ADAPTIVE LEARNING: MAPPING PERSONALITY TYPES TO LEARNING STYLES

Errikos Siakas[1], Anastasios A. Economides [2]

[1] Technological Educational Institution of Thessaloniki,
Department of Informatics, P.O. Box 141, 57400 Thessaloniki, Greece,
esiakas@gmail.com

[2] University of Macedonia, Information Systems Department,
156 Egnatia Avenue, Thessaloniki, 54006 GREECE, economid@uom.gr

Abstract

Considerable attention has been lately paid to instructional interventions trying to accommodate learner differences, such as differences in learning styles and state of the learner as well as the surrounding state in which the learning takes place, including educational activity, infrastructure and environment. Recent developments in Web-based implementations have led scholars to reconsider the learning style research in adaptive systems. Emphasis has been put on learning style identification and diverse frameworks of adaptivity. Very few studies address the effectiveness of adaptive learning. Scholars proposing various adaptive learning frameworks also seem to suggest increased student satisfaction and performance despite the lack of enough empirical student evaluations.

The aims of this paper are to discuss current trends, potential research gaps and implications of adaptive pervasive ubiquitous learning. In this paper we concentrate on the personality parameter by drawing parallels to Myers–Briggs type indicator (MBTI[1]).

1. Introduction

Educative programs are used in various knowledge areas aiming to facilitate the learning-teaching process and to improve effectiveness of learning. Today education and learning is undergoing a world-wide change by participation of teachers, students and industry and with governments actively involved in its promotion. The trends today are characterised by decreasing dependence on face-to-face teaching and increasing reliance on Information and Communications Technologies (ICTs). The developments in ICTs, however, demand re-thinking of pedagogic principles and frameworks.

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[1] Myers–Briggs type indicator and MBTI are registered trademarks of the Myers–Briggs Type Indicator Trust.

A trend in today's learning environments are on creating, fostering, delivering and enabling learning at own place, own pace and own time with increased peer-based learning tasks and promotion of learning within Communities of Practice (COPs) (1). Another trend focuses on personalised instructional design facilitating individual learners' learning requirements, such as learning style, prior knowledge and learning priorities (2). Adaptive learning systems, intelligent systems that dynamically are organised based on the observation of the learning preferences, originate in Artificial Intelligence (AI) research in the 80s (3). However, the Learning Management Systems (LMS) of today, such as Moodle and Blackboard, seem to have discarded this feature, which require a dynamic content sequencing engine in order to organise learning assets according to individual preferences. Some attempts have been done, such as the Dynamic Course Generation (DCG), which automatically generates individualised courses according to goals and previous knowledge of learner, and adapts the course content according to the success of the learner in acquiring new knowledge (4), (5). In order to satisfy preferences of learners (learning styles and prior knowledge) multiple sources of information need to be adapted to the educational activities of every situation and condition. The necessity for auto-configured, tailored learning according to the needs, interests and abilities of learner is a precondition for personalised and adaptive learning.

2. Constructivism

It is widely recognised that learners achieve their learning objectives at different levels of success when the same learning content is provided due to the fact that the individual learners interpret meaning and construct knowledge from the learning content differently (2). Constructivism encourages a user-centred approach in contrast to course-driven design. Learners engage in the learning process by constructing new ideas and concepts based on their current or past knowledge.

Jonassen (6) refers to "*the implications of constructivism for instructional design*" by showing how knowledge construction can be facilitated. He proposes the following principles for knowledge creation:

- providing multiple representations of reality;
- representing the natural complexity of the real world;
- focusing on knowledge construction, not reproduction;
- presenting authentic tasks (contextualizing rather than abstracting instruction);
- providing real-world, case-based learning environments, rather than pre-determined instructional sequences;
- fostering reflective practice;
- supporting collaborative construction of knowledge through social negotiation;
- enabling context-and content dependent knowledge construction.

The social constructivist theory in particular emphasizes the influences of cultural and social contexts and interaction in learning (7).

Various definitions have been provided of context, such as *user context* (e.g. the profile of user, location, time, and current social situation), and *physical context* (e.g. noise levels, lighting, and temperature) (8). Schmidt et al. (9), categorised the context in *self* (physiological and cognitive state), *environment* (physical and social state), and *activity* (behaviour and task). Also the willingness of the learner to participate in the proposed learning activity is related to the context (10). Dey and Abowd (11) argue that any information that can be used to characterize the situation of an entity (e.g. person, place or object) can be considered as context.

3. Adaptive Learning

Previous studies on adaptive learning have proposed adaption of the sequencing, the learning flow or the content (12). Economides and Roupas (13) proposed adapting the exams to the examinee's knowledge so that if the examinee answers correctly/wrongly a question, then the next question would be more difficult/easier. Adaptive Feedback could thus be tailored to the needs of the examinee (14).

Despite the fact that there are many studies trying to model adaptive learning, learning context and ubiquitous learning there are very few that provide an integrated comprehensive description of relevant parameters involved that need to be taken into consideration.

Economides (15) proposes adaptive pervasive and ubiquitous learning based on a holistic context model that enables interoperability among various systems and applications. The adaptation engine employs deterministic or probabilistic adaptation decisions by taking into consideration as input the state of:

the Learner (L);

the educational Activity (A);

the Infrastructure (I);

the Environment (E).

The output can be adapted to the educational activity and/or infrastructure. Every state consists of various dimensions and every dimension consists of various variables. The learner's state, for example, consists of dimensions such as demographics, education, previous achievements, preferences, cognitive, social and cultural abilities, personality etc.

4. Personality Dimensions

Different cultural contexts bring about differences in assumptions about learning and the expectations that participants have regarding learning and teaching, the teaching model and the relationships between educator and learner, the way the technology itself is experienced, the pedagogical aspect, the design of online courses and the way in which individuals and groups communicate and respond to their environment. New

trends in teaching and learning, including adaptive blended learning environments, require a shift from instructor/educator-centred to learner-centred learning. A paradigm shift embracing active learning and knowledge sharing is needed. Participative learning is not only imperative but also made possible in the information and knowledge society.

The pedagogical trend today focuses more on learning than on teaching and calls for flexibility in teaching and assessment methods. To this respect, the nature of the new technologies (ICT) helps considerably. Blended learning is an approach culturally embodied by diverse students, different cycles of learning and different countries.

In order to embrace the contemporary teaching and learning trends emphasis need to be placed on specific learning context and how real-world outcomes both in short-term and long-term are influenced by non-cognitive factors, such as rational and emotional components, personal background including interest, motivation, experience and competence (16), (17), (18).

Previous research show that personality traits relate predictably and systematically to a whole range of educational outcome variables (19), including learning style and assessment preferences (20), (21).

Myers–Briggs type indicator (MBTI), a 94-item questionnaire of preferences (based on Jung's personality types (22)), for example, can be used to identify the psychological type of a person (23). The MBTI focuses on four areas of behaviour preferences by using pairs of opposite concepts (totally 16 distinct psychological types) to identify how people make decisions, how they gather information, where they get their energy, and which working style they prefer. It is likely that learning style will have similarities with working style. The individual personality profile is identified along four dimensions including pairs of opposite preferences.

> ***Orientation to life:*** Extrovert (E) vs. Introvert (I);
>
> ***Decision making:*** Sensing (S) vs. iNtuiting (N);
>
> ***Perception:*** Thinking (T) vs. Feeling (F);
>
> ***Attitude to the outside world:*** Judging (J) vs. Perceiving (P).

Within each pair of opposite preferences, a person leans toward one or the other in most cases.

Combining the four dimensions, sixteen unique personality types emerge as shown in the Type Indicator Table below, which lists the sixteen personality types that represent the differences between individual personalities.

Table 1: Myers-Briggs Systematic Type Indicator Table (MBTI)

			Sensing Type		iNtuitive Type	
			Thinking	Feeling	Feeling	Thinking
			ST	SF	NF	NT
Introvert Type	Judging	I-J	ISTJ	ISFJ	INFJ	INTJ
	Perceiving	I-P	ISPJ	ISPJ	INFP	INTP
Extravert Type	Perceiving	E-P	ESTP	ESFP	ENFP	ENTP
	Judging	E-J	ESTJ	ESFJ	ENFJ	ENTJ

Every combination shows a distinct personality variation and is described by Rutledge and Kroeger (24), as:

ISTJ natural organizer that sees the world in terms of tangible facts (Sensing), handled objectively (Thinking) through structure (Judging).

ISFJ committed to getting the job done. Comfortable working quietly (Introverted) in a structured environment (Judging). Has a realistic view of the world (Sensing) and makes decisions based on interpersonal factors (Feeling).

INFJ is considered inspired leaders and followers. Reflective (Introverted) and sees life as full of possibilities (iNtuitive). Does subjective decisions regarding these possibilities (Feeling), which are implemented in an orderly, scheduled manner (Judging).

INTI is an independent thinker, who reflects on ideas (Introverted) and sees the world in endless possibilities (iNtuitive). Translates these ideas and possibilities into objective decisions (Thinking), and implements them through a structured order (Judging).

ISTP is known for the ability to get things done. Often difficult to read (Introverted), lives in the present, and perceives the world in tangible terms (Sensing). Makes objective decisions (Thinking) on the spur of the moment (Perceiving).

ISFP thinks that an individual's actions speaks louder than words, and believes that plans and actions should be thought out in an orderly manner (Introverted). Sees the world as tactile (Sensing) but make subjective decisions (Feeling). Likes to keep their options open (Perceiving) rather than corning to a decision.

INFP has a gentle personality that enjoys contemplation (Introverted) integrated with imagination (iNtuitive). Uses personal values to make decisions (Feeling), and enjoyes keeping things flexible (Perceiving).

INTP likes to resolve problems by reflecting (Introverted) on the possibilities (iNtuitive), which was a basis to make objective decisions (Thinking). At the same time, easygoing and adaptable (Perceiving).

ESTP makes the most of the moment by scanning the external environment (Extraverted) and looks at it in a factual and grounded fashion (Sensing). This information is used to make objective decisions (Thinking) for whatever will be happening in the immediate moment (Perceiving).

ESFP enjoys fun through an outgoing nature (Extraverted) and has a realistic outlook (Sensing). Makes subjective decisions (Feeling) in a spontaneous manner (Perceiving), and is very flexible.

ENFP is people oriented who enjoys social interactions (Extraverted) and searches for endless possibilities (iNtuitive). Makes decisions based on interpersonal interactions (Feeling), while keeping the options open (Perceiving).

ENTP enjoys the external world of people (Extraverted) and the endless possibilities of theoretical connections (iNtuitive). These theoretical connections are objectively filtered (Thinking) but not binding, as they continued to consider new options (Perceiving).

ESTJ is natural administrator because of outgoing and direct manner (Extraverted), but sees the world in a practical and realistic way (Sensing). Uses this information to make impersonal, analytical decisions (Thinking) and implements them in a structured manner (Judging).

ESFJ is considered trusted friends who interacted with others easily (Extraverted). Pays close attention to personal details (Sensing), and uses this information in an interpersonal way (Feeling) through a scheduled order (Judging).

ENFJ is a natural persuader who is socially oriented (Extraverted), considers the possibilities (iNtuitive), and makes subjective decisions (Feeling). Uses these attributes in a structured manner (Judging) to become excellent at networking.

ENTJ is considered a natural leader with people oriented skills (Extraverted). Sees connections and possibilities (iNtuitive), is able to analyze them objectively (Thinking) and implements them in an organized fashion (Judging).

David Keirsey, a behavioural scientist who developed the modern theory of temperament, correlated his theory to the MBTI system and classified the sixteen personality types into four temperament types (25), (26). The four types were established by combining MBTI's **S**ensing, **P**erceiving, i**N**tuition and **J**udging functions, and express a person's preference for being:

Expressive vs. Attentive	*Artisan:* combination of SP traits;
Observant vs. Introspective	*Guardian:* combination of SJ traits;
Tough-minded vs. friendly	*Idealist:* combination of NF traits;
Scheduled vs. probing	*Rational:* combination of NT traits.

The Keirsey temperament sorter (KTS2) is a 70 question forced choice scored instrument with which temperaments can be quickly identified.

5. Mapping Personalities to Learning Styles

Kolb (27) developed the Experiential Learning Model (ELM) built upon the idea that learning preferences can be described in two continuums: active experimentation vs. reflective observation and abstract conceptualization vs. concrete experience. The combination results in four individual's learning preference entailing a cycle of repeatable learning attributes, namely:

> Concrete experience;
>
> Observation of and reflection on that experience;
>
> Formation of abstract concepts based upon the reflection;
>
> Testing the new concept.

Despite the fact that the link between personality and learning was clear, corporate trainers had not recognized the personality attributes as a critical factor in corporate training programs. Dubois and Rothwell (28), when reviewing corporate training models, pointed at the importance of using personality in developing corporate training. They advised corporate trainers to focus their attention on individual needs by motivating learners to structure their own learning activities in order to process information in an effective manner.

Felder and Silverman (29) developed the Index of Learning Styles (ILS) as a comprehensive learning style indicator, by using Kolb's (27) expanded theory on experimental learning (individuals learn based on experience), Jung's personality type (22), behaviourist theories (behaviour can be measured and changed through the application of behavioural ideology), and cognitive learning studies (nature of intelligence and how it develops through interaction with the environment).

Biggs (30), (31) created a Study Process Questionnaire (SPQ) to measure learning style. He found three qualitatively different learning approaches to studying, namely:

> *Surface learning:* A student with the aim of achieving the minimum requirements learns in a superficial manner and uses a predominantly surface approach. The student is goal-oriented rather than focused on deriving any intrinsic meaning from the task.
>
> *Deep learning:* The student is interested in reaching a meaningful understanding through extensive reading and research.
>
> *Achieving learning*: The student is highly committed to gaining good grades and is likely to take a systematic approach to studying.

Every approach consists of a congruent motivational pressure and a corresponding study strategy. Biggs (30) articulates that students use predominantly one of these approaches to learning, and that these approaches are correlated to different performance outcomes. He claims that the identification of learning profiles is useful for identifying the compatibility of the student with a particular learning environment. The SPQ instrument has been successfully used in other studies (32), (33) that confirm his findings.

In table 2, a synoptic comparison of different learning and personality style models, adapted from Montgomery and Groat (34), is presented.

Table 2: Comparison of Learning and Personality Style Models

Mode	Range	Myer-Briggs	Kolb	Felder-Silverman	Biggs
Orientation to Life	Extrovert - Introvert	x			
	Active- Reflective		x	x	
Decision Making	Concrete-Abstract		x		
	Feeling-Thinking	x			
Attitude to World	Sensing-Intuitive	x		x	
	Judging-Perceiving	x			
	Visual-Verbal			x	
Organisation	Inductive-Deductive			x	x
Understanding	Sequential-Global			x	
Depth of learning	Surface-Deep-Achieving				x

In table 3a to 3d, identified learning styles are mapped to the four personality areas of opposite preferences according to Myer-Briggs (a) Extrovert (E) vs. Introvert (I) (b) Decision making: Sensing (S) vs. iNtuiting (N), (c) Perception: Thinking (T) vs. Feeling (F), (d) Attitude to the outside world: Judging (J) vs. Perceiving (P). Below each table, the implications for teaching depending on the dimension, is discussed.

Table 3a: Learning Preferences mapped to Extroversion vs. Introversion types

Learning style	Extroversion	Introversion
Degree of collaboration	Group interaction	Individual activity
Source of motivation	People and environment	Concepts and ideas
Degree of multitasking	Variety of tasks concurrently	Few tasks simultaneously
Orientation	Action oriented	Observe and reflect
Engagement in tasks	Spontaneous	Planned and organised

When students belong to the extroversion dimension the teaching style and the course should be adjusted to the input and the attention level of the students. Movement and noise in classroom should be tolerated since this is the way students prefer to work.

When students belong to the introversion dimension the learning activities should be structured and emphasis should be put on the topic. Quiet and orderly classrooms are preferred by students.

Table 3b: Learning Preferences mapped to Sensing vs. iNtuition types

Learning style	Sensing	iNtuition
Assignments	Precise directions	Emphasising creativity
Material Presentation	Step-by-step	Variety of presentation
Time focus	Present	Future
Orientation	Practical application	Principle and theory
Engagement in tasks	Routine tasks	Variety of tasks
Value	Experience	New ideas

When students belong to the Sensing dimension the learning material and tasks should emphasize facts and practical information. Students expect question regarding facts and predictable responses.

When students belong to the iNtuition dimension emphasis should be put on concepts, relationships and implications. Students expect question regarding synthesis and evaluation.

Table 3c: Learning Preferences mapped to Thinking vs. Feeling types

Learning style	Thinking	Feeling
Value	Individual achievement	Group achievement
Orientation	Task oriented	People oriented
Needs to know	Principles, ideas, and facts	Influence on people
Interests in topics	Technology-oriented	People-related
Enjoy	Demonstrating competence	Pleasing people

When students belong to the Thinking dimension objective standards and few evaluative comments should be used. The class should be addressed as a whole.

When students belong to the Feeling dimension the instructor should regularly provide evaluative comments. Both objective and subjective standards can be used. Individual students can be addressed separately.

Table 3d: Learning Preferences mapped to Judging vs. Perceiving types

Learning style	Judging	Perceiving
Directions	Clearly-defined	Freedom and choices
Enjoyment in project	The completion (results)	The project activity
Uncertainty avoidance	Structure and predictability	Cope with uncertainty
Engagement in tasks	Organized and systematic	Spontaneous
Assignment completion	Well in advance	In last-minute
Work on projects	One at a time	Many simultaneously

When students belong to the Judging dimension they prefer to set and adhere to fixed schedules. Guided discussions are favoured in noiseless and tidy classrooms.

When students belong to the Perceiving dimension independent and open-ended discussion should be promoted by the instructor. Movements and socializing in groups should be encouraged.

6. Conclusions and Further work

There are many reasons to increase the understanding of learning styles and learning preferences. Many instructors are bias toward one learning style over another; usually the one suitable for their own learning style. The pedagogical trend today focuses more on learning than on teaching. To this respect, the nature of the new technologies (ICT) helps considerably. This implies that the role of the instructor include advising, moderating and facilitating, a role different than in a traditional setting. A lecture class no longer entails simply a delivery of information but includes an increased degree of

active learning techniques. Student populations also tend to be increasingly diversified in terms of ethnicity, gender, age, and cultural background, thus covering a wider range of different learning styles.

Adaptive learning aims to accommodate different learning styles though the provision of adaptive pervasive ubiquitous learning that facilitates student to interact with various devices adapting learning methodologies to learning styles of students. The aims are to help students to learn more effectively, at a faster pace, and with greater understanding. Some of the elements of adaptive learning include monitoring the activity of the students, interpreting the results, understanding their requirements and preferences, as well as, using the newly gained information to facilitate the learning process.

The basic components of a learning system (the subsystems regarding the learner, the teacher and the way they interact between them) is vital in the process of learning, despite the interest of the learner in completing a curriculum in order to obtain a new degree or in acquiring new knowledge that leads to additional qualifications. In any goal-oriented situation a moderator is always needed, who designs some steps and recommends a plan for achieving the potential goal. A learner trying to acquire knowledge in a random and haphazard way is in danger to be lost in the information mass space.

In order to motivate learners to take full advantage of learning resources, the creation of a suitable learning environment catering for diverse learning styles is imperative. Awareness of different learning styles is also likely to help to underused learning skills that are needed for the learner to learn how to learn.

Further work will concentrate on investigations in real-life situations in order to test the hypothesis revealed though the mapping of personality types to learning styles. Controlled experiments will be designed and carried out regarding the personality traits (MBTI) and the learning styles (Questionnaire combining Kolb's, Felder-Silverman's and Biggs' learning styles) of Software Engineering Students. These results will be correlated to performance measures (actual grades received by students) and satisfaction indicators (questionnaire regarding satisfaction of provided choices).

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