategies which are optional.”

On the basis of the previous definitions the learning style is a predisposition to create and/or adopt some learning strategies and to incline to some methods and processes.

Learning styles diagnostics

Measuring the characteristics of learning styles and learning styles diagnostics is a sophisticated process because of the complexity of this problematic (many variables that are hardly controlled). Various qualitative and quantitative methods are used by psychologists in the learning styles research. They include observation, interview and questionnaires.

For the purpose of our research we choose to diagnose learning styles by a learning styles questionnaire. We consider it advantageous because of the complex nature of obtained data and because there is a variety of questionnaires the validity and reliability of which was tested and studied thoroughly.

Learning Styles Inventory (LSI)

The LSI questionnaire was developed by R. Dunn, K. Dunn and Price. The authors of this tool define learning style as: “The way in which each learner begins to concentrate, process and retain new and difficult information. That interaction occurs differently for everyone” [7].

In consistency with this definition each individual’s strengths and preferences are identified across the full spectrum of twenty elements that are grouped into five categories: environmental, emotional, sociological, physiological and psychological stimuli. These elements and categories are visualized by the scheme in Figure 2.

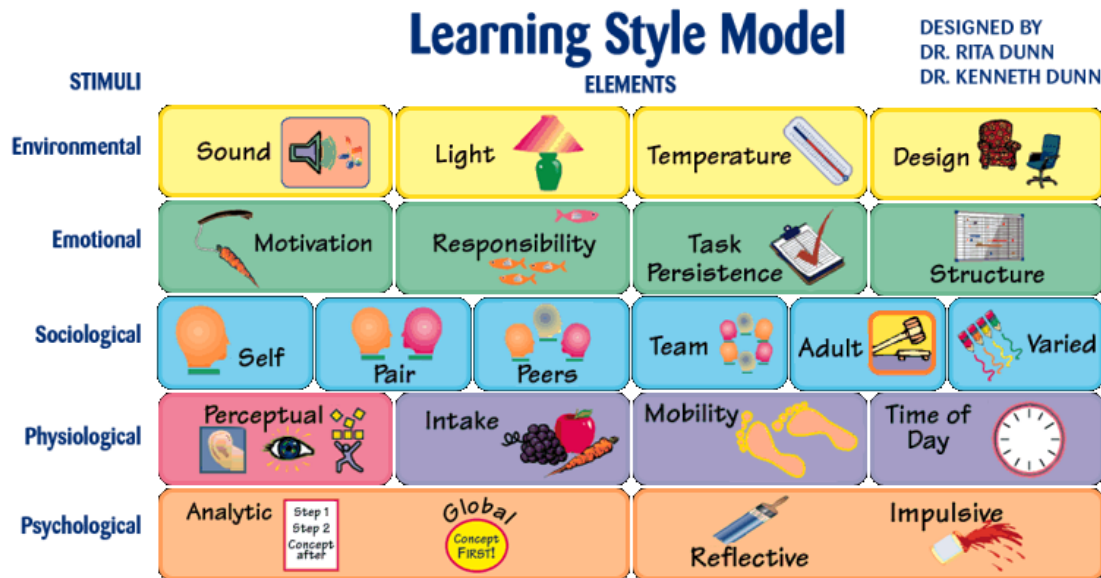


Figure 2. Elements and categories of the learning style mode of Dunn, Dunn and Price (from the Internet).

Versions of the LSI for primary and secondary school children and for adults were developed. A reasonable reliability of the questionnaire and good validity data have been demonstrated in existing studies [2, 8].

This questionnaire was also translated into Czech by J. Mareš and V. Slavík. This Czech version was constructed for 3rd to 12th grade students and it was verified with 891 secondary level students and 402 high school students. Compared to the original version this adaptation has only 71 items and less strict limits of the scale for 5th to 12th grade students.

Motivated Strategies for Learning Questionnaire (MSLQ)

The MSLQ tool was developed by P. R. Pintrich and T. Garcia for the testing of secondary and high schools students. It is designed to measure student’s motivational orientations and their use of different learning strategies. This questionnaire consists of 81 items which are answered via 7-point Likert scale where 1 stands for “not at all true of me” and 7 means “very true of me.”

Components of the MSLQ are divided in two broad categories: the motivation section and the learning strategies section. These categories and their sub-scales are summarised in Table 3.

Several examples of actual questionnaire items

Figure 3 illustrates one MSLQ questionnaire item. It is also related to the content of the course.

LSI questionnaire items (see Figure 4) are rated through the 5-point Likert scale (Figure 5). The items shown in Figure 4 refer to environmental preferences of the learner.

From the previous information it is obvious that the LSI questionnaire can provide answers to the questions about the learning environment of the learners, their preferred learning situations or about their reactions to the assigned tasks. In contrast, MSQ is more narrowly focused. It encompasses students’ motivation and their learning strategies, so it provides different information than LSI.

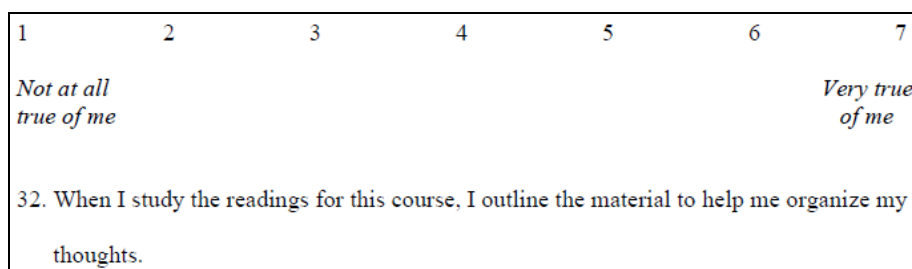


Figure 3. MSLQ item example [11].

Table 3. Components of MSLQ [11].

Part 1: Motivation Scales		Part 2: Learning Strategies Scales	
Scale	# of Items	Scale	# of Items
1. Intrinsic Goal Orientation	4	1. Rehearsal	4
2. Extrinsic Goal Orientation	4	2. Elaboration	6
3. Task Value	6	3. Organization	4
4. Control of Learning Beliefs	4	4. Critical Thinking	5
5. Self-Efficacy for Learning & Performance	8	5. Metacognitive Self-Regulation	12
6. Test Anxiety	5	6. Time/Study Environmental Management	8
		7. Effort Regulation	4
		8. Peer Learning	3
		9. Help Seeking	4
Total Number of Items	31	Total Number of Items	50

- I study best when it is quiet.
 - I study best at a table or a desk.
 - I can ignore most sound when I study.
 - I like to study by myself.

Figure 4. LSI items [7].

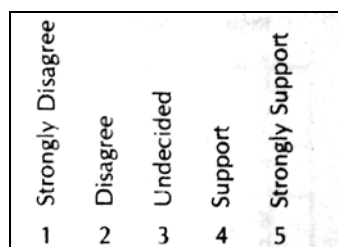


Figure 5. LSI Likert scale [7].

Our scheduled research

Three main tools are intended to be administered to the participants of our research: Learning style questionnaire, Epistemological Beliefs Assessment for Physical Science (EBAPS) and Conceptual Test in Optics originally developed for this research. The development is in progress and a detailed description will be provided for example within the ICPE 2013 conference. The respondents will be Czech high school students in their last two years of studies.

The main goal of the project is to obtain a detailed description of the learning styles used among Czech high school students in physics — optics. Our research is aimed at optics because of two reasons: (1) It has not been explored in terms of learning styles and it contains topics with both a low level of abstraction (geometric optics) and a high level of abstraction (wave optics). (2) In the Czech Republic optics is usually thought in the last two years of high school studies, when the students probably have their learning strategies fixed as reactions to their preferred learning style.

The research will also compare learning styles and strategies of students with excellent and below-average results in physics. Expected diversity in students' approaches will be presented to the wide expert public and recommendations for teachers and students will be formulated. It will allow teachers to choose appropriate methodical tools to provide a good physics learning environment to different types of students.

Conclusion

The article describes learning styles and strategies of secondary level students and the design of the research aimed at student's learning styles in physics, particularly optics. We summarize different approaches and definitions that are used in the expert community. We delimit the terminology used in our own research.

Our research is aimed at physics and its main goal is to obtain a detailed description of the learning styles used among Czech high school students in physics — optics. It will also compare learning styles and strategies of students with excellent and below-average results in physics.

We decided to use one of already existing and valid questionnaires to diagnose typical students' learning styles. The final choice will be done from one of the two mentioned learning styles questionnaires LSI and MSLQ after a discussion with experts in physics education.

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