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From Learner-Centered to Learner-Driven Sustainability Education

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Abstract: Learner-centered sustainability education has been advocated to be used in higher education, but the pedagogy is blurry. In the discussions, also an idea of a learner-driven approach has been promoted. The aim of this study is to study how these pedagogies have been described and suggested to be used by a group of higher education students responsible for planning a teacher education course on sustainability education. This case study uses grounded theory to analyze the higher education students' beliefs about learner-centered and learner-driven sustainability education. The data was obtained from audio-recordings of the planning process and two semi-structured interviews of five students acting as course designers. The course designers showed to have beliefs about the nature of learner-centered/learner-driven pedagogy, freedom, meaningfulness, acting and making an influence in the learning environment, the nature and ownership of sustainable development knowledge, the diversity of the learners, and pedagogical support. The results indicate that the learner-centered and learner-driven approach are fundamentally different in terms of all of the categories. In conclusion, it is suggested that the terminology concerning learner-centered and learner-driven approaches should be more precise, and sustainability education should be developed towards a more transformative, learner-driven education.

Keywords: beliefs; learner-centered education; learner-driven education; sustainability education; teacher education

1. Introduction

Learner-centered and learner-driven approaches have been seen as ways of addressing the challenges of sustainability education, such as the uncertainty and complexity of the sustainability issues as well as the need for interdisciplinarity in solving them [1,2]. Although there are multiple perspectives on sustainability and its education [3], these originate from environmental education which solves environmental issues e.g., [4]. Since the 1970's, the notions of sustainable development and sustainability have emerged, yet the idea of development has been criticized for, for example, the problematic idea of preserving development instead of nature [4]. The debates in how to define what should be educated, has an effect on how the education should be done. Therefore, there has been discussion about whether sustainability education should be about, in or for sustainability [5] or a combination of these [1].

It has been argued that especially within higher education, students need to get involved with shaping the content and form of their education [6]. According to the Bologna Working Group [7], student-centered pedagogy along with the development and implementation of meaningful learning outcomes, can bring about a paradigm shift in higher education, which is needed in tackling issues

such as sustainability. According to the proponents of learner-driven approaches, students should be seen as change agents of learning and teaching [8,9]. It has been argued that when students are given control over their learning process, and encouraged to take action, they can also get involved with the community. Thus, the learners can identify problems and develop solutions and actions, which allows learners to become more “transformative thinkers” capable of futures thinking, negotiation, and self-initiated action [10].

The definitions of learner-centered education and learner-driven education have been ambiguous. For example, learner-centered learning has been used to describe several levels of student involvement in their own learning, from giving the learners a choice and allowing the students to be more active to a total shift in the power relations between the students and teachers [11]. Multitude of pedagogical approaches, such as flexible learning, experiential learning, and self-directed learning have been described as learner-centered [11]. Also the difference between the two has not been defined clearly. In some cases, the concept of learner-centered education has even been used as a synonym for learner-driven education [12]. However, being in the *center* of learning, differs from *driving* learning. A dictionary definition for *center* is that it is “a point, area, person, or thing that is most important or pivotal in relation to an indicated activity, interest, or condition” [13]. So, in learner-centered pedagogy, the learner is the most important when deciding on learning and teaching activities. Whereas, *driven* can be defined as “propelled or motivated by something” [14]. Thus, in learner-driven pedagogy, the learners take an active role in which they propel their own learning.

There is also a wide variety of practical examples of learner-driven learning. For example, learner-driven learning has been described as something in which the learners develop something by themselves, such as design green chemistry experiments [15]. It has also been associated with collaborative learning, in which the students share knowledge and expertise while performing small class activities [16]. In the context of inquiry-based learning, student-driven inquiry has been defined as something in which the student has a higher degree of autonomy in different phases of inquiry [17]. Learner-driven strategies are seen especially essential in sustainability education, because building students’ capabilities of sustainability demands engaging with the world and addressing sustainability issues through action [18,19]. The proponents of the approach claim that transformative goals of sustainability education demand transformative practices in which the students are capable of self-initiated action [20–22]. One way to do that is to challenge the traditional top-down educational models and involve students in planning and managing courses, see [6,23,24].

To successfully reform any higher education curricula, it is important to take the students’ and teachers’ beliefs about learning and teaching into consideration [25–27]. A previous study on teachers’ beliefs about learner-centered education showed, that there are clear differences in the ways teachers perceived the concept [28]. Teacher-centeredness is described as teaching in which (i) student is a starting point for curriculum making; (ii) teachers and students co-participate in a learning process; or (iii) teacher strives toward intense student engagement with curriculum. Out of these descriptions, the third description approaches the concept of learner-driven education. A study on students’ attitudes comparing teacher-centered and learner-centered approaches showed, that students held very positive views of learner-centered learning, but they were unsure how such approaches might be best supported and managed within higher education [29]. Although there is some existing research of teachers’ and higher education students’ beliefs about sustainability and sustainability education, e.g., [30,31], studies on teachers’ and students’ beliefs about learner-centered and learner-driven sustainability education are lacking.

The aim of this study was to explore the higher education students’ beliefs about learner-centered and learner-driven sustainability education. For this purpose, the beliefs of a higher education student group, referred to as the *course designers*, were studied when they planned a sustainability education course. To chart out lived meanings of these concepts, see [28], the data included two interviews as well as audio recordings of the meetings in which the students planned the course.

2. Materials and Methods

This is a case study of a student-led planning process. In the process, a group of higher education students, the course designers, were given complete freedom to plan and carry out a course on sustainability education for other undergraduate students. The other undergraduate students, referred to as *the participants*, were mostly pre-service teachers, but also other students in the university interested in sustainability education could attend to the course. The participants were from different disciplines, and in different stages of their education. The course designers were not taught about learner-centered or learner-driven pedagogy before they started planning. They were chosen through interviews, but they were not instructed to plan a learner-centered or a learner-driven course. The coordinators offered to help with the coordination of the course, but the course designers could decide how they wanted to plan and manage the course. The name of the pilot course stemmed from the national curriculum of Finland in which the term “sustainable development” is used. It was however possible for the course designers to address the different concepts of sustainable development and sustainability, so that they did not have to restrict on the use of the concept “sustainable development”.

The course “Sustainable development in education” was developed at the Unit of chemistry teacher education [32] where one of the areas of focus has been the improvement of sustainable development and sustainable chemistry [33]. The course was developed as a pilot course as a part of the project ActSHEN—Action for Sustainability in Higher Education in the Nordic region project, in which six Nordic higher education institutions created a framework for sustainability education [22]. As part of the project, the course designers were invited to CEMUS, Centre for Environment and Development Studies. Cemus is a student-initiated, transdisciplinary centre at Uppsala University and Swedish University of Agricultural Sciences, which focuses on sustainability issues. The course designers visited CEMUS in the end of the planning process and could reflect on their plans with the students at CEMUS.

The planning team was multidisciplinary, and consisted of five higher education students, out of which two dropped out during the process. 14.7% of the data (codes) consisted of those two students. The course designers were majoring in chemistry education, environmental sciences (two students), mathematics education, and theology. The data consisted of audio recordings of fourteen planning meetings (1–4 h each) and two semi-structured group interviews in the middle and in the end of planning (see Appendix B). The interviews were carried out by two researchers involved in the project. The goal of the interviews was to gather more information about the planning process.

The analysis was based on the grounded theory methodology in which all data from the planning process, including the planning meetings and interviews, were analyzed to understand the phenomenon under study. The analysis had three phases: open coding, axial coding and selective coding [34]. During open coding, codes were extracted from the text in-vivo and the content was summarized into codes. Open coding was carried out in two rounds. In the first round, the codes were based on the course designers’ use of the terms “student-centered” or “student-driven” and their discussions on this topic. The first open coding resulted in 95 codes, which were grouped into categories and subcategories. To specify the differences between learner-centered or learner-driven sustainability education and suitable pedagogical strategies for these approaches, a second round of open coding was conducted. The second open coding was based on the sub-categories formulated in the first phase and resulted in another 136 codes. Open coding was carried out by the first author. In axial coding, the connections between categories were examined and the core category was found. In selective coding, the other categories were organized around the core category.

As suggested by Corbin and Strauss [34], instead of describing reliability and validity, this grounded research addresses the credibility through quality criteria. From the viewpoint of methodological consistency, the principles of grounded theory, such as systematical gathering of data, and constant comparison of the codes and categories, were used. The exception of this, however, was instead of saturating the data in the selective coding phase, the second round of open coding was performed to gather more in-depth data. The theory created through this study should, however,

be verified in different contexts. Self-awareness of the process was ensured by writing memos during the analysis of data in atlas.ti. Methodological awareness was taken into consideration by explaining the methodological decisions and providing thick descriptions of the categories. There was an effort to anchor the analysis (codes, categories, and theory) into the data as tightly as possible, although the presumptions and the pre-knowledge of the researcher were viewed to be impossible to discard completely. The researcher-related criteria were considered by engaging in the precise, laborious, and creative work that grounded theory requires. The limitations of this research include the aforementioned need for further verification of the theory, as well as the possible difficulty in alienating from the data as the course was coordinated by the first researcher. Also the analysis could have been affected by the fact that the codes had to be translated from Finnish into English.

3. Results

While the course designers planned the course, they demonstrated having beliefs about learner-centered and learner-driven pedagogy. Sometimes the concepts “learner-centered” and “learner-driven” were mentioned and discussed explicitly, but in many occasions, the course designers discussed these topics without using the specific terms, for example saying: “*Student has a central role*” [course designer 1, planning meeting]. The beliefs of the course designers were studied holistically without restricting their use of specific terms, because the initial familiarization with the data showed that they sometimes used these terms as synonyms, such as when one of them said: “*learner-centered or learner-driven can be included in some part if we plan . . .*” [course designer 1, planning meeting]. The course designers’ belief categories from the first and second open coding are presented in Appendix A.

During the axial coding, “the nature of learner-centered and learner-driven pedagogy” emerged as the core category. More specifically, the difference between more traditional learner-centered approach and a more divergent learner-driven approach to education for sustainability rose into the foreground. Thus, during selective coding the other categories were organized around the core category. A thick description of each category and the connection between categories are discussed in the following section. The coding revealed various aspects of education for sustainability where different levels of student involvement were apparent. Summary of these findings are presented in Table 1.

Table 1. The differences between the learner-centered and the learner-driven approach.

	Learner-Centered	Learner-Driven
The nature of learner-centered/learner-driven pedagogy	Pedagogy as <i>learning and teaching methods</i> which can supplement each other.	Pedagogy must be <i>divergent</i> , an example of which is project-based learning.
Freedom	Learners have <i>some freedom to choose</i> from the array of topics, issues and methods of learning decided by the teacher.	Learners have a <i>freedom to decide</i> the goals, aims and methods of learning.
Meaningfulness	<i>The teacher decides</i> the goals, aims, topics and methods of learning taking into account learners’ interests and usefulness for the learners.	<i>The learners decide</i> what is interesting and useful for them by working on a task or studying an issue they find relevant.
Acting and making an influence in the learning environment	<i>The learners participate</i> in the learning environment.	<i>The learners make an influence</i> in the learning environment.
Nature and ownership of sustainable development knowledge	For setting goals and aims, the <i>teacher defines</i> sustainability and sustainable development.	<i>Learners define</i> sustainability and sustainable development through an iterative process.

Table 1. Cont.

	Learner-Centered	Learner-Driven
Diversity of the learners	Differences of the <i>learners are taken in to consideration</i> by differentiation, and defining and modifying learners' views.	<i>Learners' interests drive</i> learning.
Pedagogical support	<i>Teacher</i> who has the responsibility of setting goals, aims and methods of teaching, which support students in learning about and the capacity to act for sustainability.	<i>Facilitators</i> creating learning environments, which enable and stimulate learners to learn and act for sustainability.

3.1. The Nature of Learner-Centered/Learner-Driven Pedagogy

Course designers believed that a wide variety of pedagogical strategies could be used in learner-centered and learner-driven education for sustainability. Although strategies such as project work were seen more suited for the approaches, they believed that even the use of traditional methods, such as lecturing, could be used in a meaningful way. Although lectures were described as “boring” and “dry”, the course coordinators saw that sometimes they did serve a purpose, for example in offering new perspectives for discussion. They also considered it to be more natural to involve visiting lecturers instead of giving lectures themselves. The course coordinators also seemed to acknowledge, that using these approaches does not necessarily result in a radical change in what is being taught:

“But I do also see it in some way in, well, student-drivenness. For example, when we looked at the pre-questions, so many of them we would have addressed several times along the week, even if it had been more sort of teacher-led the education. So, there is not always a need to go from one edge to another.” [course designer 1, second interview].

Although in some occasions, the course designers used the terms “learner-centered” and “learner-driven” as synonyms, the analysis also showed how they perceived the difference between these approaches. The learner-driven pedagogy was seen as a more divergent, borderline pedagogy, which was both new and creative. They saw the approach as a deviation from what most students are used to, and the course designers speculated that students might not be used to learner-driven practices. Eventually the course designer included a learner-driven project task as part of the course. The project was carried out using an inquiry-based approach, in which the participants carried out a project based on their own ideas, needs and interests.

“We can't plan it so much in detail before, and how the content of the course will be. So the students who enroll in it, define it, according to their needs and interests. In practice it would mean that it can't be so structured, there can't be so much sort of pre-definition as in for example lecture-based teaching. Thus the course has to be sort of project-based.” [course designer 2, planning meeting].

The perceived differences between the approaches are discussed in the following subsections.

3.2. Freedom

Learners' freedom to make decisions concerning their learning was believed to be an essential element in both the learner-centered and learner-driven approaches. The main difference between the approaches can be seen in the amount of freedom granted to the students. The course designers acknowledged, that giving students choices about some aspects of their learning was an important part of learner-centered approach. For example, after an introduction to sustainability, the student could choose a topic or an issue, which they would then familiarize themselves with more deeply. Such opportunities were seen as a way to support the students' interests in learning.

For the approach to be considered learner-driven, the freedom to make decisions is even more central. As one of the course designers noted, the learner-driven approach has to be *“based on a voluntary choice”* [course designer 1, second interview]. Students’ ability to make independent decisions was even seen as the defining element of learner-driven practice. For example, one of the course designers even claimed that *“real ‘student-drivenness’ is freedom”* [course designer 2, first interview], and argued, that in a truly learner-driven task, the goals of learning cannot be set by a teacher or another figure of authority. The course designers reasoned, that working on issues, tasks and projects defined mainly by the learners, makes learning personal and encourages engagement. They even argued, that such freedom might induce creative new solutions needed to solve sustainability issues. Freedom as a starting point for the project was explained by one of the course designers by saying:

“So that is why we should begin from zero, so creative activity would happen. So as soon as we make frames, it limits the creativity.” [course designer 2, planning meeting].

In the learner-driven project task the course designers decided, that the participants were free to choose the topic of their project freely, as long as it was suited for the given time frame and produced a concrete product, such as a lesson plan or a game.

3.3. Meaningfulness

The course designers believed that both learner-centered and learner-driven sustainability education should be meaningful for the learners. In the learner-centered approach, the teacher can decide the goals, aims, topics and methods for learning, but the learners’ interests as well as the usefulness of what is being taught and learned, should be taken into account. For example, the students could have pre-tasks in which their interests are gauged. In sustainability education, goals and aims should also be in line with what is being seen as the overarching goal of sustainability education. Thus defining goals, aims and topics is also closely aligned with nature and ownership of the sustainability knowledge. As the course planned by the course designers was part of a teacher education program, other concerns, such as discussing the demands of the national core curricula were also seen to add relevance and meaningfulness. The students also argued, that as many of the students will become teachers, they should know enough about sustainability to be able to teach it. The course designers also thought that the pre-service teachers need skills for the future:

“We want to give those tools that they can use to find information also after twenty years, when they are teaching about sustainable development.” [course designer 1, planning meeting].

From the more divergent, learner-driven perspective, learners should only work on tasks and study issues they find relevant and interesting. During the planning, the course designers argued, that when the topics, tasks and projects are defined by the learner, they will then most likely focus on issues and questions they *“need answers to”* [course designer 4, planning meeting]. In such an approach *“the student notices what is important for them, as well as how their conception of knowledge develops”* [course designer 2, planning meeting]. When the topics, tasks and projects are defined by the learners, they decide what is interesting and useful for them. In the second interview, one of the course designers described the situation as follows:

“In a way, the topic of interests come from the student. And they themselves start seeking, and set the aims they want, as well as the goals in a broader sense.” [course designer 1, second interview].

In relation to teacher education, course designers noted, that learner-driven practices have the potential to increase the pre-service teachers’ competence in sustainability education. Learner-driven tasks of preparing material and carrying out teaching sequences for other students on various levels of education were seen as especially useful.

The learner-driven project implemented by the course designers enabled participants to think about what they find unclear in sustainability or what kind of information they would need in the

future. Explaining the importance of the meaningfulness for the students' own life and to sustainability, one of the course designers said:

"Student-drivenness is in it, that you start to do your own project, so it will be interesting for you, and then you narrow it to the things you want to learn. For example, how will I bring sustainable development into my own teaching, or how will I then—according to the curriculum—teach students to be responsible citizens—according to the ideas of sustainable development—or something like that." [course designer 1, planning meeting].

3.4. Acting and Making An Influence in the Learning Environment

Creating a learning environment in which the learner participates actively was considered crucial for both learner-centered and learner-driven sustainability education. For a learner-centered approach, the course designers believed it was important that the learners participate in the learning environment by actively thinking and discussing. The participants should be made to think, how they could change their behavior, for example as a consumer. The course designers rationalized, that if a teacher manages to relate how the teaching is connected to the learners' lives, the students feel empowered and *"don't feel like they are only the victims of top-down commands"* [course designer 5, planning meeting].

In a learner-driven approach, the learners have to understand and reflect on their own place more broadly and ask *"what is my connection to sustainable development"* [course designer 5, planning meeting]. Thus the learners move from being mere participants to taking active control of their learning environment. Such an approach requires taking some sort of action, instead of just thinking and discussing:

"I think it is important in this kind of education for sustainable development, environmental education that people are given experiences that they can affect through their own actions how the future unfolds." [course designer 5, planning meeting].

3.5. The Nature and Ownership of Sustainability Knowledge

As previously mentioned, in setting the goals and aims for learner-centered sustainability education, the teacher has to somehow define sustainability. The course designers discussed about some of the overarching goals for sustainability education, such as achieving a holistic understanding of sustainable development and global issues, being able to visualize a sustainable future, and realizing how what we do locally might have global effects. The course designers also believed that values should be handled in setting the goals and aims for learner-centered sustainability education. They reasoned, that for setting meaningful goals, tasks and activities for their students, teachers should have a robust understanding about different aspects of sustainability. Although a teacher might not have a specific definition thought out at the beginning of the course, the teacher will eventually have to communicate a model, for example through answers to students' questions. The course designers also pointed out, that when teachers make decisions on what is important from the point of view of sustainability, they should speak openly and rationalize the choices they make for their students. As an example of situations in which the teacher should know a lot to be able to ask good questions and give answers to the students' questions, the course designers mentioned role-play tasks or when the students discuss or debate.

In the learner-driven approach, the learners themselves define sustainability and sustainable development through an iterative process. The learner-driven strategies were seen as tools which support critical, innovative or even transformative thinking. In the second interview, course designer 1 noted, that learners' discussions on the definition of sustainability can lead to students questioning their thinking and their current way of living.

"I think that learner-driven education works in a way, that when we stimulate the students to discuss themselves, to think about the things that is in someone's head that: 'Ok... True. This has been pretty unsustainable, this style I have been thinking about before.'" [course designer 1, second interview].

For the participants of learner-driven sustainability education, defining sustainability becomes an iterative process, in which learners gradually get acquainted with various definitions and interpretations of sustainability. The course designers also believed, that such iterative strategy is especially suitable for peer education, because the course designers themselves might feel that they do not have the credibility to decide a definition for all of the students. It was also believed that the teacher could update his or her knowledge on the way when the students start to ask questions. According to that idea, the teachers would not have to know the whole picture in the beginning of planning a course. Interestingly, learner-driven practices were considered to supplement the teachers' knowledge in cases where the teacher would not know enough of the topic.

3.6. The Diversity of the Learners

In learner-centered sustainability education, the teacher should acknowledge not only the learners' interests, but also their previous knowledge. Evaluating pre-knowledge of the learners might require, for example, the use of pre-tests or constant discussions with the students. The course designers came up with various ways with which the diversity of the learners could be taken into consideration. Those ways included dividing the students into groups based on the pre-tasks, giving the groups different tasks based on their major subject, or organizing several opportunities for educational visits and providing students opportunities to choose which visits to attend. This idea of giving the participants different tasks can be seen in the following excerpt from a conversation about taking the participants' previous studies into account:

"And then we can have different kinds of tasks, so they can choose accordingly. So of course people will choose according to what they are working with." [course designer 3, planning meeting].

The course designers themselves designed a course to a multidisciplinary group of students majoring in a variety of different disciplines. They believed that the heterogeneity of the group required learner-driven practices, in which each student would take a role according to the needs of the group, their skills and previous knowledge as well as their personal interest. However, they also had concerns that such an approach might not fit every student. As one of them pointed out, the approach might be more suitable for the already interested students *"who try to find all information that they can get"* [course designer 1, planning meeting]. As the amount of work each student is willing to contribute to a learner-driven task might vary based on the needs and interests of the students, they suggested, that the participants could receive different amounts of credits depending on their preferred use of time and effort.

3.7. Pedagogical Support

The course designers came up with several ways with which the teacher could support learning in learner-centered sustainability education, such as setting educational goals, guidelines for inquiry and problem-based tasks, arranging pedagogical visits, managing time spent on each task, providing learners with sources of knowledge and inspiration, or organizing meetings with experts and mentors. Asking questions was seen as an especially important element of support. As one of the course designers noted: *"The best teaching is that which encourages students' questions to arise"* [course designer 3, planning meeting]. By asking questions, the teacher can model the type of questions, which sustainability is involved in, such as the significance of personal choices and societal guidance. Thus asking questions can guide and encourage students in formulating their own questions.

Despite of the freedom that the course designers wanted to give to the students, they also believed that even the learner-driven approach requires pedagogical planning and support for the learner. One of them even stated that *"it is poor student-drivenness, when the students must figure out by themselves how and where to learn"* [course designer 2, planning meeting]. Thus, in learner-driven sustainability education, planning was seen mostly as a creation of learning environments. In the context of the course that the course designers were planning, one of them said that the teacher's role *"especially in*

adult education—with the connection in lifelong learning—is in creating a learning environment, rather than teaching as such". [course designer 2, planning meeting].

The creation of learning environments was also related to meaningfulness, as the peer teachers argued that the environment should support learners' motivation for learning as well as action towards a more sustainable world. Creation of such learning environments might require setting up frames and structures for students' activities and projects. For example, learners can be provided with a task or a fixed deadline. Creating an atmosphere which is not suppressive was also considered important, because such an environment is necessary when covering a topic as difficult as sustainability. The course designers also believed that the learners might need help in social aspects of learning, such as in building collaboration and teamwork. The idea of support that the course designers could give through creating opportunities for solving problems can be seen in the following excerpt:

"According to my opinion, by using this kind of student-driven approach, we could create the best possible opportunities. So that the students—who are interested about the things we create for this course—would not be given a ready-made palette. But we would create the opportunities, so that they could start to own the problems first, and then search for solutions to the problems." [course designer 2, planning meeting].

4. Discussion and Conclusions

The aim of this research was to study the beliefs' that the course designers had about learner-centered and learner-driven pedagogy. Although the course designers could plan the course with only little restrictions and they had not been taught about learner-centered or learner-driven pedagogy during the process by the coordinators, their planning could have been affected by the discussions with the course coordinators and with the ActSHEN-partners, especially CEMUS, which they visited in the end of the planning process.

Previous descriptions of learner-centered pedagogy include a wide range of ideas for student involvement and pedagogy [11]. The most radical form of student involvement, the total shift of power relations between the students and teachers, is, in the light of the results of this study, learner-driven rather than learner-centered. The results of this research suggest that the learner-centered and learner-driven approaches are fundamentally different. In the learner-centered approach, the learner is at the center, but the teacher is in control of the choice options for the student, and sets goals for learning. In the learner-driven approach, the learner is not only at the center, but the learning actions are driven actively by the learner. The teacher's role is to facilitate the process. This is in line with the dictionary definitions for center and driven [13,14].

In the learner-centered approach, the learner is taken into consideration, but in learner-driven approach, the learners take active ownership of their education. Despite of the fact that the learner-driven approach gives the learners more freedom, it can also be structured. The question is, what sort of a structure is it. When moving on to the learner-driven approach, the learners should know that they are expected to become owners of their knowledge and their learning. They can be offered, for example, timeframes or themes, but the teacher cannot give ready-made solutions and think for the learners.

In learner-centered education, the goals are set by the teacher. The meaningfulness of learner-centered sustainability education depends upon pre-defined sustainability knowledge. Teacher is in the position of owning the knowledge which they provide to the learners. On the other hand, in learner-driven education, the learners can engage in a meaningful process from their point of view, and set goals accordingly. What sustainability is and how that is related to the learner, is not predefined.

The meaningfulness of knowledge is connected to the ownership of that knowledge. Who should possess it, and is there a quality criteria? According to the course designers in this study, the learner-driven approach is suited for the course as they are not as credible as experts. But should the possession of "right" knowledge be a requirement for sustainability education? And if so, does anyone

have all the knowledge needed to address the complexity of sustainability issues? The peer teachers suggested that teachers should update their knowledge on the way. The knowledge acquisition in sustainability education can therefore be viewed as an inquiry, a cyclic process driven by the learners' interests. The teacher should guide the learners to find answers to their questions to support the process, for example help them to assess the credibility of the online resources that they use. This kind of inquiry has been described as student-driven inquiry [17].

The role of the teacher is important in both learner-centered and learner-driven approaches, for example in creating opportunities for a meaningful learning environment, such as facilitating project-based learning. Neither learner-centered nor learner-driven learning should be promoted in such a way that the learner would learn alone. However, in learner-driven education the teacher should not be seen as a driving force, but rather as a resource for the learners. For example, when moving on to learner-driven education, there might still be room for lectures, but the need for and the topics of the lectures should be suggested by the learners. And along with the teacher, learner-driven sustainability education should highlight the whole community of learners by encouraging participatory decision-making involving teachers, students and researchers [1,35]. In the model of Brundiers, Wiek and Redman [18], the learners' collaboration with community project partners increases, and the teachers' role decreases in the most advanced form of education.

For transformative sustainability education, education for sustainability, learners should be offered more responsibility over their learning than in learner-centered practices. We should move from transmissive to transformative education, see [20], especially in higher education, where the students have to engage with the world and solve real life problems [18,19]. Like the course designers in this study believed, the solving of the sustainability issues requires creative and new solutions. Sustainability issues are wicked, so divergent approaches are needed.

Transformative education has been connected to capabilities approach [36]. According to them, capabilities are broader, more holistic, driven by a persons' motivation, and highlight freedom and agency, compared to competencies which are externally demand-oriented. The promoted goals for education therefore also suggest roles for the students in higher education. In fact, Wals and Jickling [3] question whether such sustainability education would be educational if sustainability is fixed and "pre- and expert determined".

However, the transition towards a more learner-driven direction can be challenging, see [24]. The question remains, if the whole learning process can be learner-driven, or if it should it be learner-centered for some elements. Previous research has suggested, that a gradual progression towards more learner-driven approaches might be needed [18]. The students can also take different roles within the same course. On a previous intervention on student-led sustainability education, higher education students participated in student-led discussions [37]. The authors suspected that all of the students were learning, and some of the students also took teaching roles.

In learner-centered and learner-driven pedagogy, the role of interest is also crucial. In learner-centered education, learners' interests affect the pedagogy. In learner-driven education, the learners' actions create interest, which then creates more action. This kind of action-competence which is driven by the learner is close to the idea of capabilities. This is because there are no external demands for what sort of actions are required [36]. Future research should concentrate on how learner-driven pedagogy could be used more extensively, and especially how learners' actions can be used as a starting point for the learning process.

As the terms "learner-centered" and "learner-driven" have been used ambiguously in research literature, this research suggests a more specific use of terminology. The term learner-centered should not be used to cover everything, even when the use of learner-centered sustainability education practices is self-evident in the present sustainability education. And on the other hand, the term learner-driven should be restricted to be used in those specific situations in which the actions are truly based on the learners' perspectives.

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Appendix A

Table A1. Course designers' beliefs about student-centered/student-driven education for sustainable development, categories from the first open coding.

Learning Philosophy	Practical Aspects	Role of the Learner	Role of the Teacher	Benefits	Frames and Limits
unstructured	project work/working with content or theme freely	to participate actively	to guide and support	relevance of learners' knowledge and skills	requires planning, setting goals, and applying
a different way to teach	accompanies lecturing	to work independently, freely	to offer part of the responsibility to the learner	supporting the learners' thinking	requires certain qualities from the learner
learners' interests, existing knowledge and caps of knowledge as a starting point	can be done before and during instruction	to set goals	to offer relevant content/knowledge for the learners	expanding the class communities' knowledge	is not enough as a learning and teaching method
	peer-teaching		to create a learning environment which supports motivation, thinking and confident atmosphere	supporting the learners' interest	
	possibility of choice in tasks		to take the individual into account		
	way to teach and learn				

Table A2. Course designer' beliefs about learner-centered/learner-driven pedagogy in education for sustainability.

The nature of learner-centered/learner-driven pedagogy

- It can be supplemented with other teaching and learning methods
- It is motivating, increases interest
- Learner-driven pedagogy is divergent
- Project-based learning is an example of learner-driven pedagogy

Freedom

- The learners can choose from several topics and go deep into the topic
- The learner chooses the topic
- The learner sets the goals
- The learners can fulfill themselves freely

Table A2. Cont.

<p>Meaningfulness</p> <ul style="list-style-type: none"> • The topic is meaningful in terms of sustainability • The topic is close to the student, it is meaningful or useful
<p>Acting and making an influence in the learning environment</p> <ul style="list-style-type: none"> • The learners can teach each other • The learner can affect to his/her action and environment
<p>The nature and ownership of sustainability knowledge</p> <ul style="list-style-type: none"> • The teacher must have knowledge about sustainability • The goals connect to the elements of education for sustainability • It can supplement the teachers' knowledge • The goals support critical, innovative and transformative thinking
<p>The diversity of the learners</p> <ul style="list-style-type: none"> • The learners' differences have to be taken into consideration • Different learners are taken into consideration by differentiation • Defining and modifying learners' views
<p>Pedagogical support</p> <ul style="list-style-type: none"> • Learner-centered/learner-driven pedagogy requires planning and guidance from the teacher • The goals (teacher or learner set) guide pedagogical choices • Creating a suitable learning environment is important • The teacher should ask questions, and stimulate the learners' questions

Appendix B

The structure for the first interview:

- How did you decide to emphasize the different dimensions of sustainability and why?
- How do you think your students will react to what you teach?
- What was the significance of the CEMUS-visit?
- How are you going to support the group work of the participants?
- How do you feel about the course?
- How have you experienced the planning process?
- How important do you think is the pedagogical background for the course designers?
- How have you experienced the group work?
- What have you learned in the process?

The structure for the second interview:

- What do you think you learned in the course?
- Where did you learn about those things?
- Did you change your plans during the course?
- What kind of experience was this in terms of your future as teacher?
- How would you choose the next course designers?
- How would you develop the course?
- Would you do something differently now after the course?
- What kind of feelings you experienced in planning the course?
- How was student-centeredness actualized in the course?
- How has your thinking about sustainability and its education changed in the process?

- What was challenging in planning the course?
- How do you think multi-, inter-, or transdisciplinary was actualized in the course?
- How do you think that the different backgrounds of the course designers affected to the course?

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