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NARRATIVE STUDY OF TEACHER STUDENTS' EXPERIENCES ON AN EXPERIMENTAL CHEMISTRY FIELD COURSE IN FINLAND

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Abstract The aim of this study was to investigate chemistry teacher students' experiences of an experimental chemistry field course. A narrative approach was used because the aim was to obtain authentic reports. The study participants ($N = 8$) had all taken part in an experimental chemistry field course between 2013 and 2015. The teacher students reported that once they had participated in the field course, they were ready to teach science outside the classroom with students in future. Without the field course, they would be less likely to do so. The results indicate that chemistry teacher students feel they need more training in different learning environments.

Keywords: chemistry teaching, teacher education, science camp, science, narrative research

*This article is based on the author's academic dissertation.

1. INTRODUCTION

According to Väisänen and Atjonen (2005), Finnish teacher education takes a science-based approach, guiding teacher students to independent pedagogical thinking, decision-making and exploratory work. This has turned out to be a successful educational policy decision. The quality of teacher education has had a major impact on the teachers' professional skills, and is considered one reason for the success of Finnish students in the worldwide PISA assessment. The quality of chemistry teachers correlates significantly with student competence (Aksela & Karjalainen, 2008). However, what is meant by *teacher quality* is difficult to define. The concept means different things for different people. In addition, the concept can be defined in a variety of ways depending on the purpose (Goe, 2007).

In order for teachers to be able to teach productively, they should understand how students learn (Ramsden, 2003; see also Wilson & Demetriou, 2007). Yet metacognition is as important in the training of teachers as it is in students' learning. Luukkainen (2004) states that metacognitive knowledge and skills are at the center of learning. Not only do they guide learning but they are also its object. Metacognitive knowledge is the knowledge individuals have of their own processes and strategies, as well as their consciousness and awareness as learners of the complexity of different

tasks. The development of metacognitive knowledge continues throughout one's life, guiding the choice of suitable strategies (Luukkainen, 2004).

Väisänen and Atjonen (2005) see teacher education as a pedagogical process in which the most important starting points are to guide the growth and development of future teachers by supporting the development of their own resources. In addition, it is important to awaken students' interest in contemplating prevailing teaching practices and their own critical activity in order to create the conditions for renewed learning. Teacher education aims at holistic professional growth and development. The development of a teacher's personality is always the development of oneself, as the personal and the professional identity of the teacher become intertwined (Patrikainen, 2005). In the professional development of future teachers, the role of teaching practice is undeniable (Jyrhämä, 2005). Luukkainen (2004) sees guided teaching practice as a cornerstone of Finnish teacher training.

Professional identity means a perception of one's life history as a professional (Eteläpelto & Vähäsantanen, 2010). The development of a professional identity is significantly influenced by training environments. Students' training experiences can show how differently their own teacher identity can be experienced in different classes and by different instructors. Prior to the teaching practice, teacher students already have preconceptions of themselves as teachers and those perceptions are present in training situations where they are further refined and formulated. (Lauriala & Kukkonen, 2005). According to Palomäki (2009), teacher students, teachers in the field and teacher trainees have emphasized the key role of teaching practice in their professional development. Teachers' professional growth is mostly the teachers' own attempt to develop their work (Korkeakoski, 1999). The role of teachers is changing all the time and one's knowledge base as a teacher needs to be updated constantly. In addition, the contexts teachers work in have changed in terms of study time, and teachers are increasingly confronted with heterogeneous students. For this reason, teachers should think like researchers and try to constantly find new solutions to become a better expert in their field (Niemi & Nevgi, 2014).

The Department of Chemistry at the University of Jyväskylä annually organizes an experimental chemistry field course (5 credits) for chemistry teacher students. An experimental chemistry field course is included in the final stage of chemistry and biology teacher students who are actively thinking about working life. Teacher students gradually grow as teachers, and practical training plays an important role in this growth. Practical training helps teacher students develop their pedagogical subject management and learn working life skills. The field course period is carried out as part of a youth science camp in Konnevesi Research Station. The goal of the field course is to provide ready-made teaching modules teacher students can implement in their own teaching. Finally, students reflect on their own learning. The course also utilizes nature-based surveys and research literature, and includes working in small groups. In addition, students plan their lessons and teach during the field period. The themes of the experimental exercises are water and soil, in line with the basic education curriculum. The course includes 24 hours of experimental work and the field period, which lasts for three days. Thirty hours in the chemistry teaching laboratory is reserved for planning the field course.

2. RESEARCH

This case study focused on an experimental chemistry field course offered by chemistry teacher students. The research was guided by the following research questions:

1. What kinds of experiences emerge in the narratives by teacher students about an experimental chemistry field course?
2. What are the meanings the teacher students give to the experimental chemistry field course?
3. In what ways does an experimental chemistry field course support the teacher students' professional development?

This article presents teacher students' narratives of the meanings and experiences they found for an experimental chemistry field course. These teacher student narratives were then used to create a single story about the meaning of the field course. The story is divided into three parts. First, it presents three different reasons for participating in the field course. The middle of the story describes experiences from the field course and the impact the course had on their future profession as a teacher. Finally, the single story is summarized.

Section 2.1 explains how the study was carried out. Section 2.2 introduces the study participants while Section 2.3 addresses the quality of the research. Section 3 presents the results as a single story on the meaning of the field course, and Section 4 discuss the study's conclusions.

2.1. Procedure

The study was carried out by contacting, in writing, the teacher students who had participated in the field course between 2013 and 2015. Students were asked to share their experience from the field course and discuss the following aspects in writing:

- A) When did you participate in the experimental chemistry field course?
- B) What is the significance of the field course for your own learning, practical training and professional development?
- C) The field course provides students with an educational experience. How does this effect the teacher's work and teaching outside the classroom? Science camps can be defined as non-formal learning environments that inspire youth to experimentation by means of real life connections.
- D) If you are already in working life, have you been able to utilize and apply the lessons learned in the field course? In what ways?
- E) How do you see the field course is useful for your future career?

Narrativity is divided into two categories of material handling: narrative analysis and analysis of narratives. According to Patton (2015, 130), narrative analysis focuses on how stories, especially texts that tell stories, are interpreted. Narrative analysis produces a new story on the basis of collected reports, which highlights the themes of the data. In analysis of narratives, the focus is on the categorization of reports (for example, by case types, metaphors or categories). (Heikkinen 2010, 149.)

2.2. Participants

The target group for the study consisted of teacher students who participated in an experimental chemistry field course between 2013 and 2015. The first written request was sent on 7 January 2016 and the respondents were given two weeks to respond. Thirteen requests were sent and answers were received from five teacher students. One teacher student could not be reached. The response rate was only 38%. The request was sent again on 25 January 2016, and the respondents were given two weeks' time to respond. This second request produced three more responses. After two rounds of requests, the response rate was 62% (8/13).

2.3. Quality of the research

This case study uses a narrative research approach. According to Heikkinen (2010), the reliability of narrative research can be viewed in light of the traditional concepts of validity and reliability. Validity refers to how the research results correspond to the actual state of facts and reliability means the extent to which random factors have potentially affected the results of the research (Tuomi & Sarajärvi, 2013). In a narrative study, the use of validity and reliability in the evaluation of quality is difficult because in such a study the material can be understood and interpreted in many different ways.

In describing the stories, fairness has been the aim. This has been done so that every teacher student who participated had their voice heard. For narrative research, it is essential that the story opens to the reader. This allows the narrator's story and voice to be sufficiently covered. In addition, all stages of the research process have been introduced as accurately as possible to give the reader a clear idea of their content. The amount of research material was small but rich, providing an in-depth look at the teacher students' experiences. According to Partanen (2011), it is not the number of pages of texts that is essential in narrative research but the amount of narratives. Teacher students comprehensively discussed the desired themes in their reports.

At the beginning of the data collection, teacher students were clearly informed where and how the research material would be used. In addition to the submitted research request and guidance, the investigators received a cover letter detailing the research data. Protecting anonymity is challenging, especially in a small study. Students were asked to write the report anonymously, but because the request was made by e-mail, the researcher learned who had sent each text. Therefore, before reading the scripts, all the texts were compiled into a single file and all identifying

information was removed. The only background the teacher students were asked to provide consisted of the year they participated in the experimental chemistry field course. Because direct quotations play an important role in the analysis of the material, the names and the gender were randomly changed (Josselson, 2007).

3. RESULTS

The narrative analysis was based on eight teacher student reports. A single story was then built from the themes identified in the submitted material. Two researchers independently analyzed the research material and came up with an analysis of which issues emerged most often in the reports. The research uses narrativity in the data collection as well as in the analysis.

Three reasons for participating in the field course were identified, so a decision had to be made to include three different stories to first explain why students participated in the course (see Figure 1). Next, we started to build up a coherent story that included as many issues as possible (Eskola & Suoranta, 2008, 182). The main character of the story is Niina, who was a student at the university when the data were collected. She is a teacher student because five of the respondents were still completing their studies at the time of writing. However, the other three respondents were already working as teachers when the data were collected and had positive views of how the field course had influenced their work. Therefore, the side character Joonas was created in order to provide a teacher's perspective of the field course. The brackets indicate how many teacher students ($N = 8$) belong to each group. The themes reveal the main findings of the story. The story proceeds chronologically from the past to the present. Narrative research uses a linear analytical case study reporting methodology (see Eriksson & Koistinen, 2005; Yin, 2002), in which the starting points, material and methods of the research, results and conclusions are outlined.

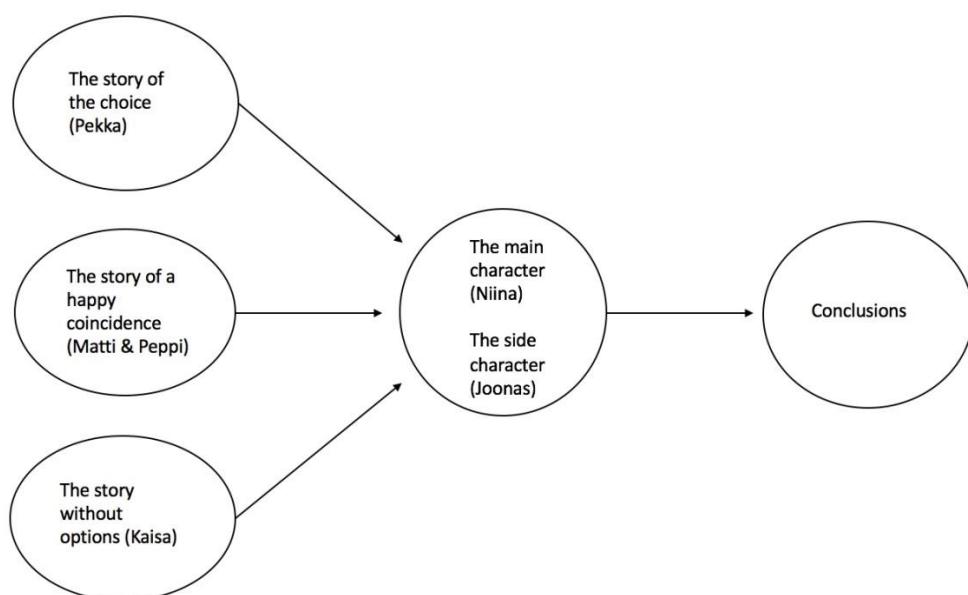


Figure 1. The form of the story about the chemistry field course

The story of the participation in an experimental chemistry field course

It all started from...

The story of the choice (5/8)

The story of the choice is based on the same idea as that of the following one, the story of a happy coincidence. Namely, in both cases, the end of the story is positive. In this story it is typical that the main character himself has taken part in an experimental chemistry field course because he has wanted new tools for his future career in science teaching. Pekka took part in the course because he felt that it would be helpful for his teaching. The course sounded interesting and it fit into his timetable. In addition, Pekka felt that nature and camps as learning environments were foreign to him. With the help of the field course, Pekka saw an opportunity to plan and carry out the science education study material that is done outdoors.

I got excited about the field course during the drafting of my personal study plan. While I was looking at the alternatives for advanced-level courses I found this field course. Teaching in nature has always interested me and I have regretted how little it is done in the schools... (Pekka)

Pekka reported that his prominent reason for taking part in the course was to acquire more teaching experience among young people. Pekka feels that, overall, there is a lack of teaching practice in his pedagogical studies. An experience similar to the field course is rarely available in teacher studies at the university.

The story of the happy coincidence (2/8)

Matti reported that he participated in the field course because he needed more credits for his advanced studies in chemistry. His pedagogical studies had taken a lot of time in the winter and they were surprisingly demanding. He wanted a chance to rest and then complete one of the practical courses. Matti says:

Primarily, I took part in this course for the reason that I wanted to get a sufficient amount of course credits before the fall. The writing of my master's thesis was scheduled to begin in the fall so I wanted to get other courses completed before that started. The academic year was therefore quite demanding because of the pedagogical studies, so there was no extra energy to take the corresponding course during the fall and spring. The summer field course was chosen in such a way a little bit "by accident". In hindsight, it was a pretty good choice. (Matti)

The comment revealed that Matti's participation in the course was the result of a happy coincidence. This story reflects the scope of other respondents' opinions as well. Despite the teacher students' high expectations for the course, these were ultimately exceeded by the course's end.

The story without options (1/8)

Kaisa saw participation in the course as compulsory, and therefore felt that it was not able to provide her with as many benefits as it could for the others:

My personal interests in and motivation for the course and the reasons for participation were perhaps a little motivated by external reasons, so maybe I did not receive the course's full potential. (Kaisa)

Criticism, even a negative attitude, was seen throughout Kaisa's report. However, she thought that practical training and experience in working with students receives far too little attention in teacher education. In her opinion, the field course provides a good complement to the pedagogical studies. However, the course schedule was challenging because the course is held in May and June, and at that time many students are already working in summer jobs.

In the field course

The middle of the story describes experiences gained from the field course. The first part presents Niina's thoughts about the design phase and teaching in nature. Joonas, at times, highlights the course's influence on actual teaching practices.

The design phase of the field course

Niina found that the course's design phase was demanding:

...As early as the design phase of the field course it could be easily be seen that a surprising number of things must be taken into account when that kind of a camp is organized. A number of days should be reserved for the design work if the program is to be planned from scratch. (Niina)

When a person attempts to do something for the first time in his/her life, it is difficult to take into account everything. Students were given the primary responsibility to design a syllabus for one camp day. A camp day at the Konnevesi Research Station began with soil or water system research at 9 am. There was a lunch break from 11 am to 12 noon and work continued with the same instruction material until about 3 pm. The experiments were conducted by motivated young campers, which influenced the fact that the aim was to ensure the adequacy of works. Niina thought that the field course's design work was facilitated by the fact that the work was done in cooperation with the other field course participants. During the course, students are generally divided into two groups, each group consisting of essentially two or three people.

The teacher students attached the most significance to their own group's topic. Niina felt that she lacked interest in the other groups' work because she did not have to self-manage other groups'

intentions for an exercise. However, Niina did acquire a fairly complete picture of the other groups' topics. At the same time, she received advice on how to create clear working instructions and how to use a chemistry vocabulary that is precise but still understandable.

The course work is very universal in many cases, perhaps even more physics or biology / environmental science. Sure, as course participants, we were given the freedom to choose what work is done. Of course, certain limits were also given. It was challenging to find suitable exercises for specific themes... (Niina)

From 2013 to 2015, subject areas in the science camp have been defined broadly as water and soil. This has made the students to feel that the role of chemistry is smaller than that of the other sciences. Exercises have always changed because participants of the field course change every year and they always get a chance to start from the beginning in designing their own educational lessons around a given theme. Themes are intentionally broad so that there can be more integration between subjects in the lessons.

Teaching in nature

In the field course students implement teaching practice outdoors. In this way, chemistry teacher students gain teaching experience that takes place outside the classroom. For me, the course was rewarding in many ways. Konnevesi Research Station was a great camp environment because its close proximity to nature meant there was a lot to explore. (Niina)

Niina saw the field course as an interesting non-formal learning environment. Niina reported that the course provided much-needed experience with teaching in nature. It also showed her how she can use the environment in her own teaching. She said that most of the schools in Finland's smaller municipalities and towns are located in the immediate vicinity of a forest or park. Unfortunately, schools do not take advantage of this situation's potential.

I think it is a very good thing that the university provides teacher students the opportunity to try to teach outdoors. In that way, the message is conveyed that teaching can be more than just cramming and laboratory work in a school building. (Niina)

At the beginning of the camp, Niina noticed that a large number of tools were needed for different tests. The field course showed that one should always be prepared for unexpected situations in nature. Working with tools and chemicals in the camp environment proved to be more challenging than expected. Handling automated measurement equipment was difficult on the boat, particularly when they involved complex wiring. In addition, measuring oxygen concentration with a pipette was not so simple under similar conditions. Niina explained:

A simple chemical test is many times more challenging in a rocking boat than in a classroom. In addition, weather conditions can sometimes cause a bump in the road. It is necessary to assess beforehand how well, for example, automated measurement devices can withstand

getting wet. One of the most unforgettable experiences of the camp was the day when we were on the lake with a few campers doing water studies. A heavy rain started exactly when we were in the middle of lake. The studies were no longer important and we started to row towards the shore. It just didn't occur to me to start explaining chemical theories, and I doubt the students would have been interested in them at that moment. Nature decided to show us that water can be found elsewhere than from the lake. (Niina)

Niina knows now what should be taken into account in order to succeed in teaching in outdoor conditions. However, the field course teachers have tried to account for variations in the weather conditions, so that the order of the exercises could be adjusted if necessary.

The course also increased the self-confidence to undertake various chemistry exercises in an authentic learning environment. A variety of teaching styles are used during the field course, thereby helping students continue to vary them in their own teaching in the future. Joonas has noticed in his work that it is always good to try different teaching styles and methods in order to avoid repeating the same procedure. In addition, students' motivation and interest can be improved by varying the teaching methods and environments (Tuan, Chin, Tsai, & Cheng, 2005).

Benefits of the field course

Niina and Joonas felt that the field course was useful because it made it easier to arrange similar projects in the future. Niina says:

Altogether the field course was enjoyable, it was valuable and a new experience. Because the course was so different compared to the other university courses, it will certainly be remembered for decades after. The course also increases the students' community spirit because the number of participants is small and they spend time together in the course closely sharing a common experience. (Niina)

Since the course was carried out intensively over a short time working in small groups, the group members developed a close community spirit. The field course taught Joonas about working in a project, which is in the new national curriculum in Finland. The design of the teaching included the curriculum's objectives related to broad-based expertise, such as the use of smart phones, tablets and communication devices. These aspects were highly relevant for teachers, who have to implement the new curriculum in upper as well as lower comprehensive school teaching.

The course complemented pedagogical studies in subject teacher education. Niina feels that practical training and experience with youth receive far too little attention in subject teacher training.

... For me, getting training experience in nature was also important because it does not take place during the normal teaching practice. Without the opportunity offered by the field course, it would feel difficult and uncontrollable to try to teach in nature. (Niina)

The field course helped broaden Niina's and Joonas's minds about teaching. They felt that the course enriched their own teaching, and it was considered relevant for their future careers in teaching.

If such a course is not completed during the studies, it is certainly a very high threshold to even think about work outside the school building or even think about alternatives to the traditional classroom teaching. While studying, students should collect as many different experiences of teaching as possible. This provides students with options and opens their eyes. In the current hectic working life, teachers do not necessarily want to try something new and strange. In addition, there is a trend in young teachers' first year: they spend the summer unemployed. This does not really encourage long-term planning for teaching. When one is older, they then often get stuck in what has always been done. After the field course, we have a certain kind of advantage to leave the school and try something new. (Niina)

The field course's impact on the future

Joonas has been able to take advantage of certain parts of the lessons he learned from the field course. He has passed these on at his own school so that the knowledge of his colleagues also grows. At Joonas's school, there is a course that integrates natural science and information technology.

Basic education and upper secondary education are implementing the new curriculum involving theme studies. In general upper secondary school there is a project course, which combines physics, chemistry, mathematics, biology and information technology. The course was piloted last spring on the subject of water. Some of the same measurements were used which we used in our own water work in Konnevesi. The experience in Konnevesi brought more ideas that can be used in this laboratory course. We are now planning a course in which the students examine the quality of the nearby lake. (Joonas)

Joonas has found that students' interest and motivation grow as students can make measurements or observations in a unique natural environment. He saw how the camp provided youth with a positive experience in the natural sciences. Such experiences get children excited about chemistry studies (see Kong, Dabney, & Tai 2014). Niina and Joonas both felt that the field course was a great experience, which also gave new ideas, motivation and enthusiasm for their chemistry teaching. At the same time, they were able to see how a science camp, as a whole, was designed. Such experience builds a foundation if at some point they want to run a similar camp for other young people.

Niina saw the course as important in terms of professional development. Experience gave her the courage and inspiration to implement teaching in an authentic environment in the future. Joonas also found that the camp produced positive experiences with the natural sciences. This affected his own enthusiasm with regard to education.

...Teaching outside the classroom can bring a lot of new and interesting things to do. I believe that this kind of teaching style also inspires the students to study more, or at least to reflect on the natural phenomena. (Joonas)

Furthermore, Niina felt that the camp would be very useful in later working life because there were also physics and biology-related exercises. Niina is not yet in working life, so she has not been able to make use of the course offerings in a real-life situation. Niina says that the early stages of a teaching career often focus on learning to make traditional classroom teaching work, and that after a few years of experience teachers can begin to develop their teaching and try something new. It was as part of this process that she perceived the experience of the field course as being beneficial. Joonas thought the course was so meaningful that at some point in the future it should be a compulsory course for the chemistry teacher students.

4. CONCLUSIONS

The aim of the study was to determine what kinds of experiences emerge in reports by participants in a chemistry field course and what meanings the participants assign to the course. In addition, the study was designed to investigate how the field course supports teacher students' professional development. An experimental chemistry field course was considered to be a meaningful way of learning in chemistry teacher education. The course provides students the opportunity to practice teaching in an authentic natural environment. Students feel that they receive little practical training during their studies, so they view teaching experiences they gain during field courses as a valuable addition to their knowledge (see Jyrhämä, 2005). A genuine natural setting offers many new teaching opportunities that a traditional classroom cannot provide (see Prater & Sileo, 2002). Students found that teaching in an authentic context requires extensive planning and testing of experimental exercises. In addition, a natural learning environment requires foresight from the teacher: weather conditions can change suddenly, so backup plans are needed.

Future chemistry teachers were introduced in the field course to a community of science-oriented youth. As a learning environment, the camp was a new experience for the teacher students. The young people who participated in the science camp were motivated to do work related to the natural sciences, and they wanted to learn more about topics related to nature. Furthermore, the field course participants shared an interest related in teaching science. Group activities were fun to make and group dynamics worked well. At the same time, students received peer support from other students and they learned how to prepare water- and soil-related learning material, experience which they will be able to take advantage of during their professional careers. The teaching of experimental works was repeated many times, which helped the teacher students to see their own development. The field course included active reflection on one's own activities, which will help students to develop professionally. The course also lowered students' threshold to carry out similar teaching in the future. The new basic education curriculum also emerged as issue in the teacher student reports. Students received a set of learning materials from the field course which is broad and crosses subject boundaries.

Training environments have an important role in terms of teacher students' professional development (Lauriala & Kukkonen, 2005). A few students from the field course have already been able to take advantage of the experience they gained on the course in their work as teachers. Information on good experimental exercises has been transferred to colleagues and new courses related to nature are being planned. The course offered a number of new ideas that can be used in contexts other than actual teaching situations. Due to the course, students' skills developed (see Cuckle, Clarke, & Jenkins, 2000). According to Korkeakoski (1999), in the background of professional growth is often the teacher's own continuing aspiration to develop him- or herself as a teacher. As teacher grows professionally, both teaching and learning quality will improve. It is important to develop professional skills as a teacher because the pedagogical skills require practice. Teacher students were in the final stage of their master's degrees, so their subject management was developed but their pedagogical skills required further development due to the lack of teaching practice.

The field course took place in a unique natural environment, which allowed the teacher students to process things more deeply than in the traditional classroom teaching. The reasons for this are the natural environment, conversations with other young people and teachers, and the learner-centeredness. In addition, an authentic learning environment enhances students' internal motivation (Gulikers, Bastiaens, & Martens, 2005). The course seemed to be useful, inspiring and informative, an experience that overall has enriched chemistry teacher training courses. Due to the field course, nowadays the teacher students more easily change their teaching styles and learning environments. The field course has made it possible to show, for example, how the surrounding environment can be used in education and what aspects the teacher has to take into account when taking students into nature. For all of the teacher students, the course was an instructive and successful experience.

This study has helped to develop the experimental chemistry field course in question. Based on our results, a decision was made to increase the role of chemistry teacher students as science camp teachers. Students have been offered more options to the design experimental exercise for the course. Instead of the previous one training package, groups will also teach experimental work on the first day of the camp. In addition, students visit the location before the field period in order to explore the natural environment of the research station and practice their exercises in an authentic context.

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