Students' Learning Preferences in a Multimedia Online Course

S. Kišiček, T. Lauc, K. Golubić

***Abstract*—**This paper presents the results of a research on the usage of multimedia resources with respect to learning styles. The research was conducted within an online course supporting multimedia resources. The course is s fully online elective course in the field of Information Sciences, offered to all students at the Faculty of Humanities and Social Sciences at the University of Zagreb, Croatia. The content of the course is offered in the form of interactive Moodle lessons containing three different types of multimedia resources: textual, pictorial resources accompanied by text and video resources. By analyzing the results of a VARK questionnaire, which label the students' learning styles as visual, aural, read/write and kinesthetic, and matching them with the results of students' feedback responses indicating what type of resources the students have been using, we determine on the relationship between learning styles and preferences. Students with stressed visual learning style show lesser preferences towards the usage of textual resources. Students with stressed read/write learning style show lesser preferences towards the usage of video resources. Understanding the learners' preferences leads to more effective instructional design in an online learning environment.

***Keywords*—** E-learning, Multimedia Resources, Learning Styles, Learning Preferences, VARK, VLE, ICT

I. Introduction

The perception stands at the beginning of every process of cognition and learning. Senses, sense organs, receptors and appropriate analyzers are considered to be the tools of perception. Learners vary enormously in learning styles, i.e. in ways and speed of collecting and processing information, forming knowledge and applying it under new circumstances [1].

Multimedia has a great potential to foster individualized learning in a virtual environment. Through interactive multimedia, the teaching and learning process is more interesting with texts, audio, animation, graphics and videos which involve all human sensitivities. The main focus of this paper is to research on the overlap of students' learning styles and their preferences in using different multimedia educational resources in an online learning environment in order to improve instructional design, teaching and learning.

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II. E-learning and ICT

E-learning is instruction delivered on a computer by way of CD-ROM, Internet, or intranet [2]. E-learning as the use of information and communication technology (ICT) for supporting the educational process, is continuously gaining importance. In the education world, ICT development has played a major role in the overall policy implementation with the current needs and development [3]. It is now widespread in higher education institutions but it is also widely used in secondary and even primary schools. It finds application in content delivery but also in curriculum design and planning, in examinations as well as in communication between students and teachers. ICT use is very closely interlinked with the educational process, therefore it is hard to imagine a modern educational system without ICT.

A variety of both custom-built and commercially produced virtual learning environments (VLEs) are increasingly being deployed to support education across the higher education (HE) sector. Each of these VLEs comprise a number of tools that seem to be primarily designed to support content delivery. For example, the tools provided can be used to develop repositories that might contain a variety of resources (e.g. Powerpoint presentations, Word/pdf documents, Excel/Access files, links to interactive tutorials and other external resources); provide assessment through on-line quizzes; and provide email communication between tutors and students. VLEs also contain tools for supporting discussion forums and synchronous chat; as well as management tools that enable teachers to track student access, to record assignment grades, to manage groups as well as the facility to set up evaluation surveys.

We conducted a research within a fully online course, managed via Moodle (Modular Object Oriented Dynamic Learning Environment), a content manaement system based on constructivist approach to learning. In the constructivist learning, knowledge is obtained by learners, as opposed to instructivist approach, where knowledge is given to learners. Among constructivist and instructivist learning approaches, we uphold the constructivist approach. In constructivism, learners are actively and constantly constructing knowledge because learning is a process of construction [4]. Constructivism

emphasizes that the learners should explore, experiment and do research. Therefore, the focus is on learning, as opposed to instructivist approach, where the focus is on teaching. From a constructivist point of view, people actively construct new knowledge as they interact with their environments. Everything one reads, sees, hears, feels, or touches, is tested against prior knowledge and may form new knowledge one carries. Knowledge is strengthened if one can use it successfully in a wider environment. Learners are not just memory banks passively absorbing information, nor can knowledge be "transmitted" to learners just by having them to read something or listen to someone. This is not to say one can not learn anything from reading a web page or watching a lecture, obviously they can, it is just pointing out that there is more interpretation going on than a transfer of information from one brain to another [5]. According to this learning approach, we place high focus on learning styles and different ways of transmitting information.

III. Multimedia Learning

Multimedia means using more than one delivery device in delivering information. Using multimedia resources in education refers to conveying instructional message in to two main formats – words and pictures [6]. Words include speech and printed text; pictures include static graphics (such as illustrations and photos) and dynamic graphics (such as animation and video). Different people learn differently. Multimedia learning opens up space for people to learn in a way that suits them best and easily master the material. Furthermore, it enables learning at an individual's pace, due to its interactivity, which is a very important aspect of multimedia learning. The user interacts with the content since information is displayed as non-linear and it is activated on the basis of user input. In this ways, the user has complete control of information transfer.

There is no single guidance for creating interactive multimedia learning programs. There are distinct design requirements regarding unique environments for developing programs It does not mean that traditional instructional design theories has to be avoid. On the contrary, for using interactive multimedia technology it is extremely important to apply knowledge of design theory more than ever because without such guidance information overload problem exists, as technology can be used superficially. The main goal of using multimedia in education is to put different types of media together in order to improve acquiring of knowledge then traditional media does.

According to Mayer [6] there are seven multimedia principles designer must have in mind when designing multimedia instructional message. These are Multimedia Principle, Spatial Contiguity Principle, Temporal Contiguity Principle, Coherence Principle, Modality Principle, Redundancy Principle and Individual Differences Principle. According to Multimedia Principle, students learn better from words and pictures than from words alone. Also, multimedia principle explains that students learn faster from animation and narration than from narration alone. It is because learners are able to build mental connections between corresponding words and pictures better when both exist (animation and narration) than when only one is presented (i.e. narration).

Contiguity Principles aim at students learning better when corresponding words and pictures are presented near rather than far from each other on the page or screen (Spatial Contiguity), as well as simultaneously rather than successively (Temporal Contiguity). Regarding Spatial Principle, if corresponding words and pictures are not near each other, learners must search for the portion of the animation that corresponds to the presented text and waste limited cognitive capacity. Following the Temporal Contiguity Princliple, learners make mental connections beetwen corresponding words and pictures with less dificulties if they are in working memory at the same time.

Coherence principle implies that pictures and words are semantically related as Schnotz interprets [7]. The theoretical explanations is that the learner may attend to the irrelevant material and therefore have less cognitive resource available for building mental connections between relevant portions of the narration and animation.

Modality principle implies that students learn more deeply from animation and narration than from animation and on-screen text. Redundancy principle implies that students learn more deeply from animation and narration than from animation, narration, and on-screen text. Redundant material interferes with learning rather than proving to be advantageous or even neutral when acquiring new information. By eliminating redundant information the load on working memory is considerably reduced, thus facilitating better learning [8]. Individual Differences Principle implies that students learn more deeply from animation and narration when the narration is in conversational rather than formal style.

IV. Instructional Design

Instructional design theories provide strategies to apply multimedia intended to promote learning. It is important to avoid using multimedia effects in ways that make no contribution to learning or, worse, in ways that actually intrude on the learning process. Instructional developers responsibility is to know how apply instructional strategies in multimedia learning environments. Awareness of some additional design and development issues that arise when the technology is utilized has to be taken into consideration.

Multimedia resources include two or more types of information, i.e. multimedia elements: text, graphics, pictures, animation, audio, and video. Every instructional development model deal with the issue of delivering training program to the end user. It should be stressed that is not sufficient just to decide to use multimedia because the use of multimedia and computers is usually confronted when media selection decisions are made. Thereby additional decisions about the different technical issues have to be taken into consideration.

To facilitate certain multimedia files, certain technical requirements need to be satisfied. For example, internal and external storage memory, network speed and quality, etc.

Multimedia developers face a unique challenge. Since technology changes rapidly, there is always an excuse not to use it because something better and cheaper is on the horizon. But such reasoning can lead to postponing adoption decisions forever. If the potential benefits of technology are to be used to advantage, adoption decisions will have to be made and the timing of these decisions becomes paramount. Adopt too early and the technology may be too expensive, unstable, non-standardized, or non-interoperable with other technologies. Adopt too late and the older technology may prove be more expensive and cumbersome than newer technology or, worse, no longer supported [9].

The ADDIE model is the generic process traditionally used by instructional designers and training developers. The five phases are: Analysis, Design, Development, Implementation, and Evaluation. In the analysis phase it is important to clarify the problem, as well as establish objectives. In the design phase strategies are planned for achieving learning objectives. In the development phase, the strategies are realized in the formed of learning material that has to be delivered in the implementation phase, which is followed by the evaluation phase where feedback from the users is obtained.

Multimedia affects instructional design in different ways. Firstly, multimedia makes it possible to shorten the development phases. Authoring tools and markup languages can be employed to generate approximations of the final product immediately so it may unnecessary to create screen layouts, tests, and other instructional assets on paper that later will be programmed. Such rapid prototyping allows is also convenient for early review of the content and design alternatives and speeds development. It should be stressed that in this way benefits are that the prototypes are concrete objects, not just theoretical plans. The second way is the testing process. The use of multimedia usually accentuates the importance of pilot testing in development projects, especially when the development projects are large and the investments in deploying technology widely are substantial. The third way multimedia affects instructional development is that it adds a requirement to do some technology assessment in the early analysis phase. It is useful to determine what technologies are being used currently in the workplace and how comfortable people feel about them. It also may be useful to determine how receptive the organization and the various groups within it are to new technology [10].

V. Learning Styles

A person's learning style is affected by individual traits such as personality, cognitive styles, temperaments, sensory processes and age [11]. There are many interpretations and definitions of learning styles. Kolb defines learning style as an individual's inherited foundation, particular past life experience and the demands of the present environment that emphasize some learning abilities over others [12]. Learning style designates the composite of characteristic cognitive, affective, and psychological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment [13]. Felder and Silverman postulate that when there is a mismatch between the learning environment and the learning style of the student, the students will become inattentive, discouraged, and discontent with the course [14].

VARK – Visual, Aural, Read/Write and Kinesthetic – is a learning style model developed by Neil Fleming (1987). Its complimentary learning style identification instrument, the VARK questionnaire, classifies learners by their preferred mode of interaction with others based on input stimulus and output performance [8]. It provides users with a profile of their learning styles as visual, aural, read/write, kinesthetic or multimodal, for the users with more than one preference, who are bimodal, trimodal, or VARK (all four modes). These preferences are about the ways that they want to take-in and give-out information [15]. The four main categories of learning styles are described as following:

Visual – refers to learners that prefer graphical forms of information; presented in pictures, diagrams, maps, symbolic arrows, circles, etc. Visual learners learn best by seeing the material from visual displays. The recommended study strategies for visual learners are underlying, using different colours, using highlighters, flow charts, pictures, videos, posters, and slides, listening to lecturers who use gestures and picturesque language, reading from textbooks with diagrams and pictures, learning from graphs, using symbols and using white space around the learning content.

Aural – refers to learners who prefer information that is heard or spoken; participating in discussions, listening to lectures, recordings, etc. Aural learners learn best when processing the information by listening. The recommended study strategies for aural learners are attending classes, discussions and tutorials, discussing topics with colleagues and teachers, explaining new ideas to other people, using a tape recorder, memorizing the interesting examples like stories and jokes, describing pictures and other visuals to somebody who was not present.

Read/Write – refers to learners who prefer information displayed as words; reading information presented in textbooks, writing essays, etc. Verbal learners learn best by reading and/or writing. The recommended study strategies for verbal learners are using lists, headings, dictionaries, glossaries, definitions, handouts, textbooks, readings, library, manuals, etc. Verbal learners are advised to write out the words again and again, to read their notes (silently) again and again, to rewrite the ideas and principles into other words, to organize any diagrams or graphs into statements, to turn reactions, actions, diagrams, charts and flows into words, to imagine the lists arranged in multiple choice questions and distinguish one from another.

Kinesthetic – refers to learners who prefer to experience

information; by concrete examples, case studies, filed trips, labs, demonstrations, simulations, videos, etc. Kinesthetic learners learn best by touching, feeling, holding, experiencing the reality by using all of the senses - sight, touch, taste, smell, hearing. It is recommended for kinesthetic learners to learn from laboratories, field trips, field tours, examples of principles, lecturers who give real-life examples, applications, hands-on approaches (computing), trial and error, collections, exhibits, samples, photographs, previous exam papers, etc.

There has been a lot of research on learning styles. Wehrwein et al. [16] report male and female students having significantly different learning styles and stress that it is the responsibility of the teacher to address this diversity of learning styles and develop appropriate learning approaches. Lujan and Di Carlo [17] report that most students preferred multiple modes (2 modes, 3 modes or 4 modes of information presentation). Knowing the students preferred modes can help provide instruction tailored to a student's individual preference and overcome the predisposition to treat all the students in a similar way. Byrne at al. [18] elaborated that students will prefer learning with some types of online multimedia better than others, depending on their individual learning style as identified by the VARK questionnaire. Ramayah at all. [19] reports on technology in the classroom being only relevant to the Read/Write learning style.

Sha [20] found nine student preferences while they use the course online learning resources. It could help teacher to design better online learning resources in order to meet the learners' preferences and needs, motivate student involvement, and enhance learning. Graf at all. [21] investigated the relationship between learning styles and working memory capacity in order to develop more adaptive educational systems in Moodle. Sankey at all. [22] presents the findings of an experiment to measure the impact of multiple representations on learning outcomes, where students reported very favorably on their use of the multimodal learning elements. Ferdandez et all. [23] presented the modules of the Adaptive Educational Hypermedia. System PCMAT, responsible for the recommendation of learning objects. PCMAT is an online collaborative learning platform with a constructivist approach, which assesses the user's knowledge and presents contents and activities adapted to the characteristics and learning style of students of mathematics in basic schools.

In our previous research we have reported on usage of online resources in a fully online course attended by students with different knowledge background who obtained same learning outcome. We found that, with respect to different undergraduate education, there is no significant difference regarding student achievement [24, 25].

In order to improve learning process and considering that most people learn best by combined methods, and their preference can be referred to as multimodal, we develop multimodal learning resources for an online course.

VI. Research and Methodology

The research was performed using survey data analysis. One survey was conducted by means of the VARK questionnaire, and other surveys were conducted by means of weekly feedback questionnaires regarding the students' usage of resources during the course. These surveys are completed by the students attending an Information Science course at the Faculty of Humanities and Social Sciences, the University of Zagreb. The course is elective for all students at the University on a graduate level and it is conducted as a fully online course via Moodle, the content management system. It covers advanced MS Office techniques for text and language processing.

A. Virtual Learning Environment

The course was conducted online, via Moodle - [26] a Virtual Learning Environment (VLE), also known as Course or Content Management System (CMS), Learning Management System (LMS), Learning Platform (LP) or Managed Learning Environment (MLE). It is an open source application that educators can use to create effective online learning sites, enabling students to access course files and documents almost at any time or place. Two basic types of content materials in a Moodle course are resources and activities. The resources are meant to be used or read without any further interaction, and they may appear in different types of files. On the contrary, the activities pursue interaction; students need to interact within activities by either submitting an online assessment, taking part in a discussion forum, or for example studying a lesson activity. Assignment submissions are time and date stamped, and this information is included along with the submitted file. Hence, information about assignment grade and due date and time can be considered.

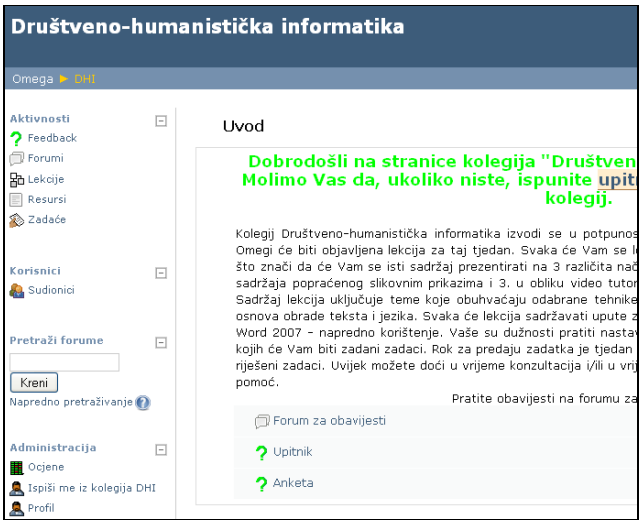

Fig. 1 Moodle course interface

B. Multimedia Resources within Interactive Activities

Fernandez et all [17] grouped the learning resource type values as active (exam, exercise, experiment, problem

statement, questionnaire, self-assessment, simulation), textual (lecture, narrative text, table) or visual (diagram, figure, graph, slide).

Fig. 2 weekly Moodle lesson activities

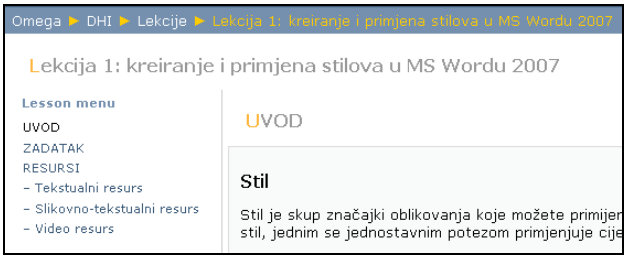

Fig. 3 example of a lesson navigation

In our research, the content of the course is conveyed through ten weekly lessons in a Moodle format, each including assignments and different types of resources. The same content within each of the lessons was presented in three different types of multimedia resources: textual resources, pictorial resources accompanied by text and video resources. The usage of the resources indicates students' preferences.

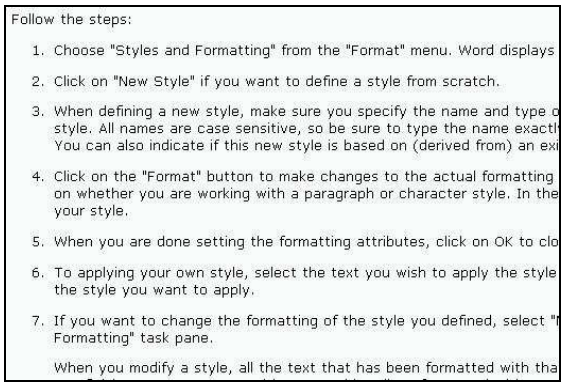

Fig. 4 example of textual resources

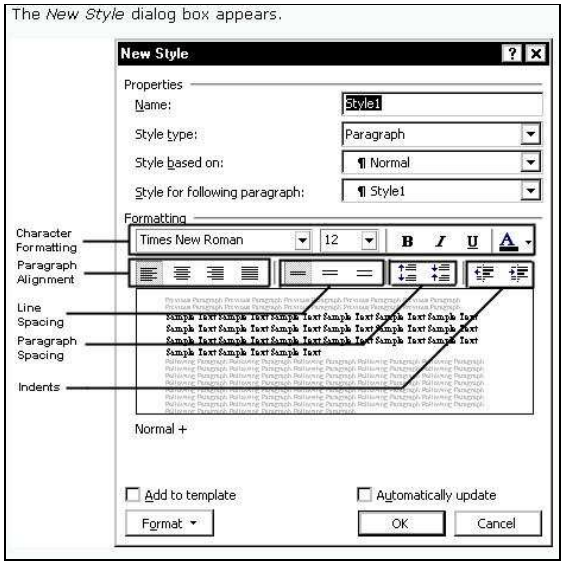

Fig. 5 example of pictorial-textual resources

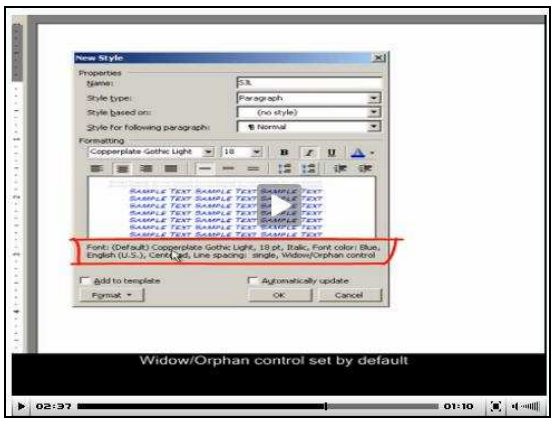

Fig. 6 example of video resources

By combining pictures with corresponding text we especially addressed coherence and contiguity principles implying that corresponding text and pictures should appear simultaneously and semantically related. Theoretical knowledge about basic language processing was implicitly given through practice-oriented assignments. The research involved a total sample of 72 students (62 female, i.e. 81%; 10 male, i.e. 19%) attending the course during the winter term in the Academic Year 2011-2012. According to students' feedback responses on the usage of resources, we bring the percentages on the usage: textual resources – 21%, pictorial resources accompanied by text – 72% and video resources – 7%.

Fig. 7 the students' usage of multimedia resources

C. VARK Questionnaire

Immediately after course enrollment, the students' learning styles were obtained by means of the VARK questionnaire. 30 students (36%) had a single preference, resulting in one of the four main learning styles; Visual (V) – 3 students (4%), Aural (A) – 10 students (12%), Read/Write (R/W) – 6 students 7% and Kinesthetic (K) – 11 students 13%. 52 students (64%) had multimodal preferences, out of which 12 students (15%) bimodal (AK, AR, RK, VK, VR), and 17 students (21%) trimodal (VAK, VAR, VRK, ARK). 23 students (28%) students had all four equal preferences (VARK).

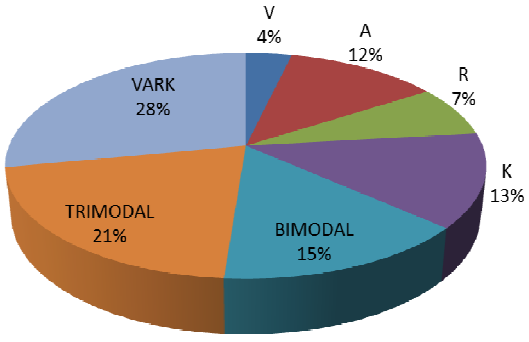

Fig. 8 the students' learning styles obtained by VARK

D. Feedback Survey

At the end of each lesson the students were required to answer a feedback survey saying what type of resources they have been using throughout a lesson; textual resource, pictorial resource accompanied by text, or video. Multiple choices were allowed. Two out of three students have multimodal learning styles, and prefer using combined types of resources.

VII. RESULTS

Our aim was to establish the level of correlation between the students' learning styles detected by the VARK questionnaire and their preferences indicated by the usage of multimedia resources. Data analysis showed that the students preferred learning with some types of multimedia resources better than the others, depending on their individual learning style identified by the VARK questionnaire.

The survey data analysis is performed on the following indicators for each participant:

1) Number of pictorial resources accompanied by text used during the course
2) Number of textual resources used during the course
3) Number of video resources used during the course
4) Number assigned for visual learning style variable in VARK questionnaire
5) Number assigned for read/write learning style variable in VARK questionnaire
6) Number assigned for kinesthetic learning style variable in VARK questionnaire

The number of using each of the resources is expressed by values 0 to 8 considering number of course multimedia lessons. For every student's learning style, each of the four dimensions is expressed by values from 0 to 14. The students with a single aural preference were excluded from our sample, since we did not find the aural dimension comparable to any of our resources.

The following questions were used to guide the research:

1) Question 1: Is there association between the value assigned for visual learning style and the usage of pictorial resources accompanied by text?
2) Question 2: Is there association between the value assigned for read/write learning style and the usage of textual resources?
3) Question 3: Is there association between the value assigned for kinesthetic learning style and the usage of video resources?
4) Question 4: Is there association between the value assigned for visual learning style and the usage of textual resources?
5) Question 5: Is there association between the value assigned for visual learning style and the usage of video resources?
6) Question 6: Is there association between the value assigned for read/write learning style and the usage of pictorial resources accompanied by text?
7) Question 7: Is there association between the value assigned for read/write learning style and the usage of

video resources?

8) Question 8: Is there association between the value assigned for kinesthetic learning style and the usage of textual resources?
9) Question 9: Is there association between the value assigned for kinesthetic learning style and the usage of pictorial resources accompanied by text?

Since the distribution of the compiled data is skewed, the analysis is based on nonparametric statistics. Therefore, the Spearman's rank correlation coefficient is used to answer the above mentioned questions. These correlations were tested to a significance level of 95% ($p < 0,05$).

The Spearman's rank correlation coefficient measures how one variable varies as the other does and it is applied to the ranks of the data. The data was calculated using SPSS software for statistical computing.

1) Research answer 1: The Spearman's coefficient (ρ=0.146) shows that the correlation between the value assigned for visual learning style and the usage of pictorial resources accompanied by text is low. However, the correlation is not significant (p=0.221).
2) Research answer 2: The Spearman's coefficient (ρ=0.016) shows that there is no correlation between the value assigned for read/write learning style and the usage of textual resources.
3) Research answer 3: The Spearman's coefficient (ρ=-0.059) shows that there is no correlation between the value assigned for kinesthetic learning style and the usage of video resources.
4) Research answer 4: The Spearman's coefficient (ρ=-0.237) shows that the correlation between the value assigned for visual learning style and the usage of textual resources is negative and low.
5) Research answer 5: The Spearman's coefficient (ρ=-0.016) shows that there is no correlation between the value assigned for visual learning style and the usage of video resources.
6) Research answer 6: The Spearman's coefficient (ρ=-0.090) shows that there is no correlation between the value assigned for read/write learning style and the usage of pictorial resources accompanied by text.
7) Research answer 7: The Spearman's coefficient (ρ=-0.280) shows that the correlation between the value assigned for read/write learning style and the number of video resources used is low.
8) Research answer 8: The Spearman's coefficient (ρ=-0.055) shows that there is no correlation between the value assigned for kinesthetic learning style and the usage of textual resources.
9) Research answer 9: The Spearman's coefficient (ρ=-0.0119) shows that there is no correlation between the value assigned for kinesthetic learning style and the usage of pictorial resources accompanied by text.

VIII. Discussion

As shown in Table 1, there are two significant correlations between values assigned for specific learning styles, obtained by VARK, and the usage of different resources indicating the students' preferences obtained by their feedback responses. The correlation between the value for visual learning style and the usage of textual resources is negative and low: -0.237. The second correlation between values assigned for read/write learning style and the usage of video resources is negative and low: -0.280.

The log file data analysis on the accessing of specific resources did not show significantly different results. Due to similar results, which substantiate our research, we plan to conduct a more detailed log file analysis measuring time spent on certain resources and activities.

For future work, pictorial resources need to be re-designed, with a higher focus on the picture itself, reducing the amount of text. Following these guidelines, we expect to obtain more explicit preferences of visual type learners towards the usage of pictorial resources. Furthermore, interactivity including drill and practice components, needs to be added to our video resource in order to make it more appealing to kinesthetic learners.

Tab. 1 correlations between learning styles and learning preferences

VARK / Resources	**Visual**	**Read/Write**	**Kinesthetic**
Textual	***ρ*=-0.237** p=0.045	*ρ*=0.016 p=0.892	*ρ*=-0.055 p=0.654
Pictorial-textual (P_r)	*ρ*=0.146 p=0.221	*ρ*=0.090 p=0.450	*ρ*=-0.012 p=0.319
Video	*ρ*=0.016 p=0.894	***ρ*=-0.280** p=0.017	*ρ*=-0.059 p=0.623

IX. Conclusion

The correlation between the value for visual learning style and the usage of textual resources indicates that the students with visual learning style tend to show lower preferences towards usage of textual resources. The correlation between values assigned for read/write learning style and the usage of video resources indicates that the students with read/write learning style had lower preferences towards the usage of video resources. The two significant correlations between values assigned for specific learning styles and the values indicating the students' preferences in usage of different

resources showed that students with extremely distinguished learning styles will prefer resources that do not match their learning style less.

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