

Students Learning Styles Classification For e-Education

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Abstract— The paper discusses the results of studies in the literature for modeling learning styles. It presents the basic aspects of the problem, and selected models. The paper ends with a detailed description of the selected model - including the manner of its recognition and how to store it in a computer system.

Keywords— e-learning, learning style classification, VAK model

I. INTRODUCTION

The learning process in order to be effective needs to ensure a student certain conditions: quiet and comfortable environment for knowledge acquisition and aptly prepared teaching material. It is commonly believed that the ideal learning environment is characterized mainly by: a quiet room, a large desk with comfortable chair, a decent lighting, and books written in an accessible way appropriate to the age of the pupil. Such learning environment is being met by every young person starting his education in a primary school and continuing it through a high school, and finally at university. It is common knowledge that the ideal conditions for learning do not always meet the expectations of all learners. It is not always the case for everyone - no matter age, gender and psycho-emotional state at the moment, that the best timing to assimilate the knowledge is time between 8 am and 3 pm, or in a group 20-30 people, sitting in at a school desk. Over time, each person finds their own optimal learning environment, allowing maintain optimal concentration levels and to provide excitatory stimuli for the own characteristic.

However there are aspects that in a traditional teaching seem to natural, and which ought to be introduced into the e-learning, in order increase student friendliness and increase learning effectiveness. Experts [14, 16] suggest that the effectiveness of the on-line courses is impacted by given below factors, such as:

- *Acquaintance of the other course participants.* It is a typical aspect of the effectiveness of each learning environment, and it results directly from the natural human need to communicate and stay together. In the distant learning, communication between participants is substituted by the following means: forum, chat, instant messaging or e-mail. In recent years, the relationships between Internet users are being built around social networking sites (e.g. Facebook) [11], which may also

serve as a communication platform – to introduce online training participants one another.

- *Clear objectives of a course.* It is imperative, not only related online systems that courses should be created on the basis of the framework plans and have defined minimum standards to comprehend. Each student participating in a course should be familiar with the presented at the beginning, its requirements and objectives. A very important aspect is also a simple and easy to grasp assessment system - and agreed a minimal score to pass [13].
- *Cooperation and competition.* A very important aspect in teaching is to provide participants possibility to work in groups, as well as the opportunity for discussion, criticism and self-assessment of their skills against the group. In the case of traditional teaching these things are natural and easy to implement. Students willing to work in groups create their internal structures and divide their responsibilities. Each group has a teacher that supervises their work - acting as the moderator and consultant - he can keep track and assess the progress of work of each group. At the same time, each participant during the lesson can evaluate the progress against own group or/and against the whole class. Cooperation and competition provide many incentives to deepen the knowledge and for gaining new skills. Working in groups, in the case of e-learning is much more difficult because of communication problems, distributed responsibility and work synchronization. Nonetheless it is not impossible - but it is necessary to deliver adequate tools to facilitate the exchange of information, communication and rapid assessment of the progress within work group. The rivalry element within the entire group is relatively simple to achieve. Each student can compare the quality of his expressions, work and test results against the performance of other participants, if only course supervisor decide to publish such, even aggregated, results or rankings.
- *Technical support.* The course participants on distant learning platforms are people with different levels of expertise and computer skills. Therefore, it is an essential element for online courses to provide continuous technical support for both students and teachers (who should not perform any administrative functions related to learning platform) and act only as

knowledge experts or trainers within their domain of competence.

- *Flexible learning environment.* A remote learning environment should adapt to the individual needs of students, their interests and priorities, while standing guard over the assumptions and objectives for the course taken. It is very difficult to achieve, in particular, if we think about the implementation of an automatic approach, without any involvement of a third party. What nowadays platforms provide, is the ability to build an individualized learning and repetition schedule of teaching material acquisition - but at a rate and within a time frame specified by a supervisor. A desirable solution would be systems capable of identify areas of interest of individual students, adapting the course material in such a way as to make it more interesting from the viewpoint of each participant.
- *An extensive knowledge base.* Every online course should take advantage of benefits that come from the medium that links current material with external links to additional content e.g. in the Internet. With this solution, students, may quickly (materials are refined, categorized, pre-assessed) deepen even more their knowledge in particular topic related to the subject of training.

The above-mentioned elements of an effective learning environment should be treated as a base, a kind of skeleton for building online learning platforms [19]. Unfortunately, most commonly used tools available today do not implement all of these requirements, which mean that online teaching is not as effective as it could be [18]. The main reason for failures of modern tools may be found in relatively high, the potential gains from sharing the platform, cost of their preparation and maintenance. Generally speaking profits are primarily being generated by courses that are often in use and repeated – a specific training, due to a smaller audience (target group) is associated with far higher costs of teaching materials creation and technological platform maintenance.

In addition to the technical conditions mentioned above, the effectiveness of the learning in both classroom and distant approach is affected by factors such as the complexity of the learning material, quantity and diversity of material in a lesson, lesson duration, time of knowledge acquisition and the initial knowledge level of a student. In the given context, a platform of distance education is much more flexible than the equivalent of classroom learning. It allows a student for independent decision making about how long and when will he learn. It does not require the presence of the teacher when the student begins to learn - which allows the use it around the clock. However, traditional learning, has a huge advantage over e-learning, a teacher can observe not only the performance of the student (as in the case of e-course), but also to supervise and oversee the progress of knowledge acquisition and if necessary - to intervene, correct and explain. All these features are missing in on-line trainings.

II. STUDENT'S EVALUATION

Any process, including teaching requires the tools to assess the correctness of its course. The main evaluative element in the learning process is to assess the acquisition of knowledge from the subject of training by participating students. At each stage of education, we are subjected to various forms of verification of our knowledge, and then receive grades, which in a discreet manner determine our expertise level of the subject. The emergence of new forms of learning such as distance learning, has forced the emergence of new measurement tools and evaluation of educational progress, relevant to the technical capabilities and taking into account the specificities of place and time.

A. Assessment in distant learning

The subject of e-learning is very interesting to the professionals from various branches including psychologists, educators, theorists and practitioners in methods of teaching [5, 14]. Many of them claim that e-learning methodology requires changes in both teaching methodologies and approach to its assessment [1]. However, a typical solution is to remodel the traditional assessment and adopt its principles into new situation. The main differences in assessment by a teacher and e-instructor result from replacement of direct contacts between a student and a teacher by indirect one through Internet medium. One can define two basic differences in traditional approach to assessment versus and remote one:

- The teacher cannot observe the student's progress in learning.
- The teacher assesses only the finished '*product*' that is submitted for assessment.

The first point is arguable. Student's actions can be tracked through the activity records, recorded automatically by e- platform in the logs. This information, however, does not provide us answers to the question whether the student actually devote time to analyze the content of the course, or just opened a browser window on the website of the course, and then took up other activities. Moreover, a teacher besides simple activity records is not being given the real picture what is the actual behavior of a student. This information is "an added value" to evaluate educational process - resolved task, ended up test in traditional teaching is used in evaluation and tracking of student's learning progress and accomplishments gained so far.

Another problem associated with the assessment of learning, is to verify if the task was performed by the student on his own, or with somebody's help. The absence of a teacher, while solving problems / writing tests becomes an extra incentive for use of additional materials, or somebody's help or even to commit plagiarism (conscious or unconscious).

In the distant learning, the teacher must adapt the forms of assessment to features of given technological platform. In e-learning it is almost impossible to use such traditional

methods like oral response, unannounced test, or student presentations for the group. The assessment model in the e-learning is usually very limited to tools such as:

- *Student's self-assessment* – it requires from a student a lot of self-discipline, and a fair approach to the problem (thus the evaluation requires the proper pattern before it starts).
- *Automatic evaluation* - such assessment may be subjected only 'closed' tasks that previously given answers. This method may prove to be ineffective if the student will give substantially correct answer which was not envisaged by the author and thus it cannot be validated.
- *Group assessment* - a sense of anonymity on the Internet and the belief that we will never meet the other members of the course promotes this type of valuation. Using this approach, students can assess the involvement in the work of other learners, and reviewing the substantial value of their statements in the discussion forum. This method is not without a flaw, because it leaves room for abuse - which can lead to excessively high assessment of selected students, or the reverse situation - to the detriment of the persons concerned.
- *Teacher's evaluation* - often used in traditional teaching, in e-learning makes many of aforementioned problems and it is limited by the availability of a teacher. E-learning courses are characterized by a large number of participants, which requires the teacher to devote much time to this type of assessment.

Due to the scale of the problem, *Automatic evaluation* rules in teaching via Internet. It is the least absorbent for the teacher (who turns out to be the narrowest bottleneck of e-learning), and the most objective of all mentioned above. Preparation of multiple-choice test in today's tools is an easy task. At the same time to check and evaluate it - is done automatically, and a student receives almost immediate feedback. In addition, the test results easy to compare with each other and provide clear information which lesson units caused the greatest problems for course participants. The main drawback *automatic evaluation* is the potential possibility to pass exam without mastering the course content - by simply guessing the answers, or filling up by a random selection resulting in a correct sequence of responses. However, assuming the students honesty, this method can be considered good, enough for traditional and e-learning.

B. Learning styles

Learning is one of the fundamental concepts of psychology. By a term 'learning', one can understand the concept of a process of acquiring knowledge, skills, leading to permanent changes in the behavior of the learner. Whether there is a learning process, we conclude on the basis of observed changes. The effectiveness of learning depends on many factors [10, 19], both external - discussed earlier, as internal

and individual, such as short and long term memory, attention, motivation, interests and abilities.

People learn in different ways. In this process, we use all the senses, but over time some of them specialize better than others, which makes it much easier to absorb a new material with the use of those senses. Theoretically, at each stage of education, we should use our best sense and style of learning. In a practice, it appears that it is impossible to adjust the content of didactic forms of communication to the preferences of a group of students at the same time - if we have only one room and one teacher. Only thanks to Internet, and e-learning materials, the postulate of adaptation to individual may come true. The starting point for its implementation is a correct diagnosis of learning styles. This is essential to e-learning become effective. In the [5, 9] one can find some classifications of learning styles that are based on different aspects of learning process, among others:

- *Allinson and Hayes' Cognitive Styles Index (CSI)*,
- *Apter's Motivational Style Profile (MSP)*,
- *Dunn and Dunn model and instruments of learning styles*,
- *Herrmann's Brain Dominance Instrument (HBDI)*,
- *Honey and Mumford's Learning Styles*,
- *Index of Learning Styles (ILS) - Felder, Silverman, Solomon*,
- *Kolb's Learning Style Inventory (LSI)*,
- *Memletics Learning Styles (MLS)*,
- *Myers-Briggs Type Indicator (MBTI)*,
- *Paragon Learning Style Inventory (PLSI)*

1) Kolb's Learning Style Inventory

One of well-known and the most frequently quoted classifications is David Kolb's learning styles Inventory (LSI).

David Kolb, a professor at Case Western Reserve University, developed a theory of learning, and suggested four styles of learning. All four styles are based on the basic activities in the learning process: sensing, observation, thinking (reasoning) and acting. Their dependencies and relationships are shown in the figure below (Fig. 1).

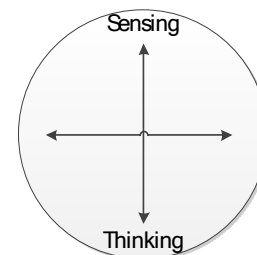


Fig. 1 Activities and dependencies

Learners are being categorized depending on which phase is dominant during learning process in the following manner:

- *(Diverging) sensing and observation* - 15 - 20% of the population. This group includes people who like to ask

questions 'why'. Their strengths are a rich imagination, the ability to look at a problem from different angles. They easily create new ideas, have wide cultural interests.

- *(Assimilating) observation and thinking - 35 - 40% of the population.* This group includes people who like ask questions 'what' type. (What's the cause?). They are interested in abstract ideas, have the ability to create theoretical models, excel in inductive reasoning.
- *(Converging) action and thinking - 30% of the population.* This group includes people who like to ask questions 'how'. They are able practically use their ideas and focus on deductive reasoning. People in this group have rather narrow scope of interests.
- *(Accommodating) action and perception - 15 - 20% of the population.* This group includes people who like to ask questions 'if' type? They are ready to take risks, respond quickly to unexpected circumstances, in an intuitive approach in solving problems. The strongest characteristic is their specific approach to action.

According to [8], recognition of learning style is done by filling out the test, containing twelve sentences, prepared answers that allow classifying a learner. Unfortunately, the prepared test is copyrighted, and must be purchased to be used later on.

2) VAK model

Another very popular and widely used model of learning style is the VAK model (Visual, Audio, Kinesthetic). This classification, proposed by Neil Fleming, divides the population into three classes [1]:

- *Visual learners* - prefer quiet and order around them other case they have difficulty maintaining concentration. They well remember the colours, drawings, and faces and the position of objects in space as well. They have a problem with remembering names, and titles. Visual learners remember best what they see in the form of text, video, graphics, and plots. They like to make handwritten notes, prefer the visual arts. During learning are not bothered by surrounding sounds.
- *Auditory learners* like to talk, sing, and whistle. They learn by listening to lectures, reading aloud, and leading discussions. They remember well: music and the conversations however may have problems with reading the graphic forms, such as maps, geometry. They prefer to speak about the action rather than watching it. They require silence to learn, music and noise do not allow focus them. They have a great ease of language learning.
- *Kinesthetic learner* feels best in motion. They become tired sitting at the desk, listening to a lecture. During the speech they often gesticulate. They require a break between learning sessions. They like to work in a group. Any movement around them may be disturbing for them.

The incidence of individual learning styles in the population is shown in figure above (Fig. 2) [7]. One can notice that the dominant style is Visual learner, and a negligible share of the population have Kinesthetic. This is information quite

important and the same time good from the perspective of e-education, because Kinesthetic is the most demanding kind to satisfy in online education.

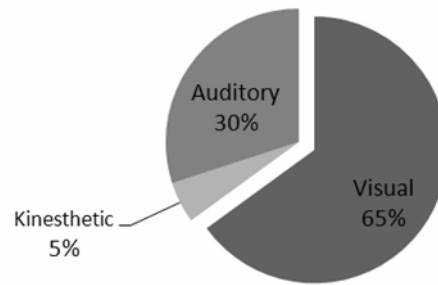


Fig. 2 Learning style distribution in learners population

Because of its simplicity, the VAK model is widely recognized in education. Virtually everyone has a general intuition about yourself to qualify for one of the categories proposed by this model. These characteristics have decided that further consideration will be used to define student's model in online educational system.

III. STUDENT'S MODEL IN A E-SYSTEM

Prior enrollment in the e-learning system every student should be obliged to solve a psychological test, which allows determining his dominant learning style. The multiple choice test has been developed by authors on the basis of [3, 4]. Here is a sample test:

Instructions

In answering questions 1 -13 select the answer that best reflect your preference. You can select more than one answer, if this does not suit your perception. Leave the blank if it does not apply to your person.

- 1. You are about to give guidance to the person standing next to you. It stopped at the hotel in the city and wants to visit your house later. He has a rented car. Do you?*
 - a. draw a map on paper*
 - b. tell him how to get to you*
 - c. write the instructions (no maps)*
 - d. give him a lift with your car*
- 2. You are not sure whether you should write the word " dependant " or "dependent. " Do you?*
 - a. check the dictionary*
 - b. you can see the word in your mind and choose the correct one*
 - c. it sounds in your mind*
 - d. you write both versions on paper and choose one*
- 3. You just have received an information about your participation in a trip around the world. Your friend is also interested in it. Do you?*
 - a. to call him immediately and tell about it*
 - b. send him a copy of the information you received*
 - c. show off him this tour on the world map*
 - d. share with him your plans for each site you visit.*

4. *Would you like to cook something special as a treat for your family. Do you?*
 - a. *cook something familiar without the need for provision*
 - b. *flip fingers cookbook looking for ideas with drawings*
 - c. *The right to resort to a cookbook where you described are good rules*

5. *A group of tourists has been assigned to you to find information on nature reserves or parks. Do you?*
 - a. *drive them to a reserve or a park*
 - b. *show them slides and photographs*
 - c. *would give them a brochure or a book on reserves.*
 - d. *would talk with them about the reserves or parks*

6. *You're going to buy a new CD player. What, besides money, would have the greatest influence on your decisions?*
 - a. *salesman telling you all about what you want to know*
 - b. *reading the specifications of the CD*
 - c. *check up the features and listening to music*
 - d. *whether the CD looks really smart and trendy*

7. *Remember the time in your life when you learned how to play, for example, a new table game. How do you learn best? By:*
 - a. *visual traces - drawings, diagrams, graphs*
 - b. *reading the instructions*
 - c. *listening to someone*
 - d. *doing it or trying to*

8. *Having trouble with your vision. Do you prefer to ophthalmologist:*
 - a. *told you what is wrong*
 - b. *shown a diagram informing what it is not right*
 - c. *used the model to show you what is not right*

9. *You want to learn how to use a new computer program. Do you:*
 - a. *sitting in front of the keyboard and start exploring the possibilities of the experiment*
 - b. *read the instructions that tells how to use a computer program*
 - c. *You are calling a friend and ask him questions*

10. *You're in a hotel and you have a rented car. Would you like to visit friends, whose address / location you do not know. Do you need your friends:*
 - a. *draw a map on paper*
 - b. *hear how you go*
 - c. *write you how to get there (without a map)*
 - d. *pick you up from the hotel*

11. *Whatever the price, which would have the greatest impact on your decision to buy a particular textbook?*
 - a. *the earlier use of this manual*
 - b. *talk about it with a friend*
 - c. *quickly reading parts*
 - d. *your impression when you watch it*

12. *New touring cinema came to town. What would be the biggest influence on your decision to go (or not)?*
 - a. *hear the radio audition before*
 - b. *read the review about it*
 - c. *see information about it*

13. *Do you prefer a lecturer or teacher who likes to use?*
 - a. *book, writing, reading*
 - b. *graphs, charts, transparencies*

- c. *laboratory classes, practical classes,*
- d. *speaking, discussions*

Each answer in the test, was assigned a learning style from VAK model (Matching types assigned to answers are given in Table 1). Assessment, which style is dominant, for a student, requires counting the number of responses. Prevailing number of answers points out student's dominant learning style. The prepared system may be useful, but for the most accurate classification – calculation of answers belonging to other styles may be advisable. With this information, it will be possible to match student type and learning strategy that best fit to the student's learning style.

TABLE I
MATCHING VAK MODEL TYPES AND ANSWERS

Question	Answer A	Answer B	Answer C	Answer D
1	V	A	V	K
2	V	V	A	K
3	A	V	V	K
4	K	V	V	-
5	K	V	V	A
6	A	V	K	V
7	V	V	A	K
8	A	V	K	-
9	K	V	A	-
10	V	A	V	K
11	K	A	V	V
12	A	V	V	-
13	V	V	K	A

Student's model in the e-learning system may be represented by a vector: [preferred style of learning, student proficiency, the initial test result, profile of an individual learning style, the recent results] - Fig. 3. Preferred learning style, and the individual learning style profile – these can be derived from aforementioned VAK test. Other vectored components can be determined during e-system operation.

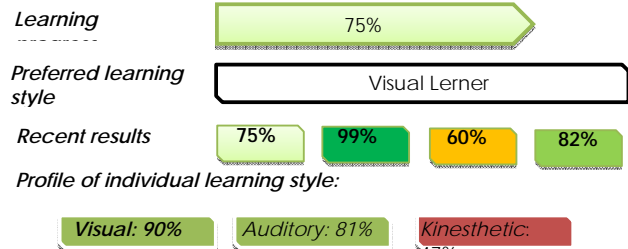


Fig. 3 Student's profile - vector

Student proficiency is determined empirically, it is the level of intellectual abilities of the student. On this basis, an algorithm can route a student on a minimal, average, or advanced educational learning path of a course [18]. This parameter is assigned and modified during the tests carried out after each portion of material that has been acquired by a student. It depends on the weighted average of its actual value and the result achieved in the tests (Fig. 4).

$$W_z = 0.8 \cdot W_z + 0.2 \cdot T_i \quad (\text{Fig. 4})$$

W_z – actual value of learning progress

T_i – result i-th test

Initial test result is defined by the percentage rating the student's knowledge of course content, prior to it, allowing to choose the path of learning appropriate to their knowledge of the subject - and best use of time student.

Recent student results shape his results vector. It allows in time for detection a trend of grades received by a student, and for judgment if learning strategy adopted is right for him.

IV. CONCLUSIONS

Problems related to the effectiveness of teaching in distant learning are well known and often described in the literature [7, 15]. Authors presented a number of principles and rules which were supposed to make e-learning environment more student-friendly and above all more efficient. The main focus of these considerations was put on the adaptability of the course content to suit needs and preferences of the individual student. Psychologists and educators have developed many models, illustrating the techniques and styles of learning, which familiarity with, promotes effectiveness of the knowledge acquisition. One of models, which is the most frequently used in conventional teaching, and in authors opinion can greatly contribute in increasing of teaching in e-learning systems is VAK model. Research on learning style showed that the majority of the population constitutes Visual learners (65%) and then Auditory (30%). So it is recommended to focus on these two styles and try to prepare appropriate e-content that matches learning style of each group.

The recognition of a student's learning style is not a trivial task [17]. The problem lies in that in human population, there are no two other persons alike, everyone differs – but there are similarities among individuals. None of the publications, neither from pedagogy nor from psychology of teaching, state unequivocally that a student must represent only one teaching style. It is quite the contrary, the variety of learning styles models [10], only confirms this fact. They are based not only on the method of learning material presentation, as it is in the case of VAK model, but also take into account the process of deduction, emotional states, the impact of environment, attitude to learning - and all the combinations between them. This means learning style even properly recognized could not be good enough to encourage student to learn. None the less it may at least help to better acquire the knowledge provided by us

Despite of difficulties with recognition learning style of a student and matching it with teaching strategy, one problem still remains - what to do next with successfully detected learning style. Although we can determine, better or worse, the student's preferred learning style, there are still not present widely available educational systems that implement the adaptability of the course material to the student type. Main cause of this situation primarily are high costs associated with both preparation of appropriate tools (e-learning platforms), and teaching materials (e-content) that would meet the requirements of the model. Taking into account simple VAK

model, and taking assumption that the material is delivered on three levels for every lesson unit one has to prepare as many as nine different versions of the content.

Hypothetical solution for the problem of the large amount of lesson variants to prepare, can be shared lesson objects, such as LOM, SCORM, which allowing reusing lesson units (called Learning Objects) for various courses on different platforms [2]. Thanks to them, there exists a sort of confidence that it will be easier preparing diversified teaching content suitable for an individual.

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