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Multimedia Factors Facilitating Learning

SYLVIA ENCHEVA
Stord/Haugesund University College
Department Haugesund
Bjørnsonsg. 45, 5528 Haugesund
NORWAY
sbe@hsh.no

SHARIL TUMIN
University of Bergen
IT-Dept.
P. O. Box 7800, 5020 Bergen
NORWAY
edpst@it.uib.no

Abstract: Multimedia technologies are widely used to faciliatate user access to applications. A lot of work has been done to develop multimedia design, presenting information in a variety of formats, which resulted in enrichment of users' experience and improving the learning process. This paper discusses important interrelationships among students perceptive abilities and use of multimedia for learning.

Key–Words: Multimedia, lattices, learning preferences, learning styles, learning situation

1 Introduction

Numerous research and development contributions such as authoring systems, online tutorials, collaborative learning and multimedia facilitate today's educational use of computer technology. Presenting information via multiple media formats enriches users' experience and improves the learning process. Multimedia application in a learning situation stimulates students interest in a subject and increases their motivation.

This paper discusses important interrelationships among students perceptive abilities and use of multimedia for learning.

The rest of the paper is organized as follows. Related work is listed in Section 2. Selected theory is presented in Section 3. Multimedia factors related to learning are discussed in Section 4. Learning orientations are described in Section 5. A concept lattice relating multimedia factors that effect students' learning is constructed in Section 6. The paper ends with a conclusion placed in Section 8.

2 Related Work

Various effects of multimedia on students' achievement are discussed in [13] and [14].

Theoretically grounded and empirically supported strategies that can be used to improve the development and assessment of students' critical thinking skills are presented in [16].

Research-based good practice addressing the pedagogical, operational, technological, and strategic issues faced by those adopting computer-assisted assessment is described in [9]. Integrating assessment and instruction is discussed in [8].

A model for student knowledge diagnosis through adaptive testing is presented in [6].

lgorithms for fast discovery of association rules have been presented in [1], and [20]. The complexity of mining frequent itemsets is exponential and algorithms for finding such sets have been developed by many authors such as [2], and [5] and [19].

3 Preliminaries

Let P be a non-empty ordered set. If $sup\{x, y\}$ and $inf\{x, y\}$ exist for all $x, y \in P$, then P is called a *lattice* [4].

A lattice is a partially ordered set, closed under least upper and greatest lower bounds. The least upper bound of x and y is called the join of x and y, and is sometimes written as $x + y$; the greatest lower bound is called the meet and is sometimes written as $x\dot{y}$.

X is a sublattice of Y if Y is a lattice, X is a subset of Y and X is a lattice with the same join and meet operations as Y. A lattice L is meet-distributive if for each $y \in L$, if $x \in L$ is the meet of (all the) elements covered by y, then the interval $[x; y]$ is a boolean algebra.

A *concept* is considered by its *extent* and its *intent*: the *extent* consists of all objects belonging to the concept while the *intent* is the collection of all attributes shared by the objects [4].

A *context* is a triple (G, M, I) where G and M are sets and $I \subset G \times M$. The elements of G and M are called *objects* and *attributes* respectively [4]. The set of all concepts of the context (G, M, I) is a complete lattice and it is known as the *concept lattice* of the context (G, M, I).

For $A \subseteq G$ and $B \subseteq M$, define

$$A' = \{m \in M \mid (\forall g \in A) \ gIm\}$$

$$B' = \{g \in G \mid (\forall m \in B) \ gIm\}$$

so A' is the set of attributes common to all the objects in A and B' is the set of objects possessing the attributes in B. Then a *concept* of the context (G, M, I) is defined to be a pair (A, B) where $A \subseteq G$, $B \subseteq M$, $A' = B$ and $B' = A$. The *extent* of the concept (A, B) is A while its intent is B.

A subset A of G is the extent of some concept if and only if $A'' = A$ in which case the unique concept of the which A is an extent is (A, A'). The corresponding statement applies to those subsets B of M which are the intent of some concept.

The set of all concepts of the context (G, M, I) is denoted by $\mathcal{B}(\mathcal{G}, \mathcal{M}, \mathcal{I})$. $\langle \mathcal{B}(\mathcal{G}, \mathcal{M}, \mathcal{I}); \leq \rangle$ is a complete lattice and it is known as the *concept lattice* of the context (G, M, I).

For concepts (A_1, B_1) and (A_2, B_2) in $\mathcal{B}(\mathcal{G}, \mathcal{M}, \mathcal{I})$ we write $(A_1, B_1) \leq (A_2, B_2)$, and say that

(A_1, B_1) is a *subconcept* of (A_2, B_2),

or that

(A_2, B_2) is a *superconcept* of (A_1, B_1),

if $A_1 \subseteq A_2$ which is equivalent to $B_1 \supseteq B_2$.

The structure of a concept lattice is represented with a Hasse diagram. The Hasse diagram is a special directed graph, where the nodes are the concepts and the edges correspond to the neighborhood relationship among the concepts. The Hasse diagram of a concept lattice is used to describe the concepts hidden in the underlying data system.

4 Multimedia Factors

Multiple factors, that we consider in this work, having effects on learning are

- `Visual and auditory inputs`

  They are often considered to be of great assistance in providing more effective learning outcomes. However, learners have to divide their attention across multiple inputs when presented with instruction in both auditory and visual modes [15]. Our experience implies that if learners focus their attention on one single media resource at a time have better results than those to whom more complex delivery has been offered.

- `Interaction`

  It is important to distinguish between functional interaction and learning interaction. The first one includes functions like volume control, audio and video queuing, search tools, navigation, and configuration parameters. The latter is interaction provided for specific learning outcomes.

- `Learner styles`

  Multiple views of information can be provided rather than assuming a single information structure. This way of presenting information supports effective alternatives for different learning styles. The four Kolb learning styles [12] are Diverging (feeling and watching), Assimilating (watching and thinking), Converging (doing and thinking), and Accommodating (doing and feeling).

  The learner preferences - Active, Pasive, Visual, Verbal.

- `Content delivery and content exploration`

  Content delivery refers to educational materials like textual course notes and other supporting media where learners go through the course materials in a way they do in distance education. Content exploration has more interactive fashion - simulations, games and other complex environments. At the same time interactive systems should facilitate various learner styles and provide opportunities for learner control.

5 Learning Orientations

Student learning orientations [17] are critical for individualizing the instructional process. The four learning orientations investigated in [18] are:

- `Transforming learners`

  They place great importance on personal strengths, ability, persistent effort, strategies, high-standards, and positive expectations to self-direct intentional learning.

  They use stimulating influences, such as intentions, motivation, passions, personal principles and high standards, to direct achievement of challenging personal goals.

- `Performing Learners`

  They are non-risk, skilled learners that consciously, systematically, and capably use cognitive processes, strategies, preferences as they focus on grades and attaining normative achievement standards.

  They are short-term and task-oriented, take fewer risks with challenging or difficult goals, and rely

Table 1: Units

	VI				AI		LC			LS				LO			
	T	P	V	A	I	M	Tm	Ir	N	Ac	Ps	Vs	Vb	LT	PL	CL	RL
1	√	√	√	√	√	√	√	√	√		√	√	√	√			
2	√	√	√	√	√	√	√		√			√	√	√			
3	√			√		√	√			√	√	√	√		√		
4	√	√			√		√		√		√			√			
5	√			√							√			√			
6	√	√					√									√	
7		√		√										√			
8	√														√		
9	√	√	√	√	√	√	√	√		√	√	√	√		√		
10		√		√	√		√		√			√	√		√		
11	√										√	√			√		
12	√	√	√	√		√	√	√		√		√				√	
13	√					√				√	√					√	
14		√	√						√		√						√
15	√	√				√	√				√						√

on coaching relationships and available external resources and influences to accomplish a task.

- `Conforming Learners`

  They are compliant and more passively accept knowledge, store it, and reproduce it to conform, complete assigned tasks if they can, and please others.

  They do not typically think critically, synthesize feedback, solve complex problems, make independent decisions, or give knowledge new meaning to initiate change in themselves or the environment.

- `Resistant Learners`

  They lack a fundamental belief that academic learning and achievement can help them achieve personal goals or initiate positive change.

  These learners do not believe that formal education or academic institutions can be positive or enjoyable influences in their life.

6 The Concept Lattice

For the sake of simplicity we limit the amount of attributes that may effect students' performance to the ones included in Table 1. The corresponding concept lattice is shown on Fig. 1.

Notations in Table 1

- Visual Input
  - Text (T)
  - Pictures (P)
  - Video (V)
  - Animation (A)
- Auditory Input
  - Instructions (I)
  - Music (M)

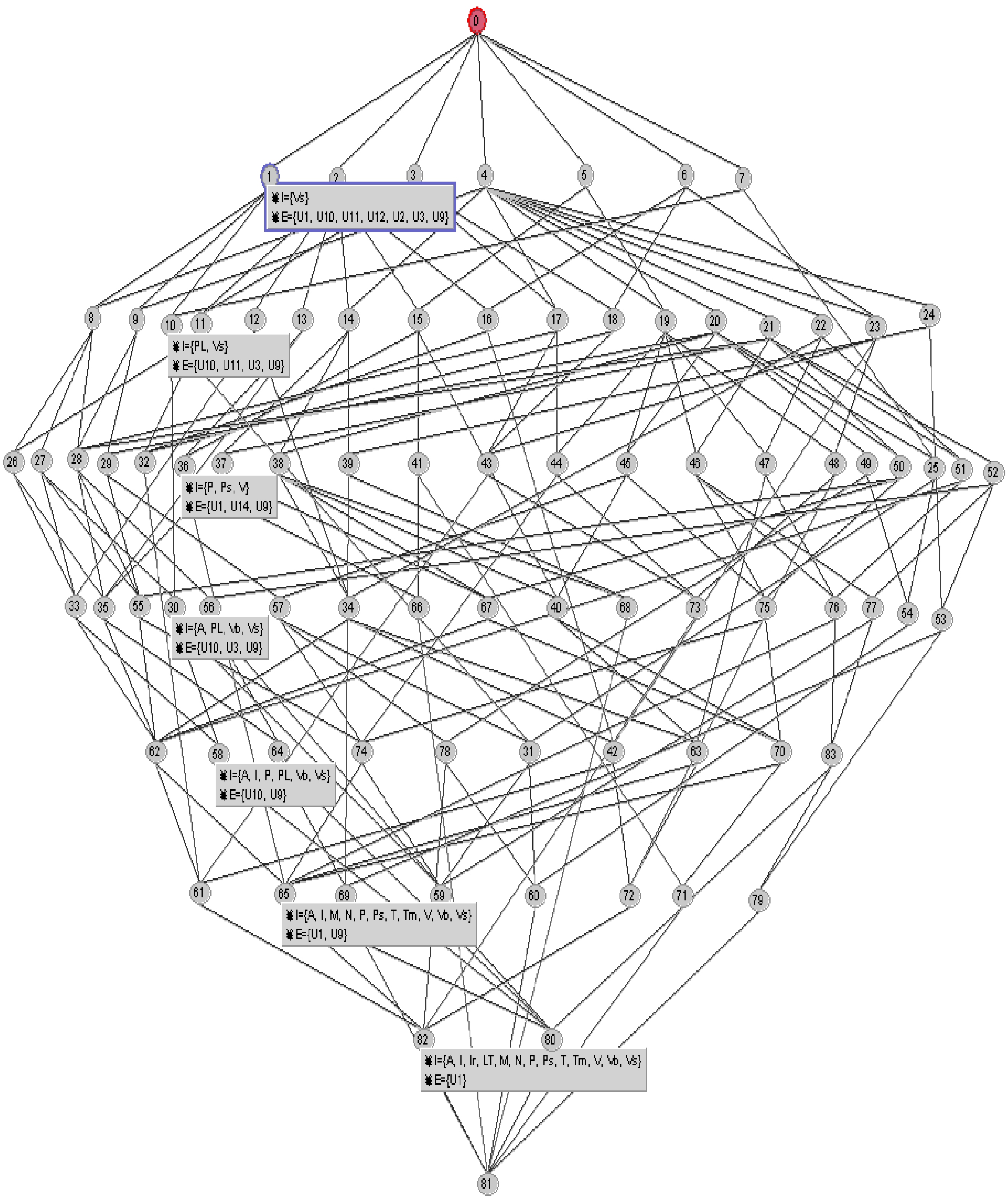

Figure 1: Concept lattice for the context in Table 1

- Learner Control
  - Time (Tm)
  - Interactivity (Ir)
  - Navigation (N)
- Learner Style
  - Active (Ac)
  - Passive (Ps)
  - Visual (Vs)
  - Verbal (Vb)
- Learner Orientations
  - Transforming learners (LT)
  - Performing Learners (PL)
  - Comforming Learners (CP)
  - Resistant Learners (RL).

Engineering students on bachelor level enrolled in a calculus course have been asked to answer a Web based questionnaire about their preferences related to learning and multimedia based inputs. Data related to Learner Styles and Learner Orientations is obtained from students assessments. In this particular case they are divided in units according to gender and results from a preliminary test as follows:

- Unit 1 - male students with score above 90%
- Unit 2 - female students with score above 90%
- Unit 3 - male students with score between 80% and 89%
- Unit 4 - female students with score between 80% and 89%
- Unit 5 - male students with score between 70% and 79%
- Unit 6 - female students with score between 70% and 79%
- Unit 7 - male students with score between 60% and 69%
- Unit 8 - female students with score between 60% and 69%
- Unit 9 - male students with score between 50% and 59%
- Unit 10 - female students with score between 50% and 59%
- Unit 11 - male students with score between 40% and 49%
- Unit 12 - female students with score between 40% and 49%
- Unit 13 - male students with score between 30% and 39%
- Unit 14 - female students with score between 30% and 39%
- Unit 15 - students with score less than 30%

Concepts are presented by the labels attached to the nodes of the lattice. The meaning of the used notations is as follows:

- node number 1 has a label
  - $I = \{Vs\}$,
  - $E = \{U1, U2, U3, U9, U10, U11, U12\}$.

  This means that only students from units $\{U1, U2, U3, U9, U10, U11, U12\}$ have visual preferences.
- node number 10 has a label
  - $I = \{PL, Vs\}$,
  - $E = \{U3, U9, U10, U11\}$.

  This means that only students from units $\{U3, U9, U10, U11\}$ are the performing learners with visual preferences.
- node number 30 has a label
  - $I = \{A, PL, Vb, Vs\}$,
  - $E = \{U3, U9, U10\}$.

  This means that only students from units $\{U3, U9, U10\}$ are the performing learners whose preferences are visual, verbal and animation.
- node number 36 has a label
  - $I = \{P, Ps, V\}$,
  - $E = \{U1, U9, U14\}$.

  This means that only students from units $\{U1, U9, U14\}$ prefer pictures, video and are passive.
- node number 58 has a label
  - $I = \{A, I, P, PL, Vb, Vs\}$,
  - $E = \{U9, U10\}$.

This means that only students from units $\{U9, U10\}$ are the performing learners who are passive with both visual and verbal preferences, like instructions and animation.

- node number 65 has a label
  - $I = \{A, I, M, N, P, Ps, T, Tm, V, Vb, Vs\}$,
  - $E = \{U1, U9\}$.

  This means that only students from units $\{U1, U9\}$ are the performing learners who prefer pictures, video, visual and verbal instructions, music, animation, navigation, text and time.

- node number 82 has a label
  - $I = \{A, I, Ir, LT, M, N, P, Ps, T, Tm, V, Vb, Vs\}$,
  - $E = \{U1\}$.

  This means that only students from unit $\{U1\}$ are the transforming learners who prefer interactivity, pictures, video, visual and verbal instructions, music, animation, navigation, text and time.

7 Association Rules

A context (G, M, I) satisfies the association rule $Q \to R_{minsup,minconf}$, with $Q, R \in M$, if

$$sup(Q \to R) = \frac{|(Q \cup R)'|}{|G|} \geq minsup,$$

$$conf(Q \to R) = \frac{|(Q \cup R)'|}{|Q'|} \geq minconf$$

provided *minsup* $\in [0, 1]$ and *minconf* $\in [0, 1]$.

The ratios $\frac{|(Q \cup R)'|}{|G|}$ and $\frac{|(Q \cup R)'|}{|Q'|}$ are called, respectively, the *support* and the *confidence* of the rule $Q \to R$. In other words the rule $Q \to R$ has support $\sigma\%$ in the transaction set $\mathcal{T}$ if $\sigma\%$ of the transactions in $\mathcal{T}$ contain $Q \cup R$. The rule has confidence $\psi\%$ if $\psi\%$ of the transactions in $\mathcal{T}$ that contain Q also contain R.

The confidence of an association rule is a percentage value that shows how frequently the rule head occurs among all the groups containing the rule body. The confidence value indicates how reliable this rule is. The higher the value, the more often this set of items is associated together.

Support is used for filtering out infrequent rules, while confidence measures the implication relationships from a set of items to one another.

Table 2: Support and confidence values for the context of preferences

Antecedent	Consequence	Support	Confidence
T	Tm	0,53	0,89
T	P	0,51	0,86
Tm	Ps	0,42	0,84
M, N	Vs	0,42	0,83
P, A	Vs	0,31	0,82
P, M	PL	0,44	0,80
T, Vs	CL	0,39	0,76
LT	Ir	0,53	0,61

Support and confidence values for the most significant rules following from the context in Table 1 are presented in Table 2.

8 Conclusion

The paper presents relationships between multimedia materials and successful learning performance. The enclosed concept lattice illustrates the effect of learning styles, learning orientations and various multimedia inputs on learning. A course supported by multimedia materials should allow students to chose their own way of progressing through the course materials.

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