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Students' Self-Organization of the Learning Environment during a Blended Knowledge Creation Course

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Abstract: Learner-centered blended learning approaches, such as Knowledge Creation, emphasize the self-organizing characteristic of thought and action, and value the students' autonomy and self-regulation during the engagement in collaborative learning tasks. In blended contexts, the students need to organize their learning paths within a complex environment, including multiple online and offline learning spaces. This process of self-organization during courses based on the Knowledge Creation approach is currently an overlooked topic of research. The present case study is aimed at addressing this research gap by providing an in-depth understanding of the collaborative self-organization of a group of five undergraduate students participating in an interdisciplinary media design course. The course was designed according to the Knowledge Creation approach and was carried out before the start of the COVID-19 pandemic. The dialogical theory of the chronotope and the theory of cultural models constitute the main theoretical tools for the research. We used qualitative methods inspired by ethnography, including participant observation, in addition to the collection and analysis of audio-visual records, stimulated recall interviews, and learning diaries completed by the students. The findings show that the group self-organization changed across different phases of the collaborative task and involved the development of specific practices of self-organization. Cultural models associated with the task contributed to determine the students' choices related to self-organization.

Keywords: chronotope; higher education; cultural models; blended learning

Citation: Ritella, G.; Loperfido, F.F. Students' Self-Organization of the Learning Environment during a Blended Knowledge Creation Course. *Educ. Sci.* **2021**, *11*, 580. https://doi.org/10.3390/educsci11100580

Academic Editors: Neil Gordon, Maria Beatrice Ligorio and Francesca Amenduni

Received: 31 July 2021
Accepted: 12 September 2021
Published: 24 September 2021

1. Introduction

Blended learning (BL) [1] is a commonly used label to denote a wide range of instructional designs involving the integration of online and face-to-face pedagogical activities [2]. BL has become increasingly popular during the past two decades and is currently considered to be a useful approach for post-pandemic education [3]. Because students' performance in BL courses appears to be affected by instructional design [4], a significant amount of the research on BL has examined the sequencing of online and offline activities, and developed multiple approaches and models aimed at optimizing the design of BL courses [5–8].

From a learner-centered perspective, BL is expected to allow students to take control of "the choices of what and when to blend" ([9], p. 2). For Masie ([10], p. 25), this is a natural process that can be observed when the students transform "training and instruction into learning". Thus, as the students engage in the learning activities, they may add new elements that are not included in the teacher design (e.g., finding additional readings or educational technologies on their own), ignore some other elements that they may not need (e.g., disregarding some of the templates or scaffolds provided by the teachers), and mix their self-initiated activities and the teachers' design elements in personal ways.

Among the approaches that emphasize the learner-centered nature of learning, Knowledge Creation (KC) [11] and Knowledge Building (KB) [12] specifically highlight the

self-organizing characteristic of thought and action [13]. Based on a series of design principles [12,14], KB and KC deliberately seek to maximize the "intelligence operative among the students in proportion to the intelligence contributed by the teacher and the teacher's tools" ([12], p. 753). Consequently, in KB and KC, learners are typically afforded a relatively high degree of autonomy concerning the organization of the learning process.

Some empirical evidence seems to suggest that the autonomy of learners constitutes an important factor for academic achievement [2,15], thus providing empirical grounds for this kind of learner-centered approach to BL. From this perspective, learner-centered BL has a high potential to provide the flexibility, independence, and responsibility, in addition to supporting the metacognitive processes, necessary for the development of the "self-determined learner" [16].

When the learning environment and the learning task offer a high degree of autonomy, self-regulation becomes an important factor for success [17]. Self-regulation is particularly relevant in BL—compared with either face-to-face instruction or online education—because the self-regulatory abilities of learners are challenged by the integration of online and offline activities [2].

In addition, in learner-centered BL, the students may face challenges related to time management and learning environment management, which are "self-regulatory attributes" included in social cognitive models of self-regulation [15,18,19]. Coping with complex and unstructured learning environments, including both face-to-face and online activities, may not be a trivial task, particularly for students who do not have previous experience with learner-centered BL.

A further level of complexity that may characterize some learner-centered approaches is the collaborative nature of learning tasks, which implies that students do not only have to individually arrange the environment in ways that "make learning easier" [20], but also to coordinate with their peers and reach an agreement about the tools to be used, the places to meet, and the schedule of the collaborative task. Although the sequential organization of activity has been considered to be an aspect of interaction that plays a significant role both in collaborative learning and in BL [21–23], little is currently known about the students' self-organization during collaborative KC activities.

The arguments discussed above demonstrate the importance of examining students' self-organization during courses involving a high degree of students' autonomy, which is currently an overlooked topic of research. In this study, we contributed to addressing this research gap by exploring how a group of students diachronically self-organized their own collaborative activity while engaging in an interdisciplinary course based on the KC approach. Because the students had a high degree of autonomy during this course, this was considered by the researchers to be a suitable research context for a qualitative case study [24] on the students' self-organization.

To obtain a theoretically grounded understanding of this process, we adopted the dialogical notion of the chronotope [25], which allowed a socio-cultural examination of space (in terms of the organization of the learning environment) and time (in terms of temporal patterns of self-organization), and the theory of cultural models [26], which emphasizes the important role played by the assumptions and meanings that people associate with particular settings and recurring events, that are tacit and taken for granted. The reason for combining these theoretical perspectives is that we consider them complementary to the investigation of self-organization in collaborative settings. In the following, we briefly introduce these theoretical concepts, highlighting their relevance for the theoretical framing of the present study.

The chronotope has been used in education as a conceptual tool contributing to the examination of patterns of management of space–time in technology-mediated learning [27,28], allowing an understanding of how spatial and temporal patterns of organization of activity are constructed in dialogical interaction. According to this conceptualization, space and time are considered social constructions that are dynamically negotiated in dialogical interaction by the participants during any educational situation [29].

In this article, the chronotope is adopted as an analytical tool contributing to identify patterns related to the students' self-organization of the learning environment in both the spatial and the temporal dimensions. This notion emphasizes the interdependency between space and time, suggesting that the isolated analysis of either temporal or spatial patterns leads to a loss of in-depth insights about the ongoing learning processes. For example, when analyzing information on the level of the whole course, temporal information about students' engagement with the learning environment is lost [30].

Chronotopic analysis encompasses the examination of both the discursive construction of space–time that emerges from dialogic interaction [31], and the material-embodied processes through which learners enact space–time configurations and project structure on the learning environment. Concerning the spatial dimension, the analytic interest of the present investigation is on the virtual, material, social, and semiotic learning spaces that the students choose to inhabit, and on how the students arrange these multifaceted spaces as they carry out the collaborative KC activity. Concerning the temporal dimension, the analysis focuses on the diachronic development of the spatial configurations and on the students' collaborative negotiation of the schedule of the activity.

The theory of cultural models [26] has been used in educational research to examine a variety of topics, including literacy practices [32], students' achievement [33], differences in meanings and practices of education among diverse ethnic groups [34], and teachers' implicit theories on students' learning and teaching practice [35]. In the present study, the analytic focus was on the so called "task models" [35], which are models that the students may use to make sense of the task. These models are expected to provide strategies for addressing the task that they represent. Scripts [36] can be considered to be a specific type of task model that is often involved in students' responses to instructional tasks. The examination of cultural models is significant for learner-centered approaches to BL, because these approaches value the students' perspectives on educational processes.

Cultural models are likely to include assumptions and expectations about spatial and temporal relations, which may guide the students' sensemaking and self-regulation, particularly when dealing with complex and unstructured learning environments that do not provide clear-cut temporal and spatial boundaries assigned by the teacher or instructional designer [37]. However, to the best of our knowledge, the literature is currently lacking studies addressing this dimension of cultural models in research on BL.

The combination of the notion of the chronotope with the theory of cultural models allows emphasis to be placed on the strict interconnections between the students' culturally situated sensemaking about educational activities, and their material-embodied experiences of the space–time frameworks in which learning takes place. Research shows that the features of learning environments are encoded by people based mainly on the physical interaction with the world, and that such embodied experience of the world is combined with pre-existing knowledge and memories [38]. Thus, although the theory of cultural models assists us in examining how the implicit assumptions and theories may mediate the students' self-organization process, its combination with the concept of the chronotope provides insights into the close interconnection between these cultural assumptions and the learners' material-embodied experience of space–time. In this manner, the theory of cultural models is adopted in this context to enrich the findings of chronotopic research.

In sum, the aim of this explorative case study was to investigate how a group of students self-organizes its collaborative activity and arranges the learning environment during a learner-centered BL course. As discussed above, learner-centered BL courses may involve complex and relatively unstructured learning environments that challenge the students' self-regulation, particularly in terms of management of the learning environment and management of time. In particular, the course analyzed in this study allowed the students to autonomously define their own learning environment (in terms of choosing the places, the technological tools, and the learning materials to be used during the accomplishment of the collaborative task). The qualitative analysis, inspired by the theory of the chronotope and the theory of cultural models, was aimed at gaining an in-depth understanding of the

perspective of the students on their self-organization as they diachronically selected and arranged the virtual and material learning spaces. In addition, we explored the expectations and assumptions related to the learning environment and the space–time organization of the course. The research questions guiding the analysis are summarized as follows:

- How do the students self-organize the space–times of the group collaboration across different phases of the BL course?
- Which practices of self-organization do the students develop during the course?
- How do the students' cultural models affect their self-organization?

2. Materials and Methods

2.1. Research Context and Participants

The present case study is part of a larger research project involving two groups of students attending an interdisciplinary media design course held at Metropolia University of Applied Sciences in Helsinki before the start of the COVID-19 pandemic. The course was designed according to the KC approach, which emphasizes tasks involving the creation and progressive refinement of tangible shared objects such as models, products, and prototypes. In KC, work is advanced through cycles of collaborative planning, brainstorming, receiving feedback, presenting, and delivering/publishing [14]. In addition, as discussed above, KC learning environments are expected to provide flexible tools for developing artefacts and practices that the students can self-organize with a high degree of autonomy.

At the start of the course, representatives of companies presented business problems to the students. The students were invited to choose one business problem and were split into groups based on their preferences. Each group worked for 16 weeks at the development of a product or service addressing the chosen problem. As intermediate tasks, each week they were invited to develop artifacts (business plan, sales pitch, etc.) that would be assessed by teachers. The students worked together for 10 h per week. The university provided a rich set of possible environments for collaboration, and the groups of students could freely book one of these rooms depending on their current needs. Each learning environment was characterized by a different technological environment involving smart-boards, desktop computers, tablets, notebooks, etc. Some of the spaces required advance booking. For example, the students could book a room (which could simultaneously host up to four groups), in which one group per time could use a smartboard and connected tablets; a smaller room that could host only one group, equipped with a round table, chairs, and a desktop computer; a computer laboratory equipped with 24 workstations; and other regular rooms that could simultaneously host two or three groups, equipped with desks, chairs, and a blackboard or a whiteboard. At times, groups also worked in subgroups located in different locations within or outside the university campus. Before the start of the data collection, each participant completed a survey to gather background information and signed an informed consent.

Of the two groups participating in the research project, one was selected for this study because only the data collected for this group allowed a comprehensive analysis of the students' self-organization. In particular, only the students of this group agreed to fill in learning diaries describing all the learning activities that each student carried out throughout the whole course, which were crucial for the conducted analysis. This group had five members, three of them Finnish (Ivy, Lenny, and Rita), one Dutch (Jack), and one South African (Carl). Because this was an interdisciplinary course, students came from different bachelor's degree programs: marketing, nursing, media engineering, industrial management, and IT studies. The observed group worked on a business problem presented by a representative of an international humanitarian institution; specifically, this problem related to the difficulty of convincing people to wash their hands carefully and frequently in order to prevent the spread of contagious diseases.

2.2. Data Collection

For the data collection, we used qualitative methods inspired by ethnography [39]. We primarily used participant observation, with audio and video recordings of a sample of collaborative activities carried out at the university premises. In addition, the participants were asked to fill in daily individual diaries briefly describing all the activities that they carried out for this course, including those not recorded by the researchers. In the diaries, the students specified for each activity carried out: (1) the physical location; (2) the technological tools and artifacts used; (3) the date and time; and (4) the people involved in the activity that were present in the same location at the same time. The diaries were filled in by four of the five participants of the group.

To follow the potential transformation of the patterns of self-organization in different phases of the course, we agreed with the participants that teamwork would be recorded for 2 weeks at the beginning of the course, 2 weeks in the middle of the course, and 2 weeks at the end. The participant observation was carried out by two researchers, one of whom handled the camera and the other who took field notes on the general impressions of the ongoing collaboration. Furthermore, the researchers took field notes during the observation of the teamwork and collected documentation concerning the observed activities. Finally, two video-stimulated recall interviews were conducted to "elicit participant's perspective on what was happening" during the recorded interaction ([40], p. 85).

2.3. Data Analysis

A qualitative case study methodology [41] was adopted for this study. The analysis was organized in four steps aimed at capturing the complexity of the studied case [42] (Figure 1).

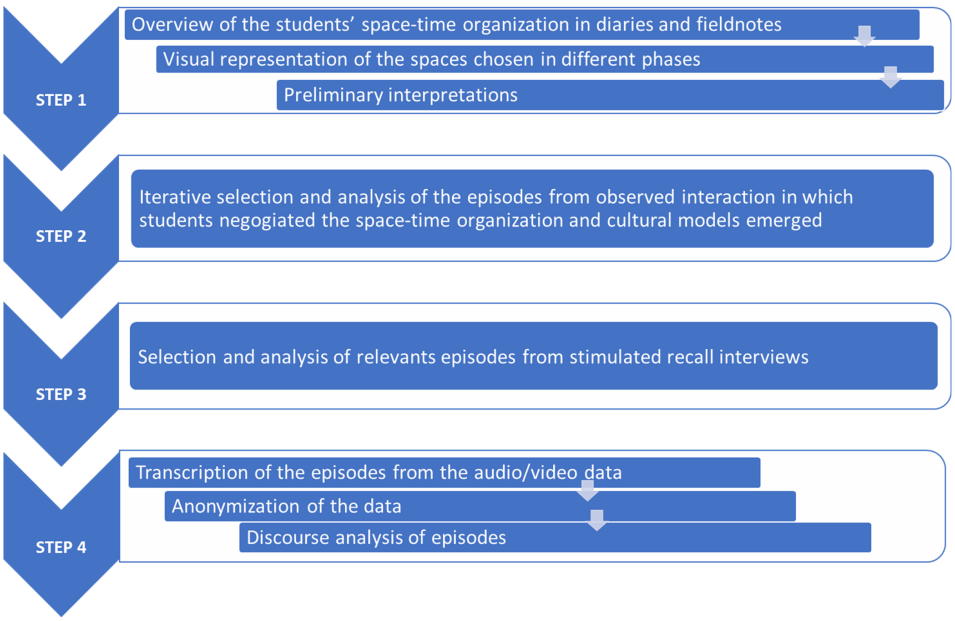

Figure 1. The four steps of the qualitative analysis.

First, the diaries and the researchers' fieldnotes were used to create an overview of the students' space–time organization during the course. To examine self-organization, it is fruitful to think in terms of the emergence of multiple heterogeneous and often overlapping physical, symbolic, virtual, and social spaces [43]. For example, physical spaces such as classrooms and laboratories may overlap with socially organized spaces involving intimate, social, and public zones, and with multiple symbolic/virtual spaces of books, blackboards, computers, etc. Tables and visual representations summarizing the virtual, social, and material spaces chosen by the students in different phases of the collaboration were developed. During this step, the researchers deleted references to proprietary software, using the generic label of the technological tool mentioned (e.g.,

spreadsheet, word processor, programming software). Based on the analysis carried out in this first step, the researchers developed preliminary interpretations that were progressively refined during the following steps.

The second step involved the qualitative examination of the video data [44], which consisted in the iterative selection and analysis of the episodes in which the students negotiated the space–time organization of the activity within the group and the episodes in which it was possible to detect the students' cultural models.

The third step involved the analysis of the stimulated recall interviews, which was aimed at developing an in-depth understanding of the students' perspective on their self-organization. The analysis of the interviews involved the selection and analysis of all the episodes in which the students (1) commented some videoclips that the researchers had selected during the second step of the analysis, and/or (2) reported their own assumptions and expectations (espoused cultural models) related to the spatial and temporal organization of the course.

Finally, the selected episodes from both the interviews and the observed interaction were transcribed and qualitatively analyzed. During this step, the researchers anonymized the data using nicknames. The students' talk and embodied actions were interpreted to answer the research questions guiding the analysis. Discourse analysis [45] was used to infer space–time relations from the discourse by considering linguistic features such as the tense, aspect, and modality of verbs; adverbs; conjunctions that marked temporal relations; and phrases that marked location. Some gestures, particularly deictic gestures such as pointing, allowed enrichment of the researchers' interpretations of how participants were defining space and time. In the analysis below, we do not report all of the episodes that were detected during the analysis. Rather, we first present an overview of the main patterns of space–time organizations that were identified, and subsequently discuss a number of excerpts that illustrate aspects of the process of space–time organization of the ongoing activity, including the role played by cultural models in this process.

3. Results

The findings are organized in three subsections. The first subsection addresses research question 1 and provides an overview of the space–time organization of the whole course and a discussion of how it changed across different phases of the collaborative project realized by the students. The second subsection addresses research question 2 and examines the process through which the students arranged specific space–time contexts and collaborative practices that contributed to improve their self-organization and coordination within the group. The third section addresses research question 3, discussing the role that the students' cultural models played in the process of self-organization.

3.1. Overview of the Space-Time Organization across the Whole Course

Table 1 summarizes how the use of different social, virtual, and physical spaces chosen by the students changed across the different phases of the course. In the table, the physical and virtual spaces are listed in order of frequency, from the most frequently mentioned in the students' diaries to the least frequent. Spaces that were mentioned only occasionally in the diaries are excluded from the table. We clarify that the students appear to have described in the diaries all the sessions of work on the project, with the exception of those that took place at home. Indeed, during the participant observation, the researchers noticed that some students contributed to a few tasks from home, particularly at the end of the course, but the sessions of individual work when these tasks were accomplished were absent from the diaries. The description of the other activities present in the diaries is consistent with the researchers' observations. Thus, we infer that the students did not consider individual work from home to be relevant for the diaries.

Table 1. Overview of the activities and main material, social, and virtual spaces depicted in the diaries.

Phase	Main Activities	Physical Spaces	Social Spaces	Virtual Spaces
First phase	Brainstorming, mind map of the project idea, preliminary project plan, user story, steering group meetings (SGM)	Mostly sitting in circle/semicircle in classrooms (Figure 1). Usage of computers/laptops, pen and paper, interactive whiteboard, tablets, post-it, photo-camera, whiteboard.	Mainly whole group activities in rooms shared with other groups.	Office suite (word processor, spreadsheet), online mind map tool, shared online folder, web-browser, graphic editor
Second phase	User story, programming, website design, information findings, sales pitch, test plan, midterm presentation, SGM	Primarily use of a private room in the library (Figure 2), computers/laptops, printer, video projector, photo-camera	Growing amount of individual work and/or collaboration in subgroups (2–3 members per subgroup), often carried out in a private space reserved for the group or a subgroup.	Shared online folder, web-browser, office suite (presentation software, word processor), programming software, graphic editor, web browser.
Third phase	Programming, website design, updating and finalizing documentation (e.g., project plan); marketing plan; financial plan; sales pitch; catch up/to do meetings with team; SGM	Shifting between the private room and the computer lab (Figure 3), individual work using computers/laptops, pen, and paper	Mostly individual work or collaboration in subgroups, weekly short briefings with whole group	Office suite (word processor presentation software), shared online folder, programming software, graphic editor.

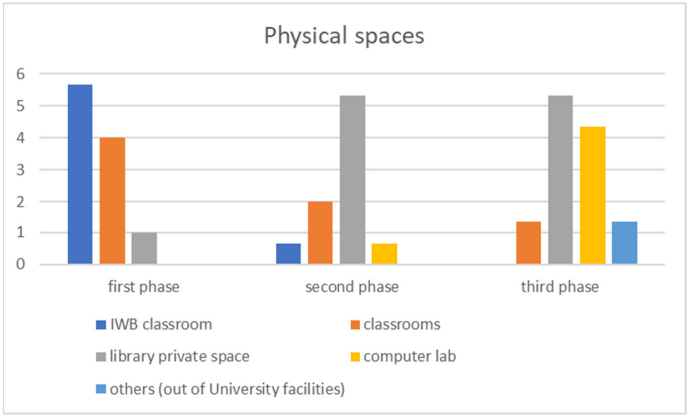

Figure 2. Physical spaces chosen by the students during the different phases of the course.

Figure 3. Primary configurations of participation during the first phase of the course.

Figure 2 represents the use of the different physical spaces during the course. In particular, the figure shows the average number of sessions that each student spent in each physical space. The figure was created based on the students' mentions of each space in the learning diaries. Table 1 and Figure 1 show that the three phases of the course were characterized by different patterns of self-organization.

During the first phase, the students mainly engaged in whole group sessions and tended to arrange their learning space sitting in circles or semicircles in classrooms shared with other groups. Typically, two or three groups shared these classrooms, each group arranging its own learning space in a corner of the room by moving chairs and desks (Figure 2). Although face-to-face conversations were the primary means of communication within the group, often oral communication was enriched by means of technological tools. For example, on several occasions the group used the interactive whiteboard that was available in one of the classrooms to project notes or contents relevant for the ongoing conversation, or an online tool allowing them to create a shared mind map to summarize the decisions of the group. In this way, physical, virtual, and social spaces were interwoven in a dynamic manner. During this phase, the students often chose to work in a classroom where they could book an interactive smartboard or in other classrooms where they could easily move the chairs and desks to arrange a suitable learning environment for the teamwork using their own laptops (Figure 3).

The figure shows that on average, during the first phase of the course, each student spent 5.7 sessions of work in the classroom with the interactive whiteboard and four sessions in other classrooms. During this phase, particularly during the first and the second weeks of the course, the participants explored the various tools available in the learning space, including the tablets provided by the teachers and a whiteboard available in one of the rooms, on which the students attached Post-its with ideas for the development of the project. In addition, they set up a shared online folder for sharing digital documents within the group.

During the second phase of the course, a growing amount of individual work and the creation of subgroups were detected. The students frequently booked a private room in the university library, which was often used by one of the subgroups composed of two members (Lenny and Jack), who worked collaboratively on the design of the website and the programming of the interactive content. At times, this room was also used by some of the students for individual work (Figure 4). Other students went to different classrooms or to the computer laboratory to carry out the subtasks assigned to them. Concerning the virtual spaces, in this phase the students ceased to use the online mind map tool, and some of them started systematically using domain specific software (especially programming software and graphic editors), whereas others used web search engines to find useful materials for the project. During this phase, face-to-face interaction involving the whole group became sporadic, and the students quite often worked from different locations. They used instant messaging or phone calls to communicate with each other, and the shared online folder for monitoring the work done by their colleagues and sharing documentation within the group. To conclude, in this phase, it was possible to observe how students decided to "blend" the collaborative activity, integrating face-to-face meetings and online activities that were carried out individually or in subgroups from different locations within the university campus. Online activity was monitored by means of the shared online folder.

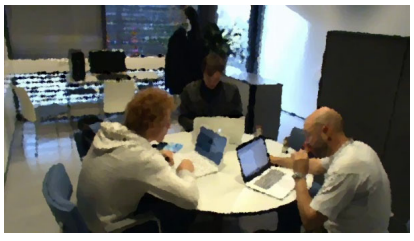

Figure 4. Primary configuration of participation during the second phase of the course.

Finally, during the third phase, the students often chose to work from the private space in the university library or the computer lab, where they carried out individual work. During this phase, in some moments all of the members of the group decided to remain in the same room, even if they were carrying out individual work. At times they split into subgroups working from different locations, similarly to the behavior during the second phase. Figure 5 shows how the arrangement of desks in the computer lab forced the students to stand when they had to communicate with one of their peers. Nevertheless, on average, more than four sessions of work on the project were spent by each student in this room. This is probably connected to the fact that oral communication among the whole group was absent for long periods of time, and, more generally, social interaction within the group decreased. Nevertheless, during this phase, every day the students organized short whole-group meetings held at the private space in the library to coordinate and make decisions relevant for the realization of the project. These meetings were described by the students as "catch-up meetings" or "to-do meetings", suggesting that they felt the need to orchestrate a specific space–time for coordination because most of the time they engaged in individual subtasks with a low level of communication. In this phase, the online shared folder was used as a tool for monitoring the work undertaken by their colleagues and sharing documentation within the group, similarly to what happened in phase 2. Apparently in phase 3, however, this was not a sufficient means for coordination and the students developed the practice of "catch-up meetings" to enhance coordination. The use of the shared folder as a tool for monitoring the contribution of their peers is particularly interesting for the aims of this study; therefore, this is discussed in the following section.

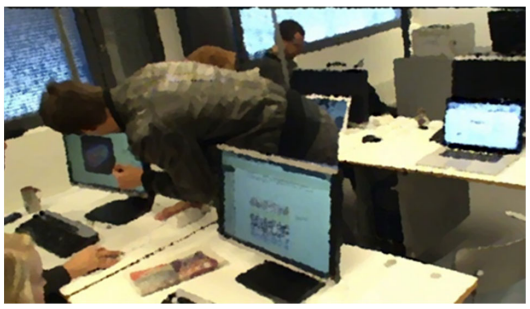

Figure 5. Primary configuration of participation during the third phase of the course.

3.2. Arranging Physical and Virtual Space–Times for Self-Organization

In this section, we discuss how self-organization involved the development of specific group practices involving both physical and virtual space–times. First, in the video data from the observed interaction of group work, we identified 19 episodes in which a shared online folder was used for purposes associated with self-organization. This folder was used for monitoring the state of advancement of the task and/or for the coordination of individual efforts. Excerpt 1 provides an illustrative example of these episodes.

Excerpt 1: observed interaction; third phase of the course

Ivy: why didn't Lenny . . . yesterday . . . ehhh did he do the second test meeting . . . he did not put any documentation in the shared folder

Carl: but he did it [the test] yesterday

Ivy: I told him that before the presentation we need the second test done

In this excerpt, we infer from Ivy's speech that she used the shared folder to monitor Lenny's work on the subtask that was previously assigned to him by the group. Indeed, Lenny was expected to carry out the testing of the website that they were designing, which involved meeting a group of potential users of the site and collecting data on their usage. In several cases such as this one, the students checked the status of documents within the shared folder and inferred from it what their peers had been doing and which subtasks still needed to be completed. Because the researchers observed that this shared folder had

become an important tool for the students' self-organization, a question was asked during the final interview to gather the students' perspective on its usage (Excerpt 2):

Excerpt 2: final stimulated recall interview

> Researcher: talking about the shared online folder . . . how would you comment on the use that you have done of the folder, what was it useful for
>
> Jack: just have any file from anyone in your computer
>
> Ivy: and you can update it and anyone can see and it's all there you don´t have to worry where was it and where did you put it and who´s saving the documents or whatever
>
> Jack: I open my laptop in the morning and then I see they start updating some presentations
>
> Ivy: who´s doing what
>
> Carl: forty files have been updated oopps
>
> Jack: and then you just gotta check it out or not whenever you want but you know [if] somebody was working on it
>
> [...]
>
> Carl: and I think it is a good way to keep track because we didn´t have the (.) the space so so I think dropbox was our virtual space
>
> Ivy: space yah
>
> Carl: where we could
>
> Ivy: save
>
> Carl: at least store stuff there we're been working on . . .

The answers provided by the students during the interview confirm that the shared folder was important for the process of self-organization for several reasons. First, for the students, this online space also allowed the placement of documentation such that it could be found more easily ("you don´t have to worry, where was it and where did you put it"). Second, the folder allows the participants to see "who's doing what" ("I open my laptop in the morning and then I see they start updating some presentations"; "you know if somebody was working on it"). Third, the online shared space appears to Carl to be a replacement for a stable physical space that they tried to find at the beginning of the course. Indeed, during the first phase of the collaborative task, the group explored the different physical environments available at the university campus and realized that they needed a stable and private place, where they could leave artifacts useful for the "project planning". Excerpt 3 is taken from the final interview and allows an examination of the students' perspective on this aspect of their self-organization.

Excerpt 3: final stimulated-recall interview

> J: I think it´s a shame that in the start we tried to have our own space to work at so we had this whiteboard up there with everything where you can see the project planning but we tried to do it for two weeks and then we couldn´t keep the board for ourselves . . . the all thing skipped and then we started wandering around the school
>
> C: looking for a place to settle
>
> J: yah I think that was a bad thing for the project because that that keeps the focus . . . where should we work now? instead of just go to the place open your laptop or whatever
>
> C: and have all the stuff
>
> J: and you can leave your ideas on the table and come back and start again instead of piling up
>
> [. . .]

J: the availability of the laptop and the ipads is cool to just have them . . . but if it´s not your own for a period of time then you never gonna do anything on it because you don´t wanna

I: yah you don´t save the documents

J: you don´t wanna save it on there because somebody else is gonna throw it away or whatever and next time you pick up the laptop somebody made a whole different background and a mess on the desktop so

J: and if the ipad is not really yours to you then you never gonna use it fully just for the browsers on the internet and then yah well then it stops after that

In this excerpt, one of the students explained that a major need of the group was to find a place that could provide stability to their iterative efforts throughout the whole process ("find a place to settle"). It appears that, for the accomplishment of the long-term task of developing the project, the students needed a stable space across the multiple situations and tasks encountered ("because that keeps the focus"). In particular, they needed a place to leave artifacts without the fear that other people could "throw them away". This was a recurring theme mentioned by most of the students during the second interview. Based on these premises, the students developed alternative solutions, such as using the shared folder and creating a recurring daily practice of "catch-up" meetings to satisfy their organizational need.

3.3. Space–Time Organization and Cultural Models

In this section, we use some excerpts from the observed interaction and from the video-stimulated group interviews to provide an in-depth discussion of the process through which cultural models were involved in the students' collective self-organization of space–time. This section aims to answer the second research question.

Excerpt 4 was taken from the second week of the course, during a session in which the students were collectively working on the profiling of the user group; that is, they defined the ideal type of user that was expected to use the website created during the course.

Excerpt 4: recorded interaction, first phase of the course

Jack: ok (.) ((pointing to Ivy)) put up a fat title of different types of users and we're gonna draw out just a list of different types of users

Lenny: yah

Carl: I want to do a mind map. I like the mind maps

Jack: we can do a mind map . . .

Lenny: yah we could . . .

Ivy: no not always the mind map

Jack: it's it's very

Carl: ok, well, so user groups are gonna be kids . . .

In Excerpt 4, Carl proposes to also use the mind map for the task of choosing the user group, to which Lenny and Jack appear to agree, but Ivy argues that they should not always use the mind map. The background needed for interpreting this excerpt is that, during the previous sessions of collaboration, the group had made intense use of mind map tools for representing the main ideas connected with the project. Carl and Jack appear to be willing to create a new mind map for the ongoing task, but they immediately accept Ivy's objection and start working on the task, dropping the idea of the mind map. A few minutes after this clip Jack said that he felt the need to draw something and started drawing a schema of the age groups that they were discussing on the smartboard. In our interpretation, when he proposed to create a mind map, Carl voiced the need of a visual representation for advancing the collective discussion. Although Carl's proposal was not accepted, later Jack re-voiced the same need when he started drawing on the smartboard. This excerpt shows that the participants may not provide clear explicit arguments when they make decisions

about the technological tools (and visualization techniques) to be used for advancing the collaborative task. The data show that during the video-recorded sessions, the dialogical interaction around this topic tends to be concise and it is difficult for an external observer to understand the rationale behind the group's choices on self-organization. This finding suggests that the process of self-organization includes implicit assumptions that are not clearly voiced by the participants.

Because the decision making about the tools to be used for collaboration was of analytical interest, the researcher showed the videoclip containing this interaction to the students and asked them to comment on it. Excerpt 5 contains part of the students' reactions to the projection of the videoclip. The participants discussed their perspective on the use of the mind map during the project and all the participants appeared to be convinced that the mind map was not the right tool in that moment.

Excerpt 5: first stimulated recall interview

Lenny: I kind can't explain why but . . .

Ivy: yep it's hard to explain but but mind map is is not the right tool

Carl: I thi I think the mind map is what you use to are starting to create something

Ivy: yah and you are changing ideas

Carl: and watching you have your basic flow

Ivy: yah

Carl: you actually you don't make a mind map for when you have certain points you wanna portray because what's the point then you just have them

Ivy: when you have a clear task you have to do it I I think mind map is not appropriated

In our interpretation, Excerpt 5 reveals assumptions that the students have developed concerning the relationship between the temporal structure of the task and the appropriate tools to be used. First, Lenny and Ivy state that it is difficult to explain the reasons behind their choice, confirming that implicit cognitive processes may have been in place when making this decision. Subsequently, Carl links the use of the mind map tools to a specific phase of the collaboration when one is "starting" to create something. Then, Ivy adds that the mind map is good when there are changing ideas, whereas the mind map is not appropriate when they have a clear task. Carl also refers to the fact that, by using the mind map (in previous sessions of collaboration), they could watch their ideas as they were emerging, and that such a means of working allowed them to reach what he calls a basic flow. Although he had initially proposed the use of the mind map in Excerpt 1, during the interview Carl appeared to be convinced that, in the case shown in the videoclip, the mind map was not the right tool because they already had a "list of points". The analysis of the data from phases two and three of the course confirms that the students no longer used the mind map tools that were used at the beginning of the course, confirming that the cultural model they espoused during the interview is compatible with their enacted self-organization.

4. Discussion

In this study, we examined the students' self-organization of space–time during a Knowledge Creation course and the role played by cultural models in this process. In this section, we discuss the findings by connecting them to the research questions that guided the analysis.

To answer research question 1, the learning environment of knowledge creation was examined in terms of a diachronic sequence of space–times that the students dynamically arranged throughout the different phases of the BL course. We showed how different physical environments and virtual spaces, and different configurations of the social space, were relevant during each phase of the task. In particular, the initial phase of the activity was characterized by oral discussions mediated by shared visual representations such as

concept maps, while during the second and third phase, a progressive increase in individual work often mediated by domain specific software (such as programming software) was observed. Across the three phases of the course, the group members contributed to the collective task from different physical spaces, thus "blending" their learning experience and alternating online and offline activities according to their own preferences and situational needs. In addition, the analysis shows that the students deliberately sought to find a stable place for the collaborative activity. This need for stability can be discussed in terms of embodied cognition. As brilliantly discussed by Kirsch [46], people tend to encode information in space, which works as an aid for thinking and lowers the cognitive load of complex tasks. Due to not being able to "leave" artifacts in a stable, physical learning space, which would work as a mediating tool for their sustained activity across several months, the students had the feeling of being lost, of wandering around the school, and of not being effective in their collaboration. This need was at least partially fulfilled through the introduction of the practices of space–time organization that were identified, which are discussed below.

The analysis conducted to answer research question 2 allowed discussion of how the students socially negotiated specific practices (and associated space–time frames) for self-organization that contributed to satisfy their need for stability. In our interpretation, these practices provided a stable anchor for the self-organization of the group and allowed discussion of how physical and virtual space–times were flexibly used for self-organization. The space–time configurations in which these practices took place were intertwined with on-task space–times, and they can be considered to be complementary to the joint problem space (JPS) theorized by Teasley and Rochelle [47,48]. The JPS is a concept that enables examination of how learners collaboratively make sense of a problem-solving task, and of the content knowledge and procedures needed for finding a solution, thus developing a shared understanding of the problem assigned by the teacher. On the contrary, the joint organizational space–times (JOSTs) detected in the present investigation are related to the students' management of complex learning environments in situations in which they face problems related to the organization of the collaborative activity. In particular, the group introduced daily "catch-up meetings" and used a shared online folder for the "monitoring" [49] of the task and the "coordination" of individual efforts, especially when working from different places. The development of these practices of self-organization is not immediate. Indeed, the data show that this was a demanding process for the group, confirming previous research suggesting that time management may constitute a significant challenge for students in blended learning contexts [50]. In addition to time management, based on the analysis of this case, we also argue that the management of unstructured and technologically rich environments may be seen both as a resource and as a challenge for the students. The students can perceive the multiple physical environments and virtual spaces as resources that can be flexibly and autonomously integrated in creative configurations of online and offline participation. This is in line with previous research showing that adult learners tend to value course designs when they contain multiple options, self-direction, and variety [51]. Conversely, such rich and unstructured learning environments can require sustained efforts across extended periods, because the students need to iteratively reorganize their learning environment based on the evolving needs of the group.

Overall, these findings can be interpreted by adapting and extending the scope of the concept of interaction space that has been used in the context of intelligent learning environments by Dillenbourg and colleagues [52]. Although the present study takes place in a radically different context, the interaction space has been conceptualized in terms of a sequence of subspaces called microworlds, thus accounting for the temporal development of learning activities which is crucial for the present investigation. According to this theoretical perspective, different phases of a learning course can be described in terms of the sequence of interaction spaces relevant at different times during the learning activity, which involved both spaces for representation (e.g., the concept maps) and spaces for

(inter)action (e.g., the design and programming of the website). Nevertheless, although previous research on the modelling of interaction spaces has been aimed at improving the design of learning environments by teachers and instructional designers, the present investigation shifts the focus onto the active role that learners can play in selecting and arranging the sequence of space–times that characterizes the collaboration in blended learning contexts. Accordingly, the investigation has allowed the detection and analysis of the space–time frames that the students arranged specifically for the self-organization of the activity. Thus, according to the chronotopic approach proposed here, the analytic focus is on how the space–time of interaction is socially arranged by the participants during the activity, rather than on how it is structured in advance by the teacher. It is not expected that all the groups of students engaging in Knowledge Creation will enact the same sequence of space–time relations observed in this group. Rather, it is hypothesized that the students may develop a set of self-organization skills, related to the iterative development of collaborative practices of self-organization, which are currently under investigated. These skills are not only relevant for the successful implementation of the knowledge creation activities discussed in this investigation. Contrarily, there is a growing awareness that the development of this type of self-organization skill is to be considered as an expected educational outcome of high societal significance. A recent review study commissioned by the European Commission on Key Competences for European Citizenship showed that skills connected to self-organization "in various forms are included in several frameworks, either as a separate skill or as part of social and civic competences" ([53], p. 18). Scientific knowledge about how students self-organize Knowledge Creation activities may be used by teachers to support the students in this aspect of the learning process. Future research in this field may uncover further details about how the students can learn to collaboratively generate effective practices of self-organization, and discuss strategies to promote the learning of such skills, which may be based on the analysis of cultural models such as the ones discussed below.

Finally, the findings associated with research question 3 allowed discussion of how the students built on "cultural models" that included assumptions regarding the space–time frames of the task when they self-organized their collaboration. The analysis of the two excerpts presented above illustrated that processes of self-organization are often implicit and allowed discussion of how the task models elicited during the interview may play an invisible form of mediation that silently guides the students' self-organization. In particular, we emphasize how the students' task models may involve specific assumptions about the space–time organization of learning tasks, for example, expecting that the creation of mind maps is appropriate only at the beginning of a Knowledge Creation course. We claim that these representations of space–time associated with cultural models are important elements of self-organization that are not yet addressed in the literature on Knowledge Creation. Our analysis shows that, at times, the students developed divergent ideas about the temporal development of the collaborative project and about the virtual/material spaces that were relevant in the different phases of the course, also based on their professional background. Students and teachers may be unaware of these assumptions and their implications for learning. Thus, developing scientific knowledge of the students' choices, challenges, and assumptions concerning the organization of the space–time of Knowledge Creation can help teachers to provide assistance and facilitation, and allow students to further develop their skills as "reflective, self-directed, self-regulating and, indeed, self-determined learners" ([9], pp. 12, 16). Our data show that throughout the Knowledge Creation process, the students may need to develop different arrangements of material and virtual tools, in addition to different configurations of online and offline participation depending on the diachronic development of the "long-term processes of knowledge advancement with shared objects" [14] that characterize KC.

The explorative nature of this case study does not allow generalization of the findings to different groups and different courses. However, the richness of the data from this case

study allowed us to illustrate relevant aspects of student self-organization that can provide directions for future research in this rather unexplored field.

Author Contributions: Conceptualization, G.R.; Data curation, G.R. and F.F.L.; Formal analysis, G.R. and F.F.L.; Investigation, G.R. and F.F.L.; Methodology, G.R.; Software, G.R.; Validation, F.F.L.; Writing—original draft, G.R.; Writing—review & editing, F.F.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are not publicly available due to privacy issues.

Conflicts of Interest: The authors declare no conflict of interest.

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