Cross-Use of Digital Learning Environments in Higher Education: A Conceptual Analysis Grounded in Common Information Spaces

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Motivation

▶ The paper presents the cross-use of different Digital Learning Environments (DLE) in a Higher Education (HE) organizational entity.

▶ DLE are different from Learning Management Systems (LMS)

▶ DLE definition: digital platforms, websites or specific webpages used by course instructors and students in a course for exchanging information or knowledge, relevant for their learning, respectively teaching, within the frame of the course. Examples: LMS platform, email systems, websites, social media platforms, communication channels etc.

▶ Problem statement: Different course instructors use different DLEs in their courses. They all together form a Common Information Space (CIS) in that specific course, for the course attendees, and the course instructor

   RQ: *What challenges do they set for the students, respectively for the course instructors; how do DLE translate as CIS: what type of CIS are they, how are those represented, and used in a HE setting?*

Background

- DLEs are often analyzed from an educational perspective, and less from a cooperative or collaborative perspective.

- Analyzing DLE in a HE organizational entity through the concept of CIS is interesting because:

  - it challenges the traditional view on DLE as educational platforms and less as cooperative or collaborative platforms.

  - DLE should be seen as cooperative platforms and as CIS since multiple stakeholders usually use them: Course Instructors (CI), Students (S), administrative staff (ADM), junior and senior researchers, and nevertheless by the IT department (IT) for maintaining, securing or up-dating them.

  - communication, and cooperative work arrangements take place.

  - HE organization usually has its own official DLEs that were either bought through a formal agreement or built in-house for many years: these can cover a range from LMS to web publishing systems, to examination systems, or submission systems.

  - Some of these DLEs official systems to the HE organization might also be official at a national level, not only at a local level;

Background (cntd.)

- Analyzing DLE in a HE organizational entity through the concept of CIS is interesting because:

  - The official DLE's are required by the Norwegian law to be universally designed.

  - HE processes and ways of interaction between different stakeholders are aimed to be automated and digitalized.

  - As such, HE institutions are more than educational entities that *produce* or prepare individuals for taking part in the workforce, but as complex and dynamic cooperative assemblages, where interactions, different negotiations amongst various stakeholders.

  - these information technologies also change the behaviors and practices of learners and teachers

  - the paper emphasizes the use of multiple systems and how these are viewed as clusters of CIS, rather than individual systems.

  - HE organizational entities viewed through the lens of cooperative work helps us in seeing beyond educational setting and reflecting on the complexity of the use of multiple virtual information spaces used in HE organizational entities, and on the need of coor-dinative practices for enabling a successful cooperative work, i.e., a successful exchange of knowledge in teach-ing/learning context.

Literature Review: on CIS

- **Defining CIS: based on Schmidt and Bannon's work "Taking CSCW seriously":**
  - CIS is necessary for distributed cooperative work, to maintain some form of 'shared' and locally and temporar-ily created understanding about the objects in the CIS.
  - A CIS has the aim to allow the members of a cooperative ensemble to cooperate and interact without formal con-straints, such as procedures or conventions

TABLE I. SEVEN CIS PARAMETERS FROM BOSSEN [17]

#	CIS Parameter	Explanation
1	degree of distribution	physical distribution of the cooperative work;
2	the multiplicity of the web of significance	several webs of significance are included in CIS;
3	degree of the needed articulation work	articulation work may vary depending on the character of the cooperative work;
4	multiplicity and intensity of means of communication	face to face communication, but also other communication means available and/or necessary during the cooperative work;
5	web of artifacts	all the artifacts included in the cooperative work;
6	immaterial means of interaction	habits, procedures, the structure of the organization, division of labor, etc. that decrease the need for coordination;
7	need for precision and promptness of interpretation, in the cooperative work.	the need for precision for the available information; this parameter is especially important in time- or safe-critical situations;

Literature Review: on CIS

- Examples of CIS:
  - A whiteboard, where several members of the cooperative ensemble jointly scribble, modify, draw, or erase things writ-ten on the whiteboard
  - An excellent example of a CIS is when a department develops its own terminology
    - For instance, in a HE institution, the meaning of a *seminar* or *laboratory assignment* may be different based on different educational departments or courses.
    - A laboratory assignment in a programming course means perhaps the development of a program by coding in an ordinary classroom environment, while laboratory as-signment in biology or chemistry can possibly mean a form of experimenting in a specially dedicated lab, where specific tools and instruments are available. In this sense, CIS has a physical character.
  - Other examples of CIS are documents and artifacts used in an organization, supporting the cooperation between the cooperative ensemble members
  - A more extreme example of CIS is the web (www), where some pages are produced by several entities that do not necessarily are tangential to each other, however, a het-erogeneous group of consumers of the CIS access infor-mation produced by several of them

Literature Review: on CIS

- Characteristics of CIS:
    1) Dialectic nature of CIS
    2) Hybrid information spaces: in-between private and common
    3) Scalability and multiplicity of CIS
    4) Multiple Centers, Peripheries and Overlapping Areas
    5) CIS Objects Re-producing Fragmentation
    6) Temporality of CIS
    7) Physical aspects
    8) Communication Means in CIS

- CIS in this study:
    - it seems that CIS was not so far studied in HE institutions and that DLEs were much more often regarded from an educational perspective rather than a CSCW perpective.
    - This study aims to bring new insights on both DLEs seen through the lens of CIS and CSCW literature, but also to the CSCW community on how DLEs can be regarded as CIS and the complexity of analyzing those as such.

Method

- Participants and setting

- Data collection and analysis:

  - The analysis was done through systematic text condensation, in 4 steps.

    - Step 1: the data was fully read to get a sense of what the data was talking about (themes: n1=6, prioritized themes n1=4);

    - Step 2: identifying and categorizing meaning units (codes n1=130 for the first theme, n2=124 for the second theme, n3=125 for the third theme, and n4=39 for the fourth theme);

    - Step 3: condensing the codes into meanings (n1=23, n2=13, n3=25, and n4=9); these subcategories were then organized in categories (n1=7);

    - Step 4: finally, during the last step, the author has synthesized the condensates into concepts (n1=3).

    - resulted concepts were: cross-platform use of DLE, user diversity in Higher Educa-tion, universal design, and organizational tensions

- Ethical considerations

Findings

- The participants mentioned 23 DLEs.

- The minimum number of DLEs used by the participants was 5, whereas the maximum was 16 out of 23.

- It seems that the youngest of the interviewee was more prone to use digital technology in class, together with her students

- The same interviewee used social media platforms and considering using instant messenger in her communication with students, arguing that these were the preferred communication channels by the students.

- The official publishing system was used by two out of three participants

- The interviewee considered the HE's official web publishing system more as an administrative tool rather than being a dedicated tool for teaching/learning.

TABLE II. OVERVIEW OVER THE DIGITAL LEARNING ENVIRONMENTS AND TOOLS

#	Participant (CI) — Systems used in a HE Organizational Entity	#1	#2	#3
1	Publishing system		X	X
2	Internally and externally used submission and assessment system	X		X
3	External quiz and input system 1			X
4	External quiz and input system 2			X
5	External quiz and input system 3			X
6	Email	X	X	X
7	New DLE system	X	X	X
8	Third-party application			X
9	Social media platform 1			X
10	Web service for forum discussions and wikis		X	
11	MOOC or MOOC like platform		X	
12	Examination platform	X		X
13	Virtual game environment 1	X		
14	Virtual game environment 2	X		
15	Virtual game environment 3	X		
16	Learning Analytics	X		X
17	Specialized analysis software 1	X		
18	Specialized analysis software 2	X		
19	Specialized video analysis software 1			X
20	Specialized video analysis software 2			X
21	Cloud-based storage			X
22	Different variants of messenger applications			X
23	The third-party plugin used in the official DLE system			X

Findings (cntd.)

- only two participants used the official examination system, whereas the third participant was aware of it, but did not find it appropriate to use it together with its course-takers.

- one of the interviewees used three simulation environments, as the leading DLE platforms, in his teaching, although another DLE was the official institutional platform.

- Two of the interviewees were using two other digital systems each in their teaching.

- Only one participant used cloud-based storage.

- one of the participants expressed the need for a participatory tool and keeping track of things in a DLE.

- The official DLE was described by one of the participants as being an administrative tool rather than supporting learning.

- The system was also described as not being user-friendly and being cumbersome; however, it was also de-scribed as being easy to access and manipulate if one is familiar with such tools.

"(…) for some of the students, they were not used to it, and they were not introduced to it in the way I would like to do it, it was just like a.., sort of a repository, like a "dump place," where all this information about the course, slides, whatever the material teachers wanted to use, it was kind of thrown into that, in an organized way - which is good. For them, this was not a discussion platform; it was not a place where they could express their views or interact with the materials where they would say: okay, I would want it in this way, or I would post my idea or view in an idea or knowledge in a discussion. They did not perceive technology as something that offers them the possibility to express, learn, engage, and be an active participant in this case in a learning activity. And I think it is an important function of the technology, to provide a platform, for those that either does not have a possibility or the attitude to do this face-to-face in plenary, for various reasons, or for those that are at a distance. So this is an opportunity. I think it is a missed opportunity if we do not present it and use it as teachers, or those who introduce it in the right way." (Participant, Interview)

"It's often that the students, like the natives, they come to the University, first-year students and they know they will be using learning platform, digital learning platforms, because most of them have used it in high school, or even in lower grades, while students coming from other parts of the world, don't have this ingrained experience, or simply experience of using the technology in this way. And I think there is always a gap there that often creates difficulties for the other group, not because they are not good performers, or good learners, or interest or motivated, because they simply need, a different encounter- start encounter with technology." (Participant, Interview)

Discussion

▶ I regionalized of DLEs units in categories and clusters of information spaces

▶ DLEs are re-grouped in this section into official systems, third-party applications, and specialized software applications, quiz input systems, virtual games environments, and social media platforms.

▶ The classification is made based on each DLE unit's own primary purpose.

▶ The reason for regionalizing DLEs in these categories is to illustrate that the majority of the DLEs in use are non-official systems, but also to showcase their distribution across different domains requiring a different set of skills for using those.

Discussion (cntd.)

- **Regionalization of the DLEs Units in Categories and Clusters of Information Spaces**
  - Information always belongs to a *place*, or for that matter, to *space*
  - this study also proves that information can belong to some *overlapped areas* and *multiple centers*

Discussion (cntd.)

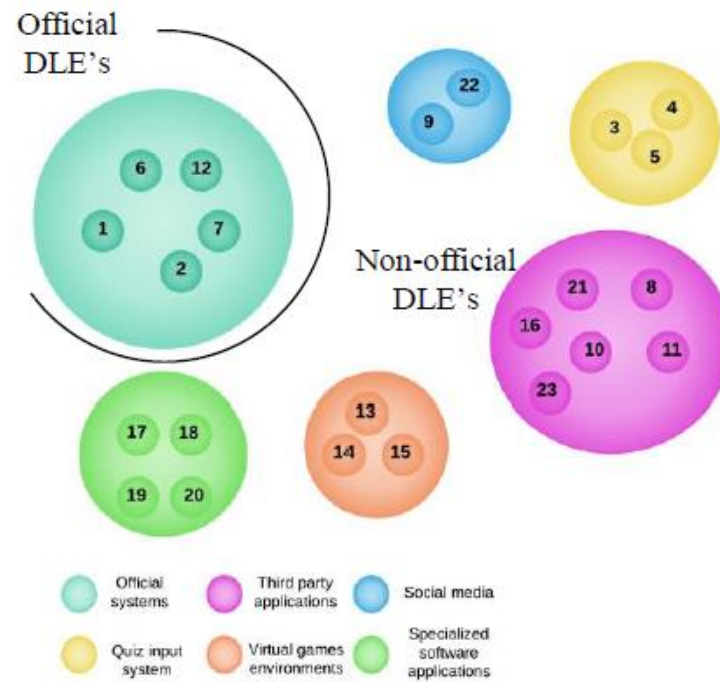▶ Figure 1 shows a heat-map on the regionalization of DLEs from Table II.

Figure 1. Heat-map over the types of DLEs used.

Discussion (cntd.)

▶ Figure 2 illustrates a heat-map over the DLEs handled by each of the interviewees, including their types, which is color-coded. It indicates a regionalization of DLEs units based on an *individual regionalization* for each of the participants.
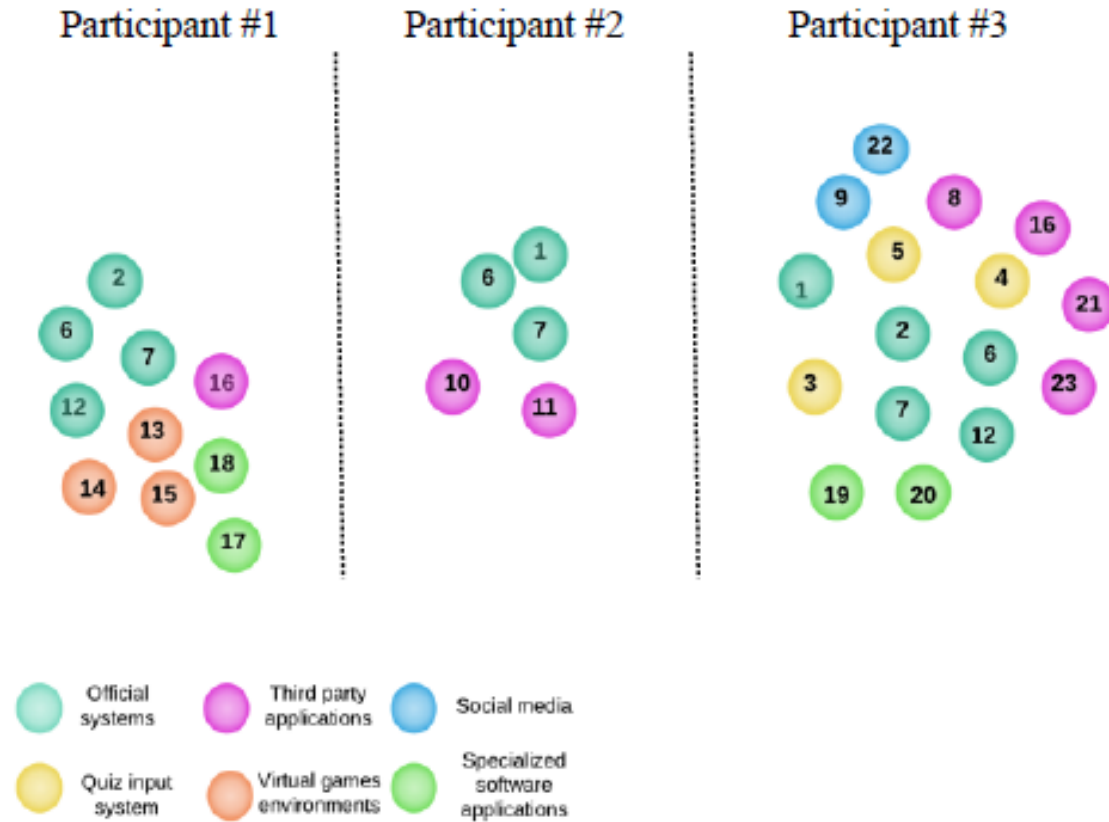
Figure 2. Heat-map over each of the participants' DLEs units used.

Discussion (cntd.)

► DLEs as Information Spaces:

   ► The physical distribution of the cooperative work across space and time calls for the need of a number of DLEs, both common and hybrid information spaces.

   ► It is essential to do not to disregard the amount of *articulation work* that comes along with this physical distribution of the cooperative work across space.

   ► We argue that the amount of articulation work required by information spaces is given not only by the cooperative work but also by the number of DLEs units included in an information space, being it *hybrid* of *common*.

   ► A *hybrid* information space composed by DLEs units re-fers to the information space created by both the private or peer group notes of a course attendant or course instructor and the information that is put in common in such an infor-mation space.

      ► Example: For instance, the CIS that participant #3 is using is, in fact, a cluster of DLEs units, or individual hy-brid information spaces, such as social media platforms. A social media platform used both as a DLE unit and as a CIS is a hybrid information space, in this sense. The cluster of information spaces used by participant #3, together with her students, is hence a hybrid one.

Discussion (cntd.)

- the information spaces' multiplicity is given by the number of entities or artifacts that intersect in the collaborative work and form the CIS.

    - Example: In the illustrated examples on the cross-use of DLEs, we can say that the students' or course instructors' information spaces' multiplicity is given by the number of DLEs units used in a course.

- The multiplicity is also given by the multiple webs of significances of the users: students and by the course instructors, each having different back-grounds, skills, different levels in digital literacy, etc.

    - Example: The web of significance is given by the number of users (students, CI) and the context the DLE units are used within.

- The multiplicity and intensity of the means of communication are illustrated by the majority of DLEs units, as many of them include some form of communication channels, especially the official systems and social media.

- The web of artifacts distributed across different DLEs units form the students' respectively, the course instructors' information space

- The immaterial means of interaction consists of all the habits, procedures, and division of labor shared amongst the stakeholders.

- The needs of precision parameter: the participants did not express any concern regarding time- or safe critical issues for the availability of information; Perhaps the *deadlines* can be regarded as such, but other than that, there are not such critical time aspects.

- Finally, the dialectic nature of DLEs clusters forming the hybrid or CIS is given by the openness and closeness of the DLEs units.

Discussion (cntd.)

- Cross-use of DLEs
  - Each of the DLE units can be considered as CIS or hybrid information spaces, based on two conditions:
    - 1) the functionalities they provide, and
    - 2) the perspective from which they are analyzed (student/CI).
  - our study shows some of the challenges posed when un-official DLEs are used:
    - the information becomes fragmented across different information spaces
    - the distribution of DLEs may cross different information spaces regions, for the students;
    - the degree of articulation work increases with the number of DLEs in use;
    - the multiplicity and intensity of the means of interactions depends on the type and number of DLEs used, as well as on the number of users;
    - using such complex information spaces that are formed out of DLE units and clusters of DLEs give some freedom and flexibility to its users,
    - but it also puts some responsibilities or expectations on them, such as collective expectations on one's availability at all the time, everywhere, increased commitment in communication, changed practices and norms, or experiencing an intensified communication

Conclusion and Future Work

- This paper has presented DLEs viewed through the lens of CIS.

- **RQ** answered: *what challenges do they set for the students, respectively, for the course instructors, how do DLE translate as CIS: what type of CIS are they, how are those represented, and used in a HE setting?*

- the article has focused on how DLEs can be designated as complex information spaces.

- DLEs are often seen, analyzed, and discussed about as educational environments

- It seems that CIS ad-dressed in educational settings seem not commonly explored.

- The contribution of the paper consists of discussing the cross-use of DLEs from a CIS perspective, moving beyond looking at DLEs just through an educational perspective.

- Future work:

  - investigating the articulation work necessary to be performed when large DLEs clusters are in use and

  - how these affect the work and performance of CI and students

  - addressing these information spaces from a universal design perspective would be both interesting, relevant, and timely