education sciences

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Investigating the Characteristics of Knowledge-Related Learning Assignments in Upper Secondary School

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Abstract: This study reports on whether students have the opportunity to acquire generic competencies when they work with knowledge-related assignments at upper secondary school. We investigated 30 assignments. The data included lesson observations and interviews with teachers. The main categories of teaching practices were theory-based, and the subcategories and the levels of intensity were based on qualitative analysis of the data. The most common categories were Object-orientedness, Epistemic challenge, Process-like emphasis, Intensity of collaboration, Cross-fertilisation, and Information practices. The least common categories were Cross-fertilisation, Process-like emphasis, and Object-orientedness. Cluster analysis produced three groups: Open and challenging assignments with guidance and support (eight cases), Demanding assignments without support (seven cases), and Well-defined, teacher-directed assignments (15 cases). Assignments of the first type support students' knowledge-related competencies the best. The second type of assignment is demanding because students work independently with limited support for challenging assignments. Assignments of the third type were well-structured and teacher-centered assignments.

Keywords: digital technology; school; teaching; learning; classroom practices

Citation: Ilomäki, L.; Lakkala, M.; Muukkonen, H.; Paavola, S.; Toom, A. Investigating the Characteristics of Knowledge-Related Learning Assignments in Upper Secondary School. *Educ. Sci.* **2023**, *13*, 471. https://doi.org/10.3390/educsci13050471

Academic Editor: Kendall Hartley

Received: 16 March 2023
Revised: 20 April 2023
Accepted: 26 April 2023
Published: 4 May 2023

1. Introduction

In today's world, secondary schools should provide students with the relevant generic competencies they need for further education and lifelong learning, as presumed by the changed conditions in studying in post-secondary education and the business world. These requirements include skills such as asking questions, collaborating with others, thinking "outside the box" for finding innovative solutions, critical thinking and creativity, becoming comfortable with complexity and ambiguity, flexibility and adaptability, taking responsibility for one's own actions, considering reflection, communication and relevant digital competence [1,2]. The frameworks for defining the generic competencies required by researchers and policymakers vary and develop over time [3,4]. A current widely applied framework in education is the framework of 21st-century skills, which includes ways of thinking, ways of working, tools for working, and ways for living in the world [5].

In the present study, we built on the approach of knowledge work competence by [6,7], in which "knowledge work competence was structured as object-bound collaboration, integration of personal and collective efforts, development through feedback, persistent development, understanding of different disciplines and related expertise, interdisciplinary collaboration, and using flexible tools and technology" [6] (p. 2084). The approach was applied to investigate higher education practices and emphasise students' competencies for the world of work. That is somewhat different from the focus of the upper secondary school, but the approach of this study shares the main pedagogical elements examined and the

theoretical background. In this article, we use the term competencies to mean collaborative working with knowledge, emphasising collaboration and the fact that at school, students practice and learn to use, produce and assess knowledge, even though they do not do real knowledge work. Following this, we investigated how students' assignments represented and educated practices of collaborative working with knowledge.

To understand how upper secondary education can be improved to support competencies for collaborative working with knowledge, we investigated the favourable conditions and shortcomings of existing pedagogical practices. Specific pedagogies, such as problem-based learning, collaborative learning, experiential learning, authentic challenges, entrepreneurship education, and comprehensive use of digital technologies, have been reported for advancing the acquisition of various generic competencies [4,8–12]. In addition, whole-task approaches (that is, teaching generic skills within one large assignment instead of teaching individual skills separately) or teaching generic skills embedded in meaningful contexts have been productive for learning the skills [13,14].

We intended to investigate the various ordinary upper secondary pedagogical practices instead of focusing on specific pedagogical approaches because there has been limited empirical research about how practices of collaborative working with knowledge canbe operationalised within everyday teaching. Furthermore, we investigated the enacted practices and assignments instead of the intended ones [15] because the enacted practices form the basis of students' learning. An assignment given by the teacher (e.g., students searching answers in pairs for a societal problem), describes, explicitly or implicitly, characteristics of knowledge to be studied and its use, the intended ways of student collaboration, the nature of working practices, and the aspects of assessment. The assignments investigated were designed and organised by the teacher, so they did not follow ready-made learning material or a textbook.

In the following chapters, we first review the research on assignments promoting generic competencies, and second, the theoretical key features for pedagogical practices that we consider essential for learning assignments using digital technologies that promote competencies for collaborative working with knowledge.

2. Theoretical Background

The relationship between pedagogical methods and students' learning outcomes is not straightforward and it cannot be explained by a single feature in the educational setting [4,16]. For assignments promoting generic competencies, teachers organise extensive and appropriate opportunities for students to learn, including both the content to be covered, teacher actions in the classroom, task characteristics that direct student engagement, and materials and other resources [17,18]. Especially in teaching complex knowledge and skills, a teacher's role is indirect: setting up background conditions for the targeted learning and working through designing the supportive pedagogical infrastructure, but not determining the contents, tasks, and activities in detail [19].

Several studies about learning assignments and generic competencies focus on learning outcomes when using a digital application in the assignment, e.g., virtual reality [20], computer-supported fading and feedback [21], using 3D computer-aided design [22] or mobile learning [23]. Some studies focus on the activities to improve learning at the school level, such as support for teachers' practices, by planning and managing the teaching of competencies systematically at the school level and accounting for the latest findings in future teacher training [24]. Rarely have the features of assignments as such been analysed. There have been a few exceptions: e.g., Feu, García-Rubio, Gamero, and Ibáñez [25] analysed learning tasks in physical education, focusing on learning by playing games. Datzko [26] analysed open and closed short tasks for learning about computational thinking and found that the open tasks supported creativity better, but both kinds of tasks are needed for learning. Parsons, Malloy, Parsons, Peters-Burton, and Burrowbridge [27] analysed how tasks supported sixth-grade students' self-determination (one essential future competence).

Their analysis focused on the authentic, collaborative, challenging, student-directed, and sustained characteristics of the tasks.

Characteristics of Assignments Promoting Collaborative Working with Knowledge

Collaborative knowledge creation is considered to be one of the central characteristics of work in a knowledge-intensive society. The knowledge creation approach to learning [28,29] emphasises processes in which epistemic objects (e.g., papers or presentations) and working practices are developed collaboratively. The social nature of learning and the importance of engaging students in collaborative practices is generally recognised by learning researchers. It is also essential that a student's own individual motivation and engagement are fostered; therefore, the integration of individual and collaborative efforts is emphasised in collaborative knowledge creation [29]. Furthermore, teachers should explicitly model and teach relevant collaboration practices and principles to students, as well as structuring, orchestrating, and scaffolding group work [30–32].

Assignments for collaborative knowledge creation arise from authentic questions, which then provide a guide to the authenticity of the object of the joint work, the working practices, and the outcomes. Such assignments familiarise students with practices and challenges of real-life knowledge work, including contexts that reflect the way knowledge is used in real life to solve ill-defined tasks, access expert performances and working models, collaborative construction of knowledge, reflection as well as assessment tied to the successful solution of the tasks [9,33,34]. These assignments include transforming, reflecting, and versioning, and these require longitudinal processes of knowledge advancement [29]. Collaborative knowledge creation requires metaskills concerning both individual activity, collaborative interaction, and object-orientedness [9,35], and practising metaskills means engagement in repeated self- and co-reflection as well as conducting multiple iterative feedback and improvement rounds [36].

The requirement for cross-fertilisation, the interaction between different ideas, cultures, categories, or organisations [29], broadens learning from one subject, one classroom and one schoolbook into a wider understanding of the phenomena to be studied and practices to be learned. Cross-fertilisation practices include for example students studying outside educational institutions, and collaborating with students in other educational institutions or with external experts [37]. Cross-fertilisation also means crossing boundaries between knowledge of various subjects, which is necessary for solving complex problems, such as climate change [38,39]. Cross-fertilisation broadens the conception of knowledge from traditional factual knowledge in schoolbooks to understand that knowledge represents various backgrounds, approaches, and cultures and provides an opportunity to be acquainted with and examine phenomena from various viewpoints. It also gives means for the critical interpretation of information [40].

The epistemic challenge of a learning assignment offers opportunities to learn real knowledge and work practices (7). It relates both to the authenticity of practices compared to real-life challenges (discussed in the previous paragraphs), and to the complexity of the problem space. Jonassen [41] emphasised the importance of engaging learners in problem-solving and suggested distinguishing between well-defined and ill-defined problem-solving tasks, which are different and teach different types of knowledge and competence. Chinn & Malhotra [42] argued that inquiry tasks in schools should epistemologically resemble authentic inquiry; they contrasted authentic scientific inquiry with the simple inquiry tasks found, for example, in textbooks.

The use of digital technology in school education is important for advancing students' digital competence in general, and managing the use of appropriate and flexible digital tools is especially central in productive collaboration around shared objects of knowledge work and practices [29]. Digital tools have a mediating role in shaping the ways of working, influencing the pedagogical practices and the type of learning activities based on the affordances that they offer [43]. At school, digital technology is often used for using digital information sources. Students should learn to search for information from multiple digital

sources, evaluate the sources critically, and create their own synthesis. The Internet has created opportunities for using authentic information sources, but according to previous studies, few upper-secondary students are competent in this [44,45]. As Saunders et al. [46] stated, students rely too much on resources such as Google and Wikipedia, they are not able to apply sophisticated search strategies, critically evaluate information, or to correctly cite sources. Therefore, online reading skills should be practised at school and integrated into subjects in a holistic way, not fragmented into small tasks, as Majid et al. [45] suggested. In some pedagogical models, the scaffolding of information skills is explicit and embedded in comprehensive working processes, such as in guided inquiry [47,48]. Many studies about students' information skills focus on textual information, although digital technology offers a range of media types, such as pictures, videos, or voice. The multimodality of information in learning settings has only recently been investigated, and the results show that students evaluate the information differently based on its digital form. For example, videos offer several opportunities for adding sound and pictures into information outcomes [49,50].

In a school context, a central element both in teaching and learning is assessment. Students are strategic in their use of time and effort, and they concentrate on what they think will be assessed and will lead to good grades [51]. Explaining assessment criteria provides a direction for students about what the desirable or acceptable performance guiding their efforts and understanding of the targeted knowledge and skills is [52]. Explicit criteria and guided self and peer assessment practices may support students' self-regulative abilities [53]. Generic competencies related to working with knowledge should be explicitly considered in assessment methods if we want students to be motivated to practice and improve them, even if they cannot be defined or assessed through strict, objectively defined criteria [54].

3. Aim and Research Questions

The theoretical viewpoints and empirical findings emphasise the need to support students' competencies for technology-enhanced collaborative knowledge creation practices. Our aim in this study is to investigate whether the characteristics of learning assignments include practices that can support the emergence of these competencies in upper secondary school.

The following research questions were addressed:

(1) What are the characteristics of investigated assignments in upper secondary courses in relation to promoting competencies for collaborative working with knowledge?
(2) What groups of pedagogical assignments can be identified in the investigated cases?

4. Materials and Methods

The study was an explanatory multiple-case study [55] in which the theory base helped to create the analysis framework for the assignment analysis as well as to interpret and explain the practical findings of the cases [56].

4.1. Context of the Study

This study took place in Finnish upper secondary schools. It takes three to four years to complete upper secondary education [57]. Passing the matriculation exams provides an option for applying for entry to higher education. The Finnish National Core Curriculum for upper secondary schools (implemented in 2016), has a course structure of compulsory and voluntary courses. A course is usually seven weeks long with 38 h of classroom teaching. In addition to its content-related aims, the curriculum recommends pedagogical methods, such as problem-solving or inquiry learning. The aims concerning general competencies are to develop information acquisition and application capabilities, to become accustomed to assessing the reliability of the information, and to learn to use information and communication technology appropriately and safely. Furthermore, a school should support interaction, cooperation, and self-expression skills, or those competencies needed for working in teams and projects. The curriculum also consists of cross-curricular themes,

such as multiliteracy and media, and technology and society. The aim of these is to engage students in observing and analysing contemporary phenomena, exploring extensive entities and crossing boundaries, sharing understanding and competence as well as in peer learning and problem-solving [57]. Based on these aims, it can be said that the curriculum is well in line with the recommendations to support the learning of the general competencies as well as research findings on how to achieve these competencies.

Finnish teachers have relatively broad autonomy in their classrooms, they have the freedom to decide on the pedagogical methods they use with students [58,59], and they have deep professional insight into education from several perspectives because of their academic background and the five-year master's level university education they must undertake. For these reasons, the courses and the assignments vary according to each teacher's pedagogical thinking and decisions, although the general curriculum is the same.

4.2. Cases

An independent and coherent knowledge-related assignment formed a case of the study because the assignment captures the pedagogical basis for learning, as explained above. For the knowledge-related assignments, students searched, compared, or evaluated knowledge, and they answered questions that required information management and processing skills, or they produced presentations, essays, or other creative outcomes themselves. The duration of knowledge-related assignments varied from one to several lessons, and they were conducted individually or collaboratively. We chose to focus on individual assignments, not on courses, because usually, a course consists of several assignments, which differ from each other. Focusing on the course level hides the details of the assignments. The participating teachers had designed and implemented the assignments (the cases) as part of their ordinary teaching practice, not for research purposes, and the researchers did not participate in the design nor the implementation of the assignments.

The study consisted of 30 cases at 14 schools. The selection of the cases had three prerequisites: first, the assignments should include working with knowledge. The subjects and the number of cases in brackets were as follows: Finnish language and literature (7), Psychology (4), Civics (3), Geography (3), Religion (3), Integrated entities (these consisted of two or more subjects) (3), Biology (2), History (2), Chemistry (1), Health Education (1), and Philosophy (1). Second, the knowledge assignment should include students' use of digital technology. Third, the courses should be obligatory for all students, so they could study how knowledge competence is taught to all students, and not only to selected voluntary groups.

The schools were selected using a convenience sampling method [60]: We first contacted principals of several schools through our collaboration and communication networks in the field of school education to ask about their interest in participating in the study. Some of them refused to participate, mainly because of the heavy workload of the upper secondary school teachers or because of several concurrent studies in the school. The principals helped in finding voluntary teachers in their schools. The second step was to contact volunteering teachers by email, and they agreed in the course, the knowledge-related assignment, and the lesson to be observed.

The permission and informed consent to conduct the study at the schools were obtained from the municipalities, schools, and participating teachers.

4.3. Participants

In all, 30 teachers participated in the study, one to four teachers from each school. They represented a wide cross-section of teachers: young, less experienced, and older with more experience in teaching; 17 were women. The students (16–19 years) participated in the courses mainly during their first or second year of upper secondary school. The number of students participating in the lessons we observed varied from 14 to 32; the mean number of students was 23.6. The participating schools were located in southern Finland; ten in the Helsinki metropolitan area.

4.4. Data Collection

To investigate the knowledge-related assignments, we collected three types of qualitative data, following the principles of a multi-methods approach [61] and focusing on the issues founded in the theoretical background. Furthermore, the different types of data supported the reliability by triangulation [62].

4.4.1. Classroom Observations

Classroom observations were used to provide information about the characteristics and nature of enacted assignments. One researcher observed one lesson from each chosen assignment. If the knowledge-related assignment was conducted over several lessons, the first and the last lesson were avoided, to see students' working practices instead of a teacher's introduction or students' final presentations. The lessons usually took 75 min. Three researchers agreed on a common structure of observation notes, following the notion of a sociocultural approach of focusing on practices, i.e., what activities were conducted during the lesson, instead of interpreting thoughts, motivation, or intentions [63,64]. The observation notes followed the chronological order of the lesson activities and events. The observations focused on (1) the assignment: its aims and contents; the teacher's and students' responsibilities (that is, the activities for which they were responsible in the assignment); students' collaboration; the digital technology used, (2) teacher guidance: guidance of all students, the guidance of groups and individuals; the content of guidance, and (3) the students working with the assignment.

4.4.2. Teacher Interviews

Teacher interviews were conducted two to three weeks after the course was finished, and they allowed the researchers to get information on the overall structure and content of the assignment as well as to clarify and strengthen their interpretations based on the observations. The structured interviews focused on the following topics:

(1) Issues related to the whole course: the aims, timing, student tasks and activities, and assessment practices.
(2) Issues related to the knowledge-related assignment investigated: general description and organisation of the activities in the assignment; the role of the assignment as part of the overall course; aims; timing; the teacher's and students' responsibilities; the outcomes and their re-use; individual and collaborative activities; process working; information sources and their use; reflection, commenting and feedback; the role of external stakeholders; digital technology used; goals and assessment. The questions were based on the theoretical background. In addition, researchers asked clarifying questions about the lesson they observed.

The interviews took from 40 to 60 min, and they were transcribed.

4.4.3. Complementary Data

Before the interviews, teachers were asked to give the researchers access to the digital learning environment or screen captures of the environment. These supported the understanding of the role of digital technology and also the assignments in general. The digital environment was reviewed with the teacher during the interviews, but its content was not analysed separately. We also received some materials from teachers, such as students' outcomes or assignment guidelines; these were used to increase our understanding of the assignments for the analysis.

4.5. Data Analysis

The analysis of the qualitative data of teacher interviews and lesson observations was explorative. The creation of analysis categories (the pedagogical practices) and subcategories (the profound pedagogical practices) was a process of moving back and forth between the theoretical viewpoints described above, and evidence, relying on theoretical propositions [55,56,65]. The analysis followed the assumptions of interaction analysis [64]

(p. 41): "building generalisations from records of particular, naturally occurring activities, and steadfastly holding our theories accountable to that evidence."

For the analysis, the observation notes and the interview transcriptions were condensed. Two of the five researchers first created an observation table, connecting the relevant findings of the observation notes and the interviews of each case, and the preliminary coding categories, which followed the interview questions. Gradually, the main categories were revised according to the data-driven analysis as well as the theoretical viewpoints described in the Theoretical background section. The key references for the categorisation of the main categories were the following:

- The knowledge creation approach to learning and object-orientedness: [9,28,29]
- Collaborative practices: [30,32,40];
- Assignments for collaborative knowledge creation: [29,33,34];
- Cross-fertilisation: [37,38,40];
- The epistemic challenge: [4,7,43];
- Digital competence and information practices: [29,45,51];
- Assessment: [53,54].

After the main categories, the sub-categories were created and revised.

The definitions of categories were created collaboratively by the authors. After this, the coding of data to sub-categories was examined more in-depth and divided into four levels based on defining the occurrence, intensity, and quality of the feature analysed in each case (see the categories and descriptions of levels in Table 1). Parsons et al. [27] used a similar analysis in their study about assignments at the elementary school level and Schoenfeld [62] used the same kind of coding schema. The qualitative levels were quantified from one to four and the frequencies of the codes were compared [64], following the example of Muukkonen et al. [7]. Level four represented the most intensive or expert-like pedagogical practices of the investigated characteristics, level one did not include the practices. Quantifying the qualitative data into four levels within each category made the differences visible [27].

Table 1. The categories and sub-categories, theory basis, and the justification of the levels of the scales.

Sub-Category	Definition of the Levels of the Scales	Examples: 1 = Lowest Level, 4 = Highest Level
	Object-orientedness	
Tangible object	Existence of a shared object; level of teacher vs. student contribution	(1) No shared object (task given by the teacher, everyone did the same task).
		(4) Students made a knowledge object (essay, presentation, video, poster, etc.) in groups aiming at influencing some issue (in society, in school, etc.).
Re-use	Existence of re-use; broadness and scope of reuse	(1) No re-use.
		(4) Students use the report created during the course and also during the second course (only those students who choose also the next, voluntary second course).
	Epistemic challenge	
Problem space	From well-defined to authentic ill-defined problems	(1) Ready-made questions to be answered, mainly factual and definition questions, with no real problems.
		(4) Examination of the chosen phenomenon from the viewpoints of psychological science.
Freedom of choice	Degree of freedom in the assignment	(1) Students did the tasks, decided by the teacher, in a pre-planned order.
		(4) Students chose the topic (phenomenon) of their essays, the teacher gave suggestions; practising professional scientific writing.
Nature of working practices	From knowledge acquisition to simulating professional or academic practices	(1) Arbitrary ways of working just for getting acquainted with the content; writing answers to teacher-created questions.
		(4) Systematic teaching of academic, scientific writing and use of academic sources.

Table 1. *Cont.*

Sub-Category	Definition of the Levels of the Scales	Examples: 1 = Lowest Level, 4 = Highest Level
		Process-like emphasis
Iterativeness	From no versioning to long-term and multiple versions	(1) The summary was written during one lesson; the teacher even encouraged them to write shortly and finalise the text quickly. Submission in the same evening.
		(4) Students reflect on the course content through the country they chose to explore and prepare a project report throughout the course. Two checkpoints for improving the report.
Reflection and feedback	Extent and versatility of reflection and feedback activities	(1) At the end of the course, the teacher asked students to submit their answers and commented on them.
		(4) Groups gave feedback to each other; the teacher gave feedback during the process. Final work was reflected; everyone also evaluated their own work.
		Intensity of collaboration
Sharing	Extent and versatility of sharing; sharing content and/or process	(1) No sharing between students, only to the teacher through Google Classroom.
		(4) Students shared the outcomes first in their own group and then with other groups, students gave feedback to others in a discussion forum sharing their preliminary thoughts.
Nature of group work	From voluntary collaboration and division of labour to organised collaborative working	(1) No collaboration.
		(4) Students worked in groups and did the experiment together, with roles based on the task. Students also wrote a pre-study in pairs.
		Cross-fertilization
Variation of information sources	From mere learning material to a rich variety of information sources	(1) School book and digital material; voluntary to use the web as an information source.
		(4) Rich variety of different historical sources: books, newspapers, pictures and photos, radio programs, and authentic web sources.
External collaboration	The intensity of external collaboration	(1) No external collaboration.
		(3) * Not emphasised but some groups visited some organisations or made surveys or interviews for their work.
		Information practices
Use of digital technology	Variation of digital technology, nature and intensity of using digital technology	(1) The teacher suggested using Google Docs for making group memos, but each group had the freedom to use technology as they liked or not use anything; oral presentations, no written guidelines, or digital platforms for sharing of outcomes.
		(4) Web-based learning environment for sharing teaching materials (Edu 2.0); groups made the posters using presentation tools of their choice (PP, LibreOffice, Google doc); teaching of layout design.
Guided information strategies	Systematic guidance of information strategies	(1) Not mentioned any strategies, self-directed search.
		(4) Teacher very clearly presented the necessary materials, guiding material included, e.g., some examples for searching and guidelines on how to write references.
Degree of multimodality	Variation of media types used and/or created	(1) Written answers/examination of claims and use of Internet resources, multimodality not emphasized.
		(4) Pictures, academic texts (even advised not to use texts including opinions or propaganda), mind maps (created at the beginning of the process), and guidance to use YouTube videos.
		Assessment
Explicit assessment criteria	From no criteria to clearly described assessment criteria	(1) Criteria not explained.
		(4) Clearly explicated assessment criteria (in a matrix) used by the teacher and the students in peer review.
Versatility of assessors	From no assessment to a variety of assessors and assessment methods	(1) Not assessed.
		(4) Self-assessment of the group work process, peer assessment, and teacher assessment; teachers considered self and peer assessment results in their grading.
Assessment of competencies of collaborative working with knowledge	Existence and relevance of assessing performance related to collaborative working with knowledge	(1) Not assessed.
		(4) Part of the assessment was the self assessment for group work, using references, etc.

* No cases in level 4.

The categorisation of data into levels in each sub-category was compared with each other several times by the first two authors, to ensure that the features ranked into the same level represented the same types of practices. When the final categories were decided on, all cases were re-coded once more by the first two authors. During the revision process, we noticed that the cases analysed first were analysed in a more critical way (similar to Timmermanns and Tavory [65], who described saturation), but with more data and better familiarisation with the data, the interpretations became more alike. The final analysis framework of the pedagogical practices with the categories, sub-categories, definitions of the levels of the scales, and examples of the lowest and highest levels is presented in Table 1.

Although the characteristics of the assignments were analysed separately from each other, in practice they are closely intertwined; for example, to answer an ill-defined question, students usually work longitudinally. They search for new information and make new versions, they get feedback from the teacher and peers, and they have a relatively large amount of independence in their working practices. To identify relatively homogeneous groups of cases based on selected characteristics [65] and to reveal the differences in the combination of characteristics between the cases, we clustered the cases according to the level values of the sub-categories see [66]. A three-cluster solution was chosen because it illustrated the differences between the cases best from the viewpoint of supporting students' competencies relevant to technology-enhanced collaborative knowledge creation. If there were more than three clusters, the solution produced was disordered and impossible to interpret, and a two-cluster solution did not reveal differences between the clusters. For the analyses of the quantified data, SPSS Statistics version 24 was used.

5. Results

5.1. The Characteristics of the Knowledge-Related Assignments

To answer the first research question, we first analysed the means and standard deviations of each sub-category (presented in Table 2) and after that, the distribution of the cases.

Table 2. The mean and standard deviation of the subcategories.

Category	Mean	SD
Object-orientedness (OB)		
OB Tangible object	2.5	1.2
OB Re-use of the outcome	1.5	0.86
Epistemic challenge (EC)		
EC Problem space	2.8	0.9
EC Freedom of choice	2.1	0.98
EC Nature of working practices	2.3	0.92
Process-like emphasis (PRO)		
PRO Iterativeness	1.8	0.87
PRO Reflection and feedback	2	0.96
Intensity of collaboration (COL)		
COL Sharing	1.7	0.99
COL Nature of group work	2.3	0.8
Cross-fertilisation (CF)		
CF Variety of information sources	2.6	0.85
CF External collaboration	1.1	0.43
Information practices (IP)		
IP Use of digital technology	2.3	0.75
IP Guided information strategies	2.4	1.1
IP Degree of multimodality	2.4	1.1

Table 2. *Cont.*

Category	Mean	SD
Assessment (AS)		
AS Explicit assessment criteria	2.2	1.1
AS Versatility of assessors	2	0.89
AS Assessment of competencies of collaborative working with knowledge	2	1.14

The scores of the sub-categories within the main categories in most cases differed from each other, and in some categories, like Object-orientedness or Cross-fertilisation, even profoundly. The means of the subcategories revealed the rarest practices: External collaboration, Iterative approach, reuse of the outcome, and Sharing. Opposite to these, especially Problem space and Variety of information sources and Tangible objects received high-level scores in the analysis.

The distribution of the cases in the subcategory levels brings to light the popular and rare practices, presented in Figure 1.

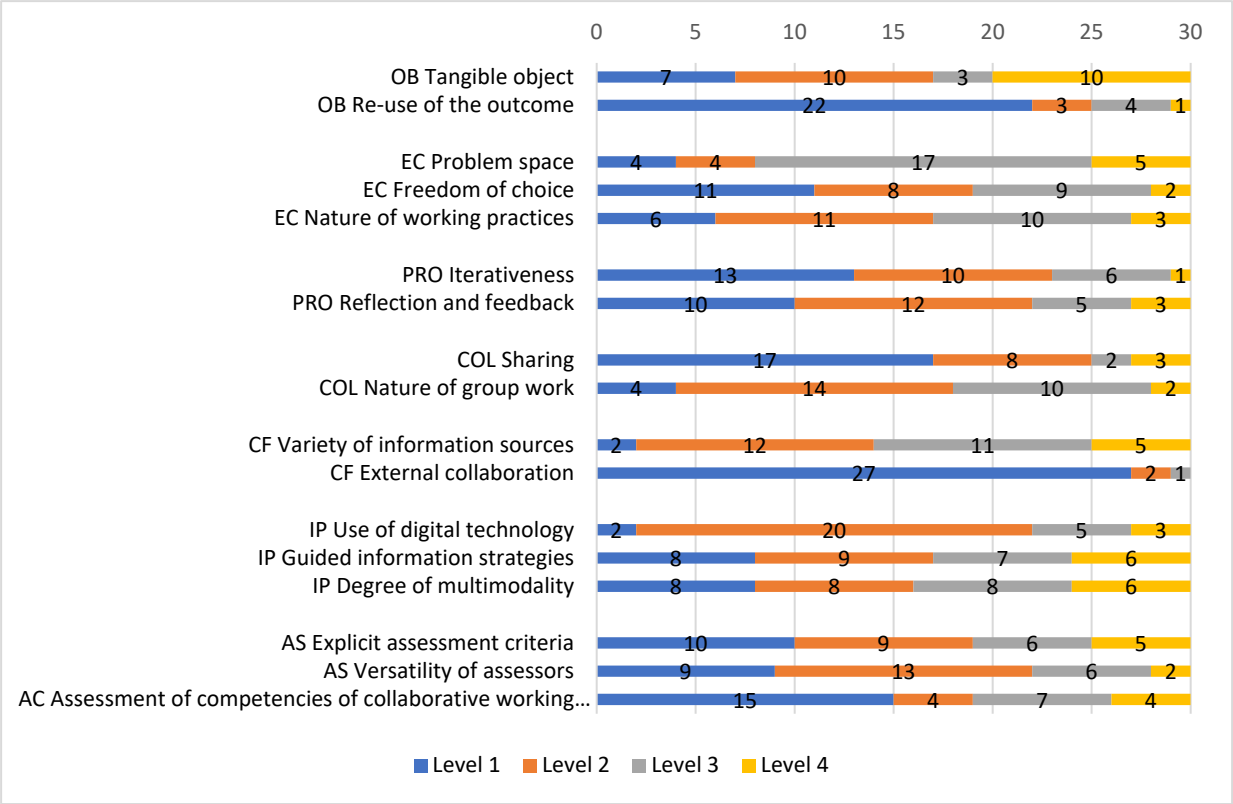

Figure 1. Distribution of cases in the levels within each sub-category.

In the assignments we investigated, the Tangible object category received high scores; in one-third of the cases, it was at level four; objects were, e.g., digital posters, essays, or written argument analysis. It was at the "highest" level of the practices used, which is promising: in these schools, students do assignments in which they produce something new. In addition, Problem space was open and challenging in 22 of the cases (levels three and four), which is also promising: students had open and authentic questions and problems to answer. As an example of a case at level four, students examined a self-selected phenomenon from the viewpoint of psychological research. Also in the category Nature of working practices, one-third of the cases were at level three, and, as an example, the teacher

emphasised real methods and the concepts of literary science, and the students' task was to analyse a given text following them.

The opposite, uncommon practices, were Re-use of the outcome; only one case was at level four, and in 22 cases there was no re-use. In 27 out of 30 assignments, there was no External collaboration, and in two assignments (level two), the cross-fertilisation was realised within the school: with a teacher of health care expertise or older students. In the only assignment at level three, the external collaboration was voluntary, and student groups visited external organisations, conducted surveys, or interviewed external stakeholders.

The other practices we investigated were between these opposite extremes. In the Explicitness of information strategies and Degree of multimodality categories, the cases were divided almost evenly between all levels.

The Use of digital technology category was at level two in two-thirds of cases, and in these cases, a digital learning environment was in use as well as basic office applications such as Word or PowerPoint. This means that students used digital technology but at the basic level.

The process-like emphasis, Collaboration, and Responsibility of the process were at a low level in most of the cases investigated. In 23 assignments, Iterativeness, and Reflection and feedback practices were either missing or they were limited. Similarly, there was no *Sharing* between students in 17 assignments. In several cases, we noticed that the teacher asked students to share the work only with themselves, not with their student peers. In some cases, this might relate to the lack of re-use practice: students' outcomes were not regarded as true products which could be useful or valuable later, or to someone else, and for this reason, they were not shared either.

Group work was voluntary (level 2) in 14 assignments. In ten assignments, students worked in groups but that was typically based on the division of labour, or the group work was only one part of the assignment. Students had limited or no responsibility for the process in 19 assignments, e.g., in focusing on content and in choosing the topic or the form of outcome. Examples of such assignments included writing answers to the teacher's questions (at level one) or groups that chose their topic and the teacher had written questions, which they had to answer (at level two).

In the Assessment, in 20 cases, the assessment criteria were not clear, or the explicitness was only at level 2, which does not support students' meta-understanding of the aims or help them to focus their learning. Furthermore, in half of the cases, the competencies for technology-enhanced collaborative knowledge creation were not assessed at all, which implicitly points out that it is not important.

5.2. Finding Clusters of Pedagogical Practices in the Cases

To answer the second research question, we conducted a cluster analysis based on the means of sub-categories. Because the levels of almost all sub-categories varied between one to four we wanted to find out if the assignments formed groups based on similarities and differences. After that, it was possible to consider what kind of learning the various groups support. Figure 2 presents the clusters in relation to the mean scores of the subcategories.

The first cluster consists of eight cases, the second of seven cases, and the third of 15 cases. The cluster profiles differ from each other although the clusters also share some similar characteristics. Cases resemble each other in some of the subcategories. The use of technology and a variety of information sources, which is close to the use of digital technology, represent practices that are quite ordinary. Subcategories External stakeholders and Re-use of the outcomes by contrast are of low level. In all cases, collaboration with external stakeholders was rare, similarly the re-use of an outcome. The major differences between the cases were in clusters 1 and 3, in all subcategories, as Figure 2 shows. Clusters 1 and 2 differed from each other, especially in the Iterativeness, and Reflection and feedback, Degree of multimodality subcategories, and all Assessment subcategories.

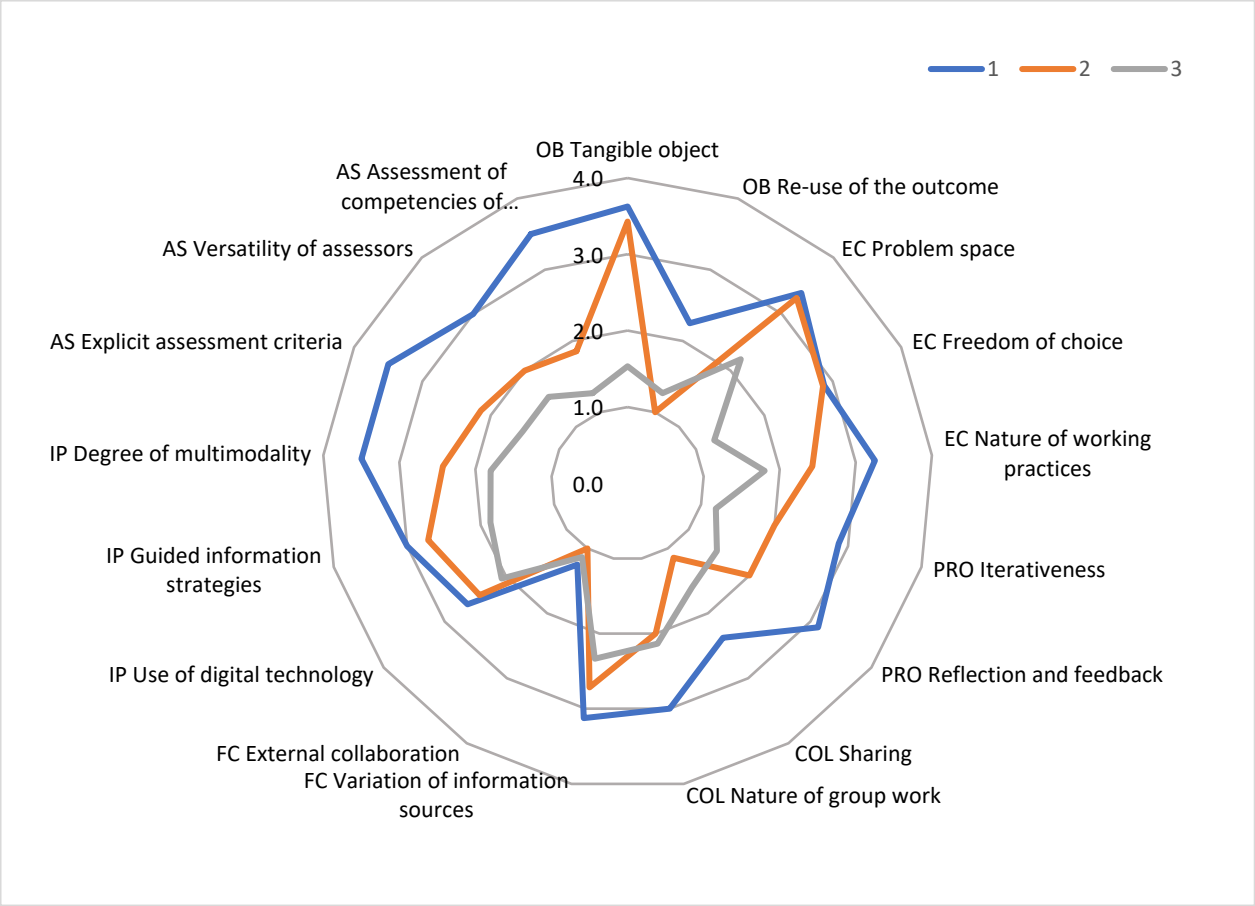

Figure 2. A solution of tree clusters of the knowledge assignments.

In short, the cases differed also between the main categories. Group 1 had high scores in Object-orientedness, Epistemic challenge, Process-like emphasis, Intensity of collaboration, Information practices, and Assessment. Group 2 had relatively high scores in Epistemic challenge, Information practices, and in subcategory Tangible object. In the other categories, Group 2 was between the other groups. Group 3 had low scores in all the categories.

In Cluster 1, the assignments were open and challenging, students had responsibility for the process, e.g., freedom to choose the content and outcome of their work as well as the ways of working, the assignments were iterative, and students received feedback from their peers as well as from the teacher. In the assignments, students often collaborated for a shared outcome (object), information practices were emphasised, and assessment was explicit. Furthermore, the competencies were guided, and they were an essential part of the assignments. We described this cluster as Open and challenging assignments with guidance and support. An example of a case in Cluster 1 was an assignment from the course Chemistry Everywhere. The assignment was an empirical experiment about "Separating methods of substances". Besides learning the topic, the aims were to learn to do experiments and to report about them, but the aim was also to learn about scientific methods in chemistry. Students worked in pairs and groups formed by themselves during the four lessons (75 min each); in addition, they also had to do some writing at home. Students' activities resembled a scientific experiment: they used professional tools, and they worked as an expert group, each with a different role, doing real experiments. During the first two lessons, students did a small study in pairs, practising how to do a study, write references and write scientifically. The study continued for two lessons with an experiment in groups of four. Students also wrote a report about it, combined with the first pair's writings. The teacher had guiding documents and videos on the digital learning

environment and he guided students several times to read and examine them instead of telling them the correct answers. He also showed a few techniques, but his guidance was situational; he helped those groups that needed guidance.

Cases in Cluster 2 have similarities with the other two clusters. There was a tangible object to be produced, the assignments were challenging, the problem space was open, and students had the freedom to choose the topic and the production of outcomes. Students used digital technology in an advanced way and the information strategies were explicitly described. However, students did not get much support for their work: the process was not iterative nor reflected, and the students got feedback mainly after finishing the work. Furthermore, the assessment practices were not explicit, and the assessment was teacher-centred. Students had a challenging task, but they did not get guidance during the process. We named this cluster Demanding assignments without support. In a case in this cluster from a Finnish language and literature course, students had to make an argumentation analysis comparing two documentary reviews. Argumentation analysis was supported by some written guidelines. The students searched and chose the reviews themselves from the Internet; the teacher helped if needed but did not teach the students web search strategies explicitly. The analysis was done during a 90-min lesson and continued at home. There was no versioning, and only the teacher gave written feedback about each text after submission. Students had the freedom to work individually, in pairs, or in groups, and to choose which digital tools to use. The products were not shared between students and there was no modelling of effective digital or collaboration practices. Assessment criteria were not explained, but the teacher emphasised that the assessment focused on the argumentation analysis skills demonstrated in the final text. The task was quite challenging for students, but they did not get much systematic support to complete it.

Cluster 3 consisted of assignments representing teacher-centred pedagogy: in these assignments, the teacher (or learning material) structured the object of working, there was limited challenge or responsibility in the working process (typically all students did the same assignment) and there was no reflection or feedback. Collaboration existed but it was voluntary, information practices were limited, and the only information source besides the textbook was the Internet, and if assessed, the teacher assessed the outcomes. We named this cluster Well-defined, teacher-directed assignments. An example of assignments belonging to this cluster is one from a Psychology course. The topic of the assignment was the biological basis in human behaviour and the students' task was to answer ready-made (mainly factual) questions on a web platform using the textbook and the Internet as information sources. Students were recommended to do the task in groups, but about half worked alone. Students worked on the task in one 75 min lesson and continued it as homework if needed. Everybody answered the same questions, and the answers were not shared between the students. The teacher gave written feedback through the digital platform after submission, and the students had the opportunity to improve their answers after that before final grading. Assessment criteria were not explained to the students. The assignment represented simple question answering without much challenge or modelling of effective or professional knowledge work practices.

6. Discussion

The present study investigated the nature of 30 knowledge-related assignments in upper secondary schools. In general, the knowledge-related assignments differed profoundly from each other. The main and subcategories helped to demonstrate the existing practices as well as the differences between the cases.

It is promising that the epistemic challenge in the form of open problem space received high scores; this indicates that students at upper secondary school faced tasks, which require their responsibility and high-level thinking. The reverse is that the challenging activities are seldom guided and supported enough, as the cluster Demanding assignments without support shows. Challenges are good for students who manage to take responsibility

and who are engaged in the assignment, but not for students with less competence, self-direction, and motivation.

In general, the low level in such subcategories as Responsibility for the process or Nature of working practices may diminish the self-leadership. In addition, the small amount of iterativeness or reflection and feedback may lead students to find it difficult to improve their outcomes. Such practices are used at school but not in subsequent education and the workforce. Students learn to finish the work in one go, following the orders from the teacher, and not regulating the work by themselves.

We noticed that digital technology was mainly used at a basic level, which is somewhat surprising: the use of digital technology in the matriculation exams requires teachers to use it during courses and it would be expected that it would be used in rich and versatile ways. Technology was not used effectively or meaningfully. For instance, the sharing options (as in Google Drive tools) were used less often than possible, and the sharing of processes and unfinished outcomes was quite rare. It is more notable since schools used digital learning environments that supported and allowed the sharing of work. The missing practice of sharing seemed to be connected to another feature in the pedagogical practices: in these cases, process-like practices were also at a low level, and, if students collaborated, it was mainly voluntary and based on the division of work, not on joint elaboration.

Concerning cross-fertilisation, the use of a rich variety of information sources seemed to represent a typical cross-fertilisation at the school level: students get "a touch" of external knowledge by using web-based references, which are easy to organise and accessible in the Internet era. Collaboration with external stakeholders was rare—we could not find any cases at level four. Our finding is in line with others' studies: there is not enough collaboration between upper secondary education and the workforce or higher education, and, if it exists, it is occasional [37,67,68].

The methods of assessment motivate students and focus their attention and activities. The results showed that the strength of well-planned and versatile self and peer assessment was seldom used. The assessment of the competencies which are not content-related, is still rare and evolving, and there is a need to revise the assessment systems cf. [54,69]. In our study, the cases in the cluster Open and challenging assignments with guidance and support included methods for assessing competencies for technology-enhanced collaborative knowledge creation, in addition to content mastery, which is a promising sign of the opportunities presented.

The three-cluster solution revealed notable differences between the three groups of cases. The first group consisted of assignments, which had features that are in line with many theoretical ideas about recommendable pedagogical practices: they were open and challenging, longitudinal and process-like, and scaffolded by the teacher, strongly in line with the requirements stated in the national curriculum [57]. From a theoretical point of view, we may say that these represent, or are close to, the knowledge creation approach to learning see [28]. The second cluster was close to the first one: the assignments were open and challenging, but students did not get guidance during the process, and feedback or reflection practices were missing. Students were left alone with a demanding assignment. Many teachers probably think that upper secondary students already have the skills and competencies expected of them and therefore it is not necessary to teach them, or the teachers themselves do not know how to teach competencies such as collaboration or advanced information management and processing skills. The third cluster represented traditional schoolwork: the assignments were well-structured, teacher-centred, and concise without iterative elaboration and the challenges were limited.

Limitations of the Study

It is obvious that the subject domain somewhat affects the pedagogical methods and the nature of assignments. In this study, the cases were not analysed according to the subjects because the number of cases in the various subjects was small. However, the results of the clustering show that the nature and characteristics of the assignments were

not based on subjects. Findings of another study partly based on the same data [38] indicate that although the same courses of a subject, run by different teachers, followed the same curriculum, the assignments varied extensively, depending on the teacher. Students reported learning practices of working with knowledge at different levels, related to the nature of assignments, not the subject of the course.

Our study was conducted in the Finnish context, and the results are closely connected to the requirements of Finnish upper secondary schools as well as the Finnish traditions of a student-centred pedagogy and teachers' pedagogical independence. However, even in other contexts, knowledge-related assignments are essential for learning generic competencies, as stated by the OECD [2] and the European Commission [70].

Thirty cases from 14 schools from several areas in Southern Finland participated in the study and the cases were based on the teachers' voluntary participation. Another knowledge-related assignment even from the same teacher could have been different. The cases helped in creating the analysis framework and explaining essential aspects to be considered in building students' competencies for technology-enhanced collaborative knowledge creation, but the results cannot be used as proof of prevailing characteristics of all Finnish upper secondary education.

The validity of the study was ensured in the following ways: The interpretation of the cases was based on multiple sources of evidence resembling an ethnographic method; we created a case study database, data were used for triangulation, and five researchers examined the data and the interpretations [55].

7. Conclusions and Implications

Students learn what they do. For this reason, we focused on investigating the characteristics of enacted knowledge-related assignments to find out what practices the students are engaged in, and whether the assignments consist of features that, according to previous research, might be expected to promote the competencies of collaborative working with knowledge.

7.1. Theoretical Implications

The analysis framework offers a theory-driven but practice-related approach for investigating assignments as well as classroom practices in different contexts focusing on collaborative work for knowledge creation. In analysing the cases and creating the analysis framework, we realised that pedagogical practices need to be examined from multiple perspectives in an integrated way because various aspects of the learning assignments contribute to students' engagement and learning of competencies. The categories of Epistemic challenge and Process-like emphasis described well the pedagogical practices in the classroom organised by the teacher. The Intensity of collaboration subcategories revealed the nature of collaboration better than just one general category for collaboration. *Information practices* is a category for analysing how the use of digital tools and information sources was implemented and guided. The *Assessment* category was necessary for understanding what practices students were directed to focus on. In future, testing the framework in other contexts will be needed, across disciplines and learning practices in different countries, to see if the framework is usable with variations of assignments. Furthermore, studies with more cases and thus more subject domains would be needed; perhaps with somewhat lighter ways of collecting data.

7.2. Methodological Implications

The creation of the analysis framework was an extensive achievement of connecting theoretical approaches to empirical findings. Based on the study, the use of the framework showed essential differences between the knowledge-related assignments.

We used mixed methods and a range of data types to capture the characteristics of the assignments. The qualitative data from different points of view and interpreted by several

researchers were necessary for understanding the complexity of teaching and learning competencies for collaborative knowledge work.

7.3. Practical Implications

At school, it is obvious that there is a need for restricted, short-term assignments but students should also have more demanding open and challenging assignments to learn generic competencies, especially for collaborative knowledge creation. However, demanding assignments without support is problematic for students if they do not have skills for self-regulation and self-leadership because the assignments do not include embedded guidance and support. Many of these assignments could easily be improved: more teacher guidance and peer feedback as well as self-reflection and clearer assessment criteria would help to raise the pedagogical level. It is essential that students have challenges in both the content and the practices during their upper secondary education, but they should also get well-timed support and guidance to overcome any difficulties and problems. In our study, only a quarter of the assignments were Open and challenging assignments with guidance and support. We suggest increasing these kinds of activities. However, it is noteworthy that there were also good practices to be found in the cases investigated, which shows that teachers have the liberty and pedagogical competence to fulfil their pedagogical aims. These exemplary practices need to be disseminated wider to other schools and teachers.

Author Contributions: Conceptualization, L.I., M.L., H.M., S.P. and A.T.; methodology, L.I., M.L., H.M. and A.T.; validation, L.I., M.L., H.M., S.P. and A.T.; formal analysis, L.I., M.L., H.M., S.P. and A.T.; investigation, L.I., M.L., and A.T.; writing—original draft preparation, L.I. and M.L.; writing—review & editing, L.I., M.L., H.M., S.P. and A.T.; visualization, L.I. and M.L.; funding acquisition, A.T., L.I., M.L. and H.M. All authors have read and agreed to the published version of the manuscript.

Funding: This work was partly supported by the Academy of Finland (Grant number 285806).

Informed Consent Statement: Participation in the study was voluntary and therefore no consent was needed.

Data Availability Statement: The data is available from the corresponding author upon request.

Acknowledgments: We are very grateful to the participating teachers who allowed us to study their courses. Without them, we could not have done this study. Thank you also to the anonymous reviewers whose comments have helped to improve the article.

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

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