WAYS OF STUDYING IN E-LEARNING: THE ICT-SPACE-TIME CONTINUUM

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Abstract

There are many research related to learning styles in education. Among others, these approaches are based on experiential learning, VARK modalities, personal abilities, attitudes, and skills. Some of these theories have been used in online learning, which uses numerous ICT and devices, allowing each student to learn with different tools, to contact or not with other co-mates, to do personal tasks, to read content in public places, and many other possibilities. In this way, this paper proposes a psychometric scale related to the frequency of performing learning tasks by online students, and taking into account many of these current common situations related to personal and adaptative uses of ICT, spaces, and times.

Using survey data for 930 online students at the Open University of Catalonia and exploratory and confirmatory analysis, a psychometric scale is proposed with six latent variables (p=0.000; CFI=0.961; TLI=0.952; RMSEA=0.071; SRMR=0.068), according to learning based on: 1) pedagogical tools for ICT-supported pedagogical practices: wikis, OER, multimedia, games, and mixed reality (5 items); 2) social connectivity with other students (3 items); 3) polychronic-multitasking learning (chronotopos) by mixing learning, personal, and work tasks (3 items); 4) seamless learning (chronochora) by combining many devices and mobile learning (3 items); 5) awareness study-life learning (kairochora) by balancing family and habits (3 items); and 6) monochronic traditional learning (kairotopos) by doing only one planned task in a personal place at home (3 items).

Results allow us to know a validated instrument for assessing the way of studying by online learners when they add many ICT tools in their own personal learning contexts and environments. The results help to understand the ICT-space-time continuum in online education. Thus, this scale is very useful for lifelong e-learning institutions, which can use it for improving their quality standards.

Keywords: e-learning, ways of studying, tools for ICT-supported pedagogical practices, ICT-space-time continuum, learning styles.

1 INTRODUCTION

Our current world is changing definitions and conceptions of space and time because of advent of Information and Communication Technologies (ICT), with three main streams aimed to technological, cultural, and collaborative visions about their future [1]. In this sense, mobile technologies, in the light of socio-technical approaches, are offering new ways of understanding time and space, which are different from common social practices [2]. Furthermore, learning environments influence on career skills [3], which has many consequences on employability obtained through lifelong learning contexts, such as online education. In this way, e-learning is emerging as one of the most powerful methodologies for improving the 21st Century skills needed on the labour market [4]. At the same time, time and space seem to be social constructs that are not neutral in e-learning [5], where online students have different space-time scales [6]. Taking into account these facts, with numerous challenges and reengineering processes affecting on e-learning [7]-[8], this paper researches on technological, spacial and temporal latent constructs related to ways of studying by online students in e-learning environments.

2 THEORETICAL CONTEXT AND RESEARCH QUESTIONS

On one hand, this paper has to do with many theoretical approaches related to learning styles, a scientific field with more than fifty instruments for their measurement [9]. Because of relationships with self-paced online education environments, it has many ties with learning styles such as simultaneous-successive processing and planning [10]; environmental–emotional–sociological–physiological processing [11]; physiological–environmental–cognitive–affective domains plus information processing [12]; and self-regulated learning [13]. E-learners’ learning styles have been researched with different
results that prove that they are related to several learning styles: information processing (active/reflective), information perception (sensing/intuitive), information reception (visual/verbal), and information understanding (sequential/global) [14]-[15]-[16]; dilatorily, transitory, and persistent [17]; diverger, assimilator, converger, and accommodator [18]; and field-independent, and field-dependent [19].

However, this research has into account a different point of view based on socio-technical influences and interrelationships between tools for ICT-supported pedagogical practices [20]-[21], social connectivity [22]-[23], and the space-time continuum, ie, links between chronos-kairos and topos-chora concepts [24]-[25]-[26]-[27]-[28]. Specifically, it analysed the following six theoretical dimensions on ICT-space-time continuum: 1) tools for ICT-supported pedagogical practices; 2) social connectivity; 3) polychronic and multitasking (chronotopos); 4) seamless (chronochora); 5) awareness (kairochora); and 6) monochronic (kairotopos) e-learning.

In this way, the research question (Q) and its corresponding hypotheses (H) that will be proved below are the following ones:

- Q: What are the dimensions related to e-learners' ways of studying in online environments?
- H: There are six dimensions: 1) tools for ICT-supported pedagogical practices; 2) social connectivity; 3) polychronic and multitasking (chronotopos); 4) seamless (chronochora); 5) awareness (kairochora); and 6) monochronic (kairotopos) e-learning.

3 METHODS

3.1 Instrument

3.1.1 Description
A questionnaire was used in this research, which had to check the ways of studying by e-learners in lifelong e-learning contexts. This questionnaire had information relating to the following areas: tools for ICT-supported pedagogical practices, ICT devices, tasks, and place while studying, and educational and socioeconomic status. A blueprint was used [29] and validated by a professor at the University of Barcelona. The sample were online students at the Universitat Oberta de Catalunya (UOC), a fully online university. A pilot process was done and validated, too.

3.1.2 Data Collection
9,621 UOC students were contacted to answer the online questionnaire and two reminders were done between February and April 2016. The response rate was 9.7%, according to [30]-[31]. The final sample (N=930) was validated, with maximum error margin of ±3.18% (p=q=0.50, confidence level of 95.5%, and finite population).

3.2 Measures on Ways of Studying

Online students answered to several issues related to the following dimensions by using the following question: "Rate the frequency with which you study online under these circumstances...", which items had a Likert scale (5-point).

3.2.1 Tools for ICT-supported Pedagogical Practices
Five items for this dimension were used: wikis, Open Educational Resources (OER), media content, games, and mixed reality. The definition of these items used several references, such as [32]-[33].

3.2.2 Social Connectivity
Three items were taken into account: chatting with peers by whatsapp, facebook, etc.; chatting with peers by email, forums, etc.; and calling and videoconferencing. The definition of these items used various references, such as [34]-[35].
3.2.3 Polychronic and Multitasking (Chronotopos)

Three items were used for this dimension: doing learning and personal tasks simultaneously; doing learning and work tasks simultaneously; and losing my concentration because of many devices. The definition of these items used several references, such as [36]-[37].

3.2.4 Seamless (Chronochora)

Three items were taken into account: using many devices, using many devices simultaneously, and mobile learning. The definition of these items were related to several references, such as [38]-[39].

3.2.5 Awareness (Kairochora)

Three items were used: negotiating study time with partner, family, etc.; applying the most optimal study habits; and using recommendations for the security of the data, etc. Items were related to references, such as [40]-[41].

3.2.6 Monochronic (Kairotopos)

Three items were considered: in a personal place at home, doing only one learning task, and following a planning. The definition of items used several references, such as [42]-[43].

3.3 Data Analysis

After creating a dataset with correct variables and without missing values, psychometric properties were analysed by using Exploratory Factor Analysis (EFA) [44] and Confirmatory Factor Analysis (CFA) [45]. EFA detected latent constructs by using several statistics: Kaiser-Meyer-Olkin measure of sampling adequacy, Bartlett's test of sphericity (Chi-square, degrees of freedom, and significance), communalities, % variance explained, structure matrix, and Cronbach's Alpha [46]-[47].

CFA tested the consistency of these constructs detected by EFA by using goodness-of-fit statistics such as [48]: estimator: diagonally-weighted least squares (DWLS) for ordinal data, p-value (Chi-square), CFI (comparative fit index), TLI (Tucker-Lewis index), RMSEA (root mean square error of approximation) and SRMR (standardized root mean square residual).

SPSS, R, and lavaan software, [49]-[50]-[51] respectively, were used for data analysis.

4 RESULTS

4.1 Exploratory Factor Analysis for ICT-Space-Time Continuum

Exploratory factor analysis results are shown in Table 1, which show the existence of six dimensions: 1) tools for ICT-supported pedagogical practices; 2) social connectivity; 3) polychronic and multitasking (chronotopos); 4) seamless (chronochora); 5) awareness (kairochora); and 6) monochronic (kairotopos) e-learning.

Table 1. Exploratory factor analysis for ICT-space-time continuum (N=500).

<table>
<thead>
<tr>
<th>ICT-Space-Time Continuum</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools for ICT-supported pedagogical practices</td>
<td>0.715</td>
<td>0.041</td>
<td>0.019</td>
<td>0.148</td>
<td>0.055</td>
<td>0.049</td>
</tr>
<tr>
<td>– Wikis</td>
<td>0.699</td>
<td>0.115</td>
<td>-0.070</td>
<td>0.151</td>
<td>0.134</td>
<td>-0.084</td>
</tr>
<tr>
<td>– Open Educational Resources (OER)</td>
<td>0.688</td>
<td>0.007</td>
<td>0.057</td>
<td>0.168</td>
<td>0.145</td>
<td>0.302</td>
</tr>
<tr>
<td>– Media content</td>
<td>0.675</td>
<td>0.214</td>
<td>0.114</td>
<td>0.107</td>
<td>-0.013</td>
<td>0.043</td>
</tr>
<tr>
<td>– Games</td>
<td>0.621</td>
<td>0.311</td>
<td>0.082</td>
<td>0.009</td>
<td>0.123</td>
<td>0.039</td>
</tr>
<tr>
<td>– Mixed reality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social connectivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Chatting with peers by whatsapp, facebook, etc.</td>
<td>0.105</td>
<td>0.836</td>
<td>0.125</td>
<td>0.075</td>
<td>0.070</td>
<td>0.096</td>
</tr>
<tr>
<td>– Chatting with peers by email, forums, etc.</td>
<td>0.205</td>
<td>0.781</td>
<td>0.052</td>
<td>0.124</td>
<td>0.117</td>
<td>0.078</td>
</tr>
<tr>
<td>– Calling and videoconferencing</td>
<td>0.216</td>
<td>0.754</td>
<td>0.118</td>
<td>-0.005</td>
<td>0.140</td>
<td>-0.047</td>
</tr>
</tbody>
</table>
Polychronic and multitasking (Chronotopos)
– Doing learning and personal tasks simultaneously
  0.062  0.106  0.849  0.088  0.076 -0.119
– Doing learning and work tasks simultaneously
  0.118  0.130  0.744  0.205  0.093 -0.149
– Losing my concentration because of many devices
  0.007  0.106  0.701  0.102 -0.140  0.187

Seamless (Chronochora)
– Using many devices
  0.127  0.001  0.051  0.800  0.108  0.013
– Using many devices simultaneously
  0.113  0.130  0.230  0.721  0.073  0.064
– Mobile learning
  0.249  0.057  0.076  0.713  0.080  0.006

Awareness (Kairochora)
– Negotiating study time with partner, family, etc.
  -0.023  0.185  0.111 -0.023  0.772 -0.015
– Applying the most optimal study habits
  0.182 -0.041 -0.061  0.183  0.703  0.241
– Using recommendations for the security of the data, etc.
  0.317  0.173 -0.006  0.137  0.605 -0.004

Monochronic (Kairotopos)
– In a personal place at home
  0.105 -0.024  0.086 -0.098  0.078  0.770
– Doing only one learning task
  0.108  0.142 -0.443  0.150 -0.034  0.552
– Following a planning
  -0.006  0.184 -0.163  0.263  0.421  0.535

KMO=0.818  χ² Bartlett=2,696.530  p-valor=0.000
Communalities>0.506  Total variance=61.230%
Cronbach’s alpha: Total=0.8; F1=0.8; F2=0.8; F3=0.7; F4=0.7; F5=0.6; F6=0.5

4.2 Confirmatory Factor Analysis for ICT-Space-Time Continuum

Confirmatory factor analysis results are shown in Table 2. Following theoretical concepts, there are six latent dimensions: 1) tools for ICT-supported pedagogical practices; 2) social connectivity; 3) polychronic and multitasking (chronotopos); 4) seamless (chronochora); 5) awareness (kairochora); and 6) monochronic (kairotopos) e-learning. CFA goodness-of-fit statistics are validated: P-value (Chi-square)=0.000; CFI=0.961; TLI=0.952; RMSEA=0.071; and SRMR=0.068.

Table 2. Confirmatory factor analysis for ICT-space-time continuum (N=430).

<table>
<thead>
<tr>
<th>ICT-Space-Time Continuum</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools for ICT-supported pedagogical practices</td>
<td></td>
</tr>
<tr>
<td>– Wikis</td>
<td>1.000</td>
</tr>
<tr>
<td>– Open Educational Resources (OER)</td>
<td>1.065</td>
</tr>
<tr>
<td>– Media content</td>
<td>1.207</td>
</tr>
<tr>
<td>– Games</td>
<td>1.105</td>
</tr>
<tr>
<td>– Mixed reality</td>
<td>1.148</td>
</tr>
<tr>
<td>Social connectivity</td>
<td></td>
</tr>
<tr>
<td>– Chatting with peers by whatsapp, facebook, etc.</td>
<td>1.000</td>
</tr>
<tr>
<td>– Chatting with peers by email, forums, etc.</td>
<td>1.004</td>
</tr>
<tr>
<td>ICT-Space-Time Continuum</td>
<td>Estimate</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>– Calling and videoconferencing</td>
<td>0.974</td>
</tr>
</tbody>
</table>

**Polychronic and multitasking (Chronotopos)**
- Doing learning and personal tasks simultaneously          | 1.000    |
- Doing learning and work tasks simultaneously              | 1.093    |
- Losing my concentration because of many devices           | 0.732    |

**Seamless (Chronochora)**
- Using many devices                                       | 1.000    |
- Using many devices simultaneously                         | 1.016    |
- Mobile learning                                           | 1.094    |

**Awareness (Kairochora)**
- Negotiating study time with partner, family, etc.         | 1.000    |
- Applying the most optimal study habits                    | 1.401    |
- Using recommendations for the security of the data, etc.  | 1.720    |

**Monochronic (Kairotopos)**
- In a personal place at home                              | 1.000    |
- Doing only one learning task                             | 1.163    |
- Following a planning                                     | 3.426    |

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<thead>
<tr>
<th>Covariances</th>
<th>Estimate</th>
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<tbody>
<tr>
<td>Tools for ICT-supported pedagogical practices</td>
<td></td>
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<tr>
<td>Social connectivity</td>
<td>0.246</td>
</tr>
<tr>
<td>Polychronic and multitasking (Chronotopos)</td>
<td>0.105</td>
</tr>
<tr>
<td>Seamless (Chronochora)</td>
<td>0.261</td>
</tr>
<tr>
<td>Awareness (Kairochora)</td>
<td>0.145</td>
</tr>
<tr>
<td>Monochronic (Kairotopos)</td>
<td>0.053</td>
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<table>
<thead>
<tr>
<th>Social connectivity</th>
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<tbody>
<tr>
<td>Polychronic and multitasking (Chronotopos)</td>
<td>0.239</td>
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<tr>
<td>Seamless (Chronochora)</td>
<td>0.213</td>
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<td>Awareness (Kairochora)</td>
<td>0.191</td>
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<tr>
<td>Monochronic (Kairotopos)</td>
<td>0.079</td>
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<thead>
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<th>Polychronic and multitasking (Chronotopos)</th>
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<tr>
<td>Seamless (Chronochora)</td>
<td>0.195</td>
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<td>Awareness (Kairochora)</td>
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<tr>
<td>Monochronic (Kairotopos)</td>
<td>0.001</td>
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<tr>
<td>Awareness (Kairochora)</td>
<td>0.156</td>
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<tr>
<td>Monochronic (Kairotopos)</td>
<td>0.081</td>
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<table>
<thead>
<tr>
<th>Awareness (Kairochora)</th>
<th></th>
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<tbody>
<tr>
<td>Monochronic (Kairotopos)</td>
<td>0.069</td>
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</table>

**CFA goodness-of-fit statistics**

Estimator DWLS: P-value (Chi-square) = 0.000
Comparative Fit Index (CFI) = 0.961
ICT-Space-Time Continuum

<table>
<thead>
<tr>
<th>Estimate</th>
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<tbody>
<tr>
<td>Tucker-Lewis Index (TLI)=0.952</td>
</tr>
<tr>
<td>RMSEA=0.071</td>
</tr>
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<td>SRMR=0.068</td>
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</tbody>
</table>

Source: Authors

5 DISCUSSION AND CONCLUSION

This paper analyses six latent dimensions related to the ways of studying by e-learners in online education. It takes into account the existing socio-technical interactions between tools for ICT-supported pedagogical practices, social connectivity, and spacial and temporal interrelationships, which are based on chronos-kairos and topos-chora links. It shows effects of ICT in learning and education by going further than influences in everyday life activities [52]. It validates a scale useful for measuring the ICT-space-time continuum. This research is a tool for researching on e-learning methodologies for improving the online education quality.

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REFERENCES


