Developing teacher competencies for teaching evolution across the primary school curriculum. A design study of a pre-service teacher education module

Additional file 3: Results of questionnaires, polls, and content analyses

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Survey on preconceptions and attitudes

Preconceptions on the place of evolution in primary school education

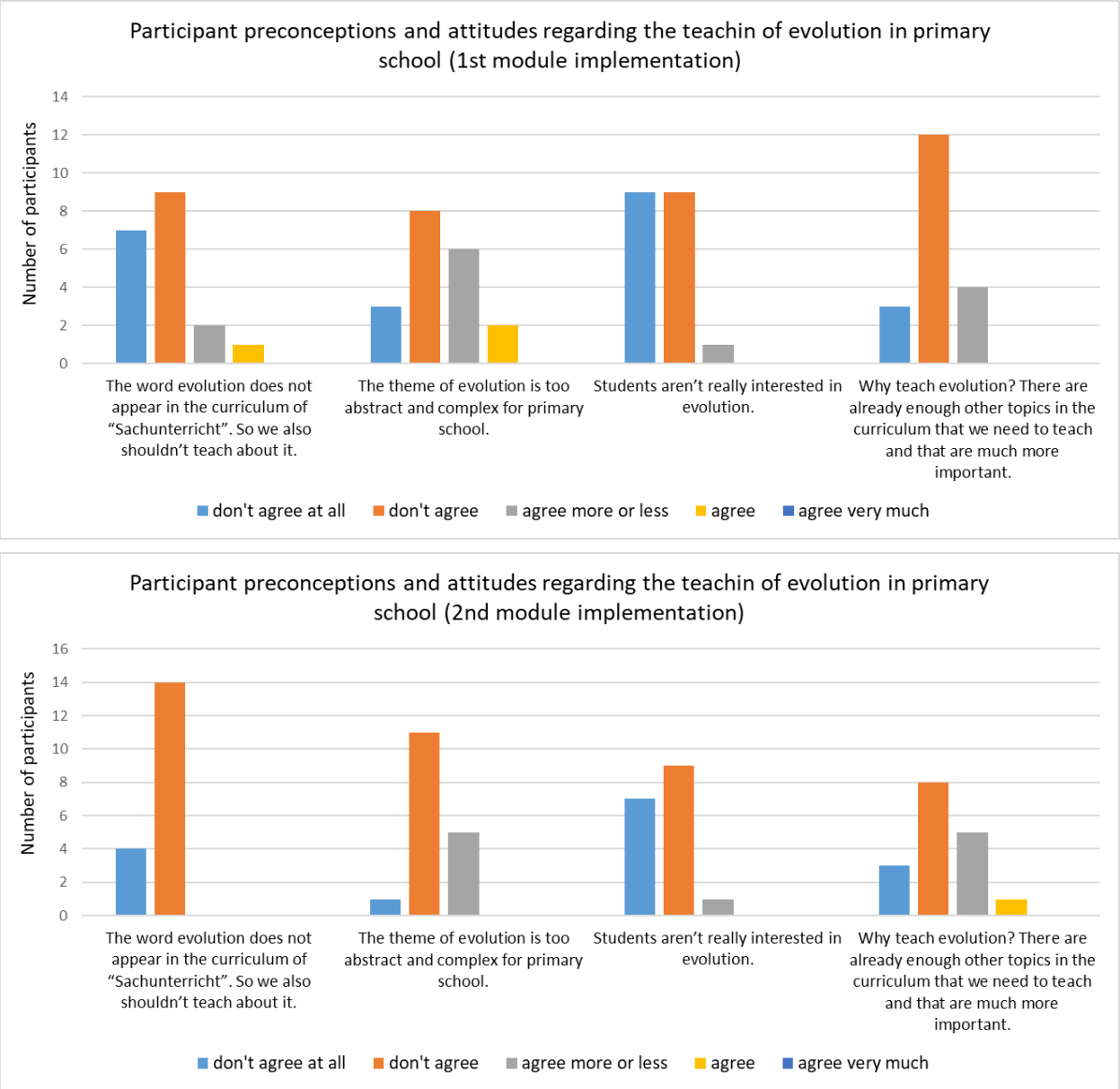


Figure S1. Participants' agreement with several statements at the beginning of the module across both module implementations.

Connections between evolution and the perspectives of Sachunterricht and social-emotional learning (2nd module implementation)

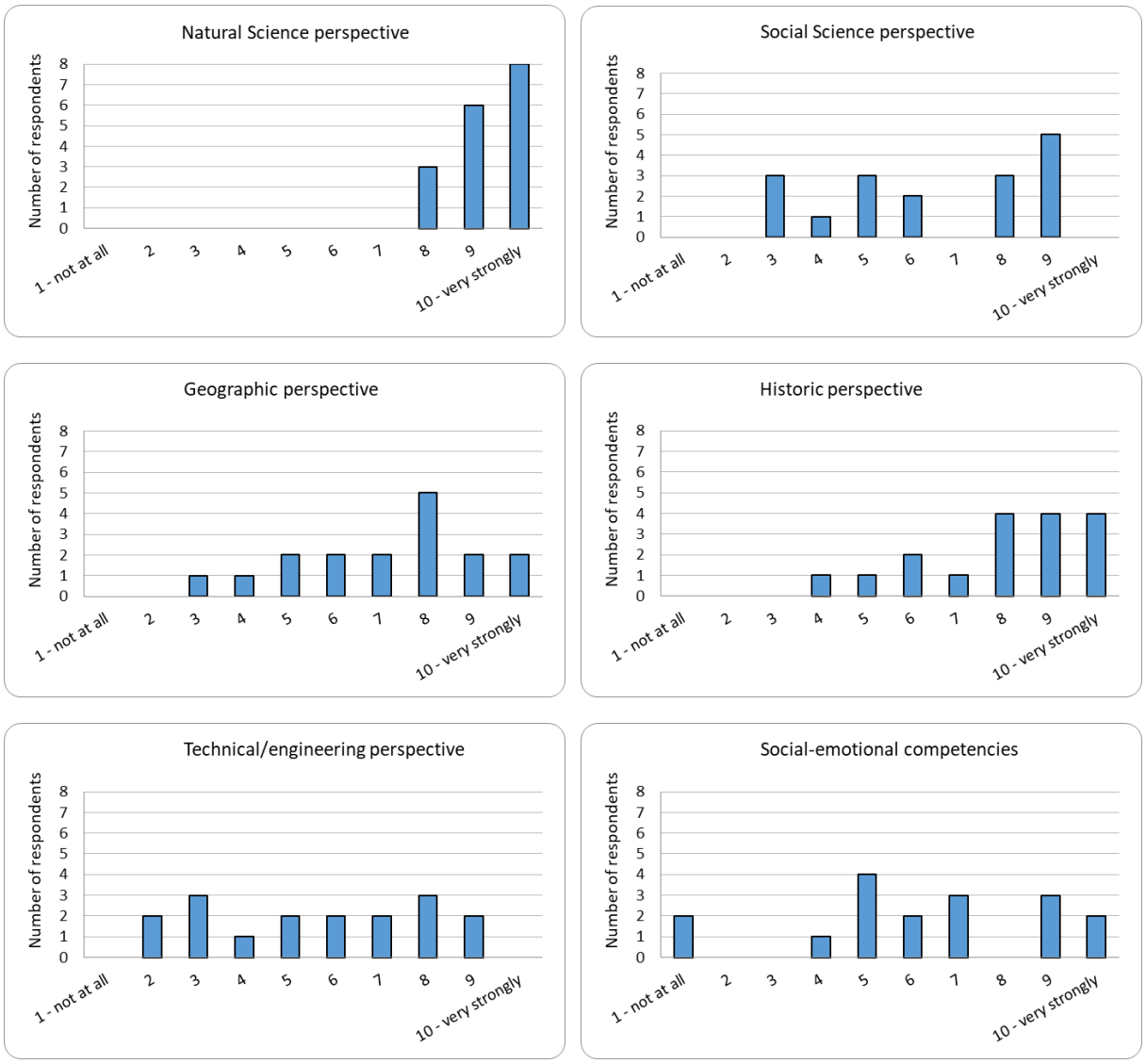
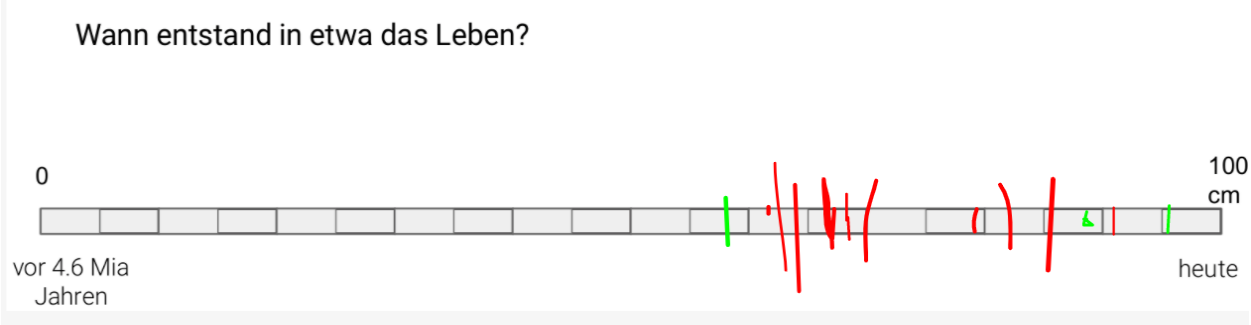
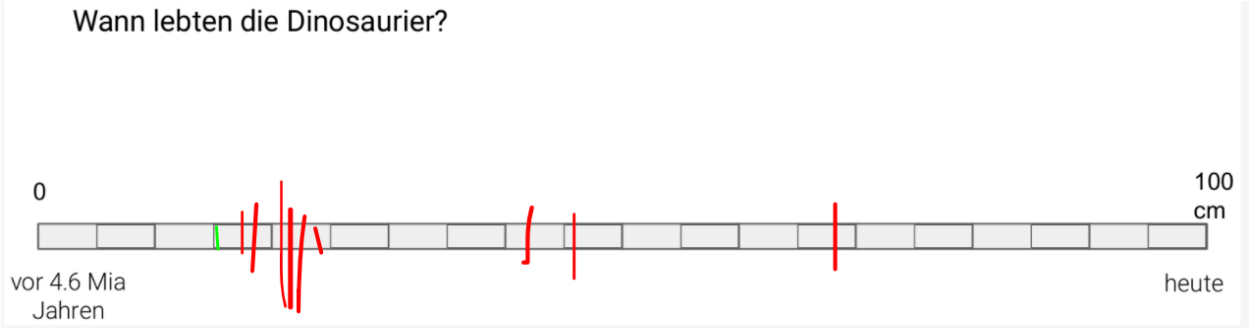


Figure S2. Participants' rating at the beginning of the module of the degree to which evolution plays a role in the different perspectives of *Sachunterricht*: natural science, social science, geography, history, technical/engineering; as well as for the development of social-emotional competencies in students (from 1 - not at all, to 10 - very strongly).

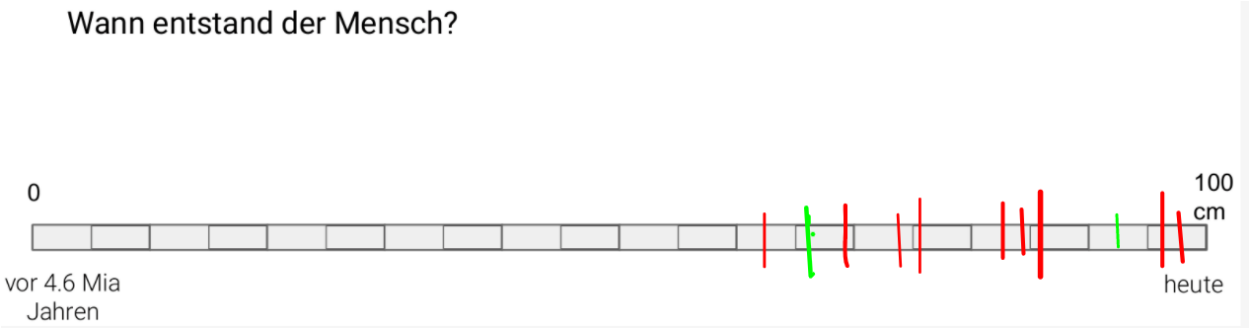
Assessment of deep time thinking



a



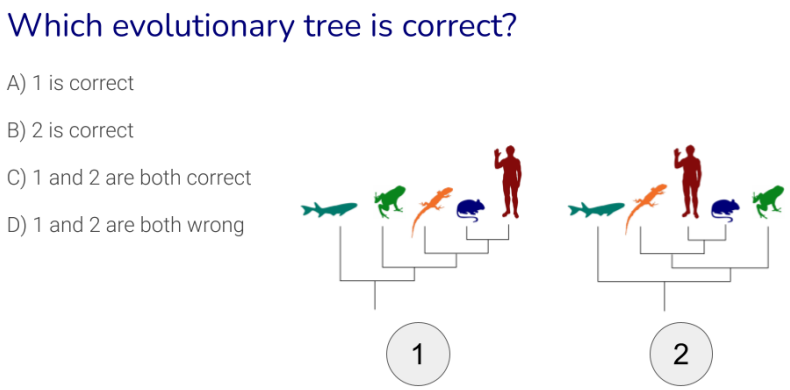
b



c

Figure S3. Screenshots of participant estimates of events on a scale of 1 meter representing the time from the origin of planet earth until today: a) the time of the origins of life, b) time of the dinosaurs, c) the time of the origins of humans.

Assessment of tree thinking



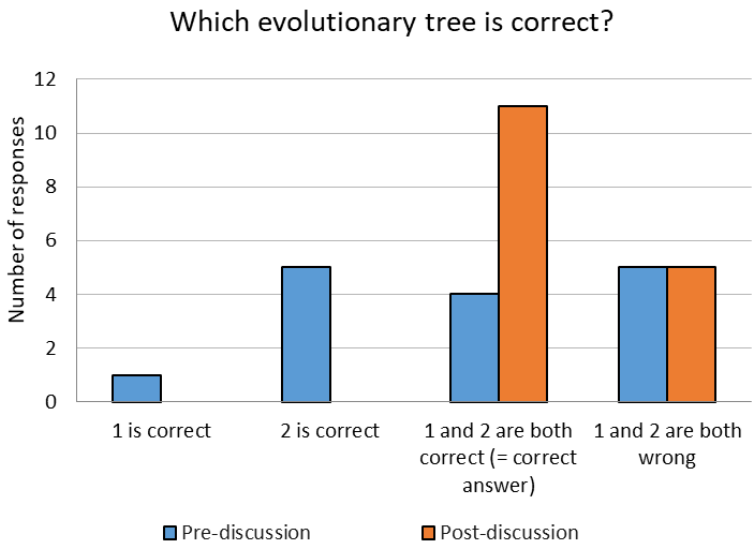
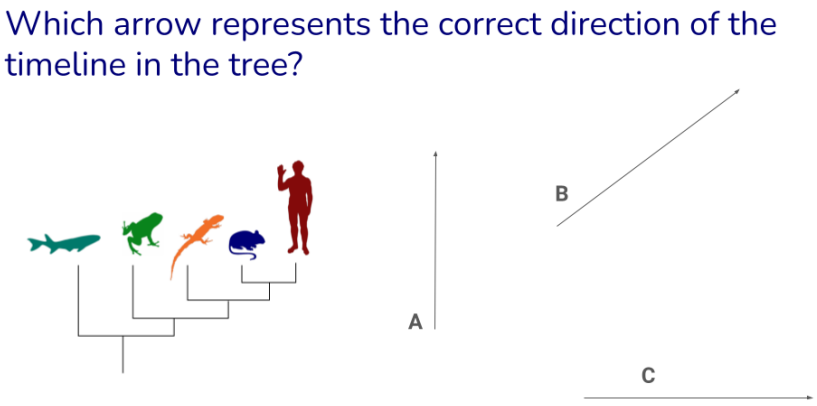


Figure S4. Pre-test on understanding of evolutionary relationships depicted in evolutionary trees (based on Baum et al., 2005). After the first round of polling, participants were given the opportunity to discuss in small groups regarding their thoughts, after which participants were polled again to see if they changed their mind after discussion (inspired by Mazur, 2009).



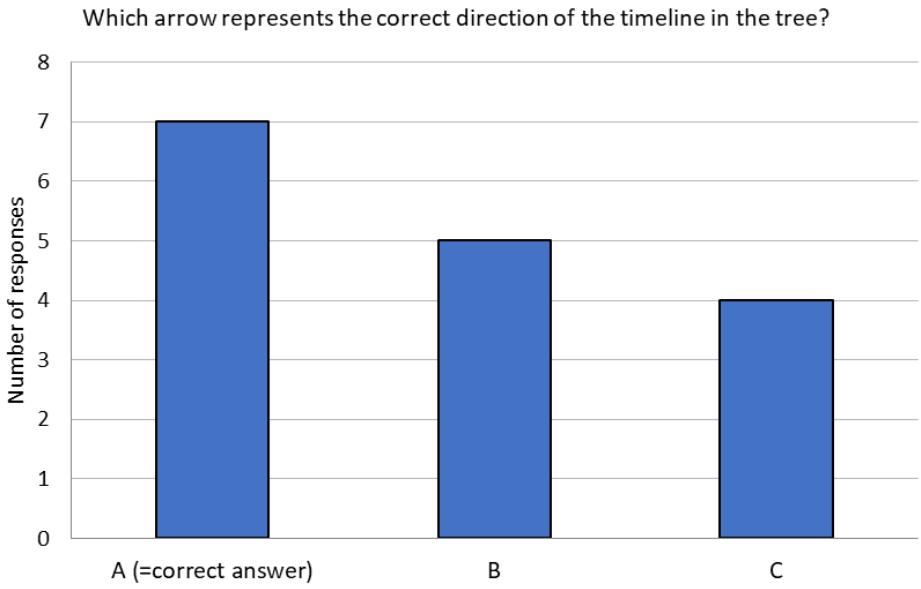
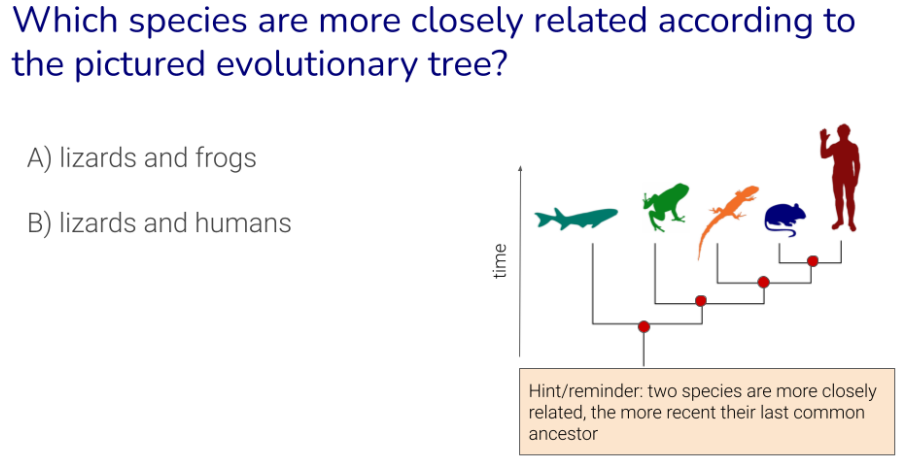


Figure S5. Pre-test on understanding of the direction of time depicted in evolutionary trees (based on Kuschmierz et al., 2020).



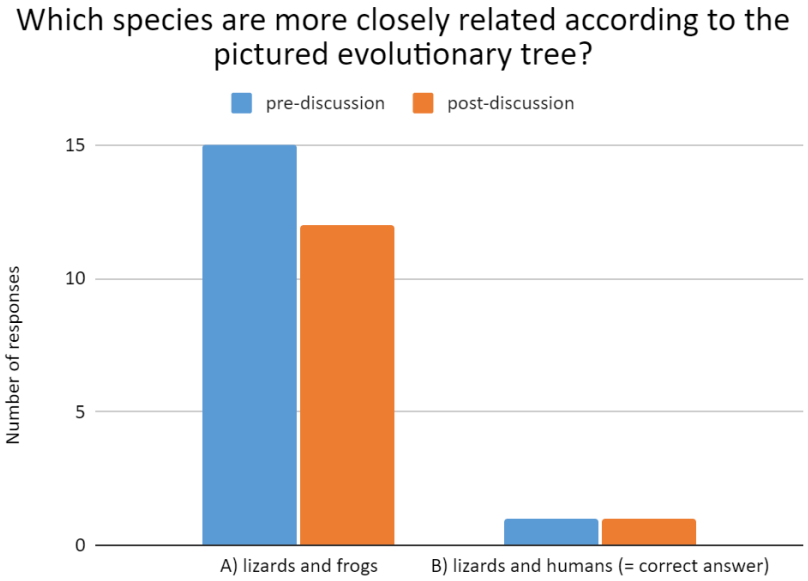
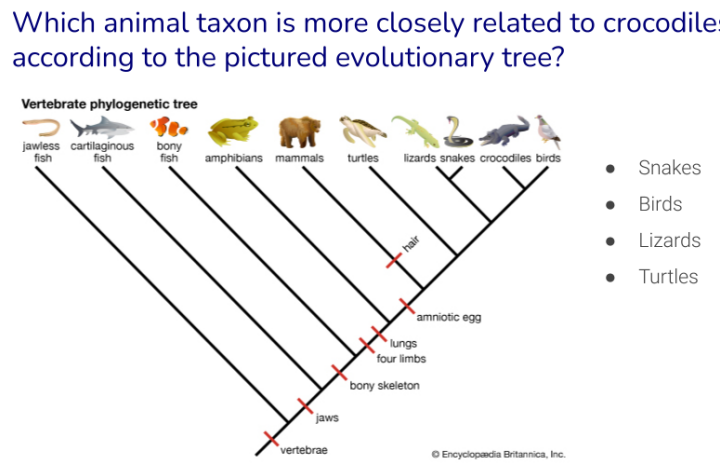


Figure S6. Pre-test on understanding of evolutionary relationships depicted in evolutionary trees (based on Baum et al., 2005 and Kuschmierz et al., 2020). After the first round of polling, participants were given the opportunity to discuss in small groups regarding their thoughts, after which participants were polled again to see if they changed their mind after discussion (inspired by Mazur, 2009).



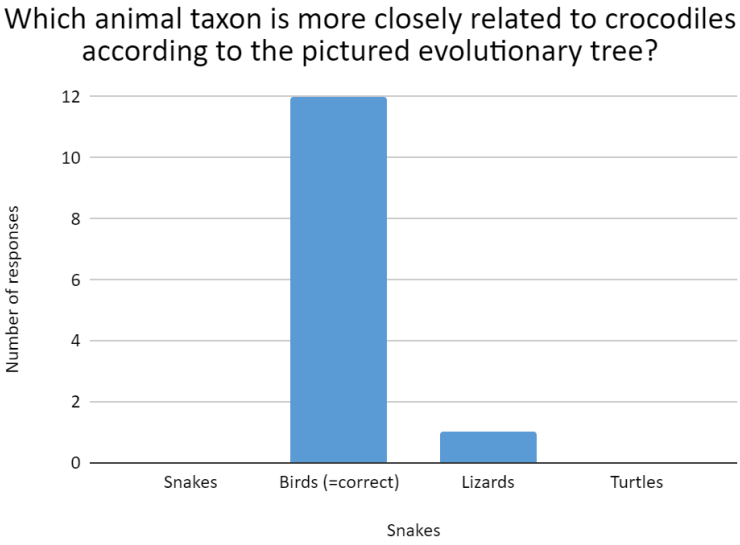


Figure S7. Six week follow-up test on understanding of evolutionary relationships depicted in evolutionary trees (based on Baum et al., 2005 and Kuschmierz et al., 2020).

Analysis of lesson plans

Topics	Theoretical foundation and citation	Originality of the materials/ of the teaching unit, suitable use of media	Learning goals/ objectives, reference to the curriculum	Reference to student understanding and knowledge	Teaching strategies, materials, sequencing	Evaluation methods
Project day on horses	1	1.5	3	2.5	2	3
Project week "Our relatives, the animals?“ with a field day at an animals shelter - Evolution, emotions, connecting with animals	3	2	3	3	2	1
Origins of life on earth with a special focus on human evolution	1.5	1.5	2	3	3	2
Inheritance, variation, adaptation and selection	1.5	1.5	2.5	2	3	3
Mechanisms of evolution: Variation, inheritance, and natural selection	2	3	3	3	3	3
Domestication of plants	1.5	3	3	3	2	3
Mechanisms of evolution - adaptation and natural selection	1.5	2.5	2	3	3	3
What is fear?	1.5	2	2	3	2	2
Adaptation and natural selection	1	2	2.5	3	2	2.5
Evolutionary theory	2	3	3	3	3	3
Time, variation, and inheritance	2.5	3	3	3	3	3
Human evolution	2	2	3	3	3	3
Human history/evolution	2	3	3	3	2.5	2.5
Domestication - how the dog developed from the wolf and its importance for us humans	2	3	2.5	3	3	3
Project days on the topic "Human and animal evolution"	1.5	3	3	3	3	3
Evolutionary anthropology	2	3	3	2	3	3
Where do we come from? The evolution of humans	2	3	3	3	3	3

Figure S8. Assessment of participant created lesson plans (first module implementation) with the help of the PCK informed rubric.

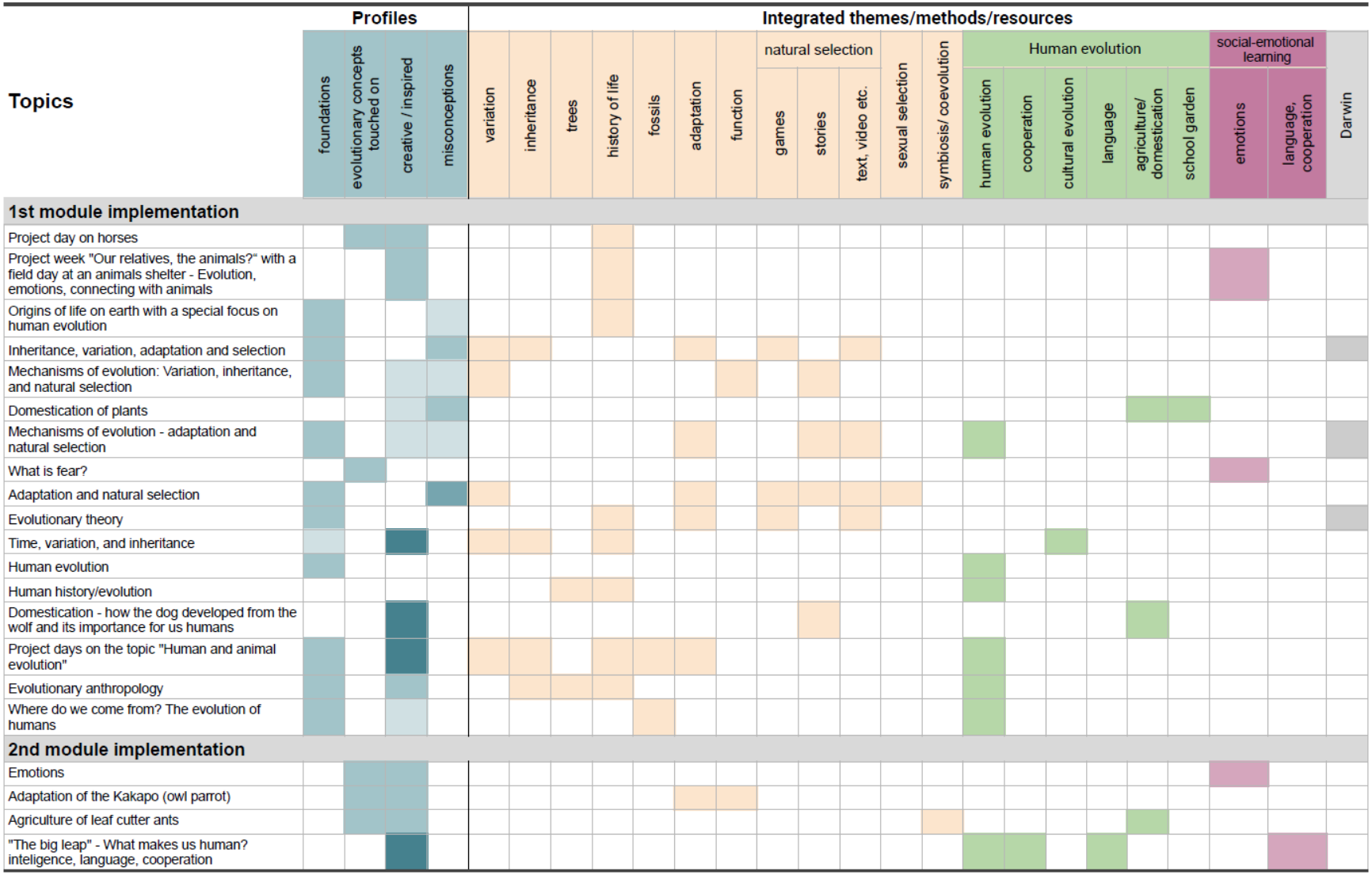


Figure S9. Thematic analysis of integrated themes and profiles of participants' created lesson plans.

Mid-semester feedback survey (2nd module implementation)

Evaluations of module content

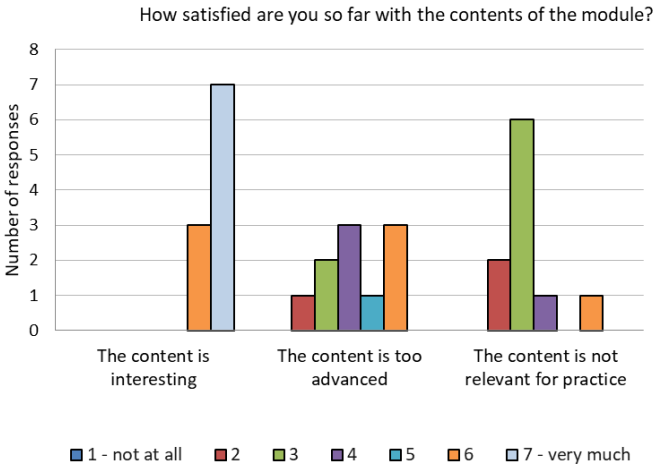


Figure S10. Participant ratings of module

content. **Qualitative responses:**

- I find the aspects discussed very interesting. In addition, the lecturer is technically very competent and uses surveys, working group phases and the like. This makes me feel very involved. The content also speaks to me very much; because current studies, interesting illustrations and exciting facts are always included. However, I think it would be better to delve deeper into the subject. I feel like I'm scratching the surface at the moment. In addition, I would sometimes wish that children with disabilities such as learning difficulties or illnesses were also addressed. Especially in the context of evolution, there are differences in the curriculum and generally a greater potential for conflict. I feel very insecure in practice when dealing with evolution and disability.
- I like the wealth of content that you can choose based on your interests. I also think it's good that lots of materials are always uploaded. Unfortunately, too much offer always overwhelms me, so I would like a small summary for teaching suggestions on the respective topic.
- I really like everything about the content. Sometimes I would only have emphasized or at least discussed the connection to the curriculum even more.
- In some places I would wish for a bit more scientific background, because I have the feeling that I know too little about some topics myself.
- I find the seminar very exciting and I can take a lot out of it for me, but I see very little connection to elementary school.

- I always find the content part very exciting. I have no suggestions for improvement.
- I find the preparation of the content of the theory of evolution and its breakdown into the individual characteristics to be very good and clear. In particular, the connection between the theoretical content and lessons in elementary school is very helpful.

Evaluations of module instructional methods

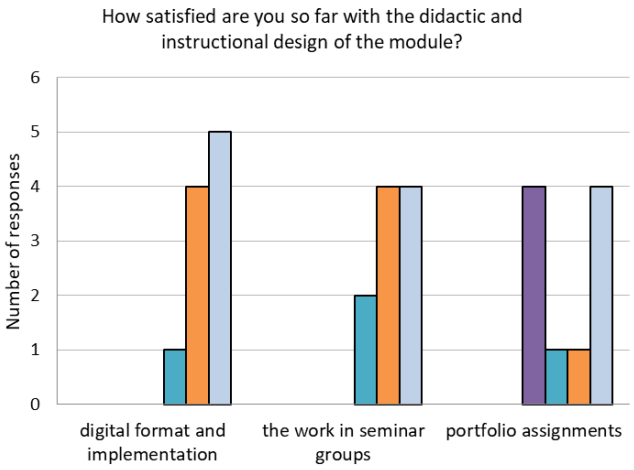


Figure S11. Participant ratings of instructional methods of the

module. **Qualitative responses:**

- I like the group work, surveys, the varied methods between zoom meetings and asynchronous work. The choices between the topics!!! For the first time I felt like I was included in an online course and not alone. Very, very big, big, fat praise!!!!
- I find the change between synchronous and asynchronous learning very good and I also like being able to choose between different tutorial videos;
- I find that sometimes there are a lot of articles that you link. The wealth of materials and offers is enriching in itself, but I just don't have the time to really look through everything. And maybe there is the possibility of uploading the presentation that serves as the basis for the zoom video PPP?
- I'm still a bit unsure if my portfolio meets the requirements. Otherwise, the digital implementation is very good and the scope is well chosen. Working in groups also works well.
- I find the digital implementation very appealing, since we often have to think about the topic in the seminar (through question and answer sessions and various group work). However, I find working with the portfolio very confusing and am at a loss as to how exactly I should deal with it . I'm not sure if I'm doing it right and what exactly is valued. I'm trying to answer the reflection questions, but I'm also very unsure about this. Perhaps

it would have been nice to discuss the portfolio in more detail. Maybe my questions will be clarified next week at the portfolio market.

- I think it's very good that we get many opportunities to exchange ideas in groups - whether in our project group or in other "foreign" groups. The division between live session and self-study also works very well. I like the Docs that anyone can work on and access at any time.
- I like the variety of methods in the Moodle course, as we can check our knowledge in quizzes and learning tasks. The interactive tasks during the seminar session also help to think more deeply about the content.

Evaluations of workload

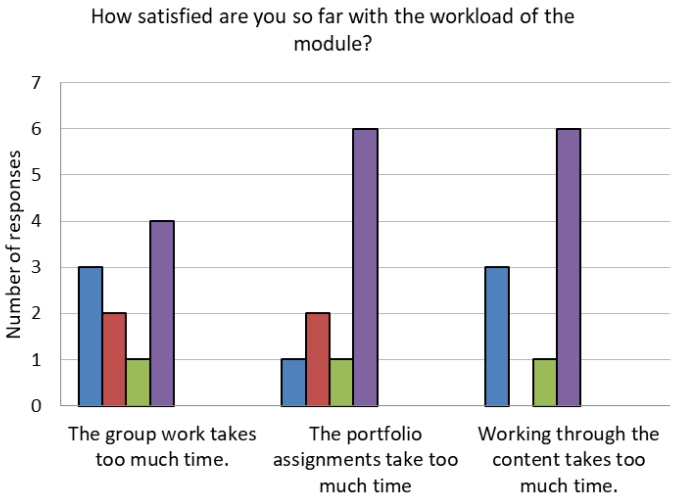


Figure S12. Participant ratings of total workload of the

module. **Qualitative responses:**

- I think that the lecturer manages to give the students the opportunity to deal with the content in very different ways with the asynchronous sessions and individual options. So I personally don't see any problems with the time required! Regarding the portfolio tasks, I could imagine that some might be unsettled by the great freedom of the task and I also think that there is a risk of dealing with the topic less intensively. Nevertheless, I can express myself all the more creatively in the tasks. I really like that!
- Actually, the workload corresponds to the seminar and the credit points and is therefore totally okay.
- In my opinion, group work does not take up too much time. If you split up the tasks a bit, it's manageable. The portfolio doesn't actually take up too much time either. But I can't

judge it completely because of my insecurities. When it comes to processing, I also find that the processing time is not too long.
- Everything great for me :)

General qualitative comments:
- If there's an opportunity for an interesting online learning that doesn't get boring and one still looks forward to it every week, this is it. This has been my first seminar for a year and a half, which I enjoy doing again and which I am looking forward to. The first seminar in which I also feel integrated. I am very fortunate to be here and to see that digital teaching can also look like this. Then my hope is not completely lost! Really great respect again for your open, respectful, sympathetic way!
- I've been really happy so far. I find the content very, very exciting and I think it's really nice how it was prepared for us. You can tell that a lot of effort went into this seminar. Thanks for that!
- I find it very interesting and the mixture of technical information and the reference to elementary school is really great. But above all I think the materials that you also make available are great, because you can then fall back on them in practice :) I would not have found most of the files/PDFs on my own.

Analysis of final reflections (2nd module implementation)

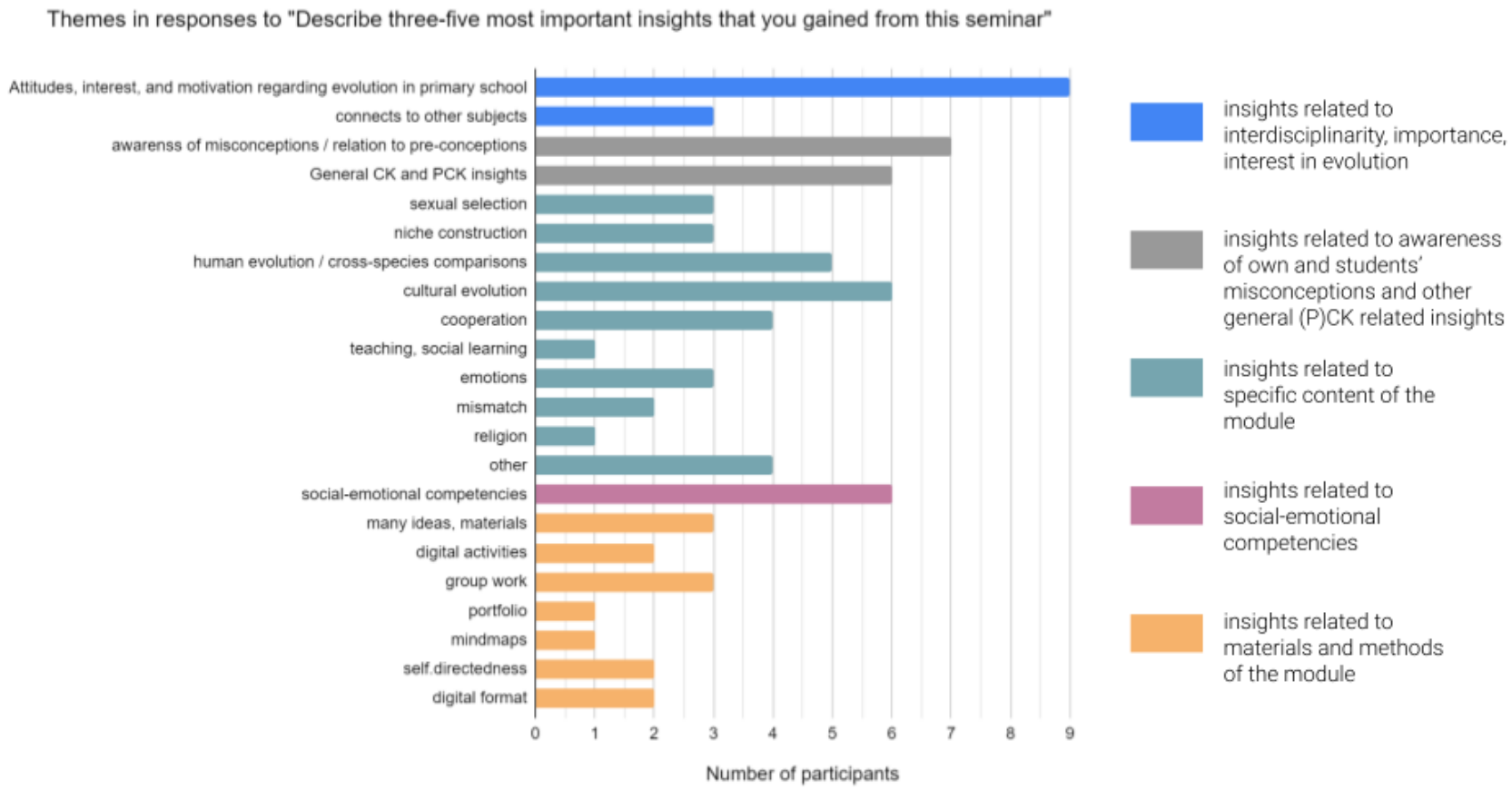


Figure S13. Quantitative distribution of themes in responses to "Describe three-five most important insights that you gained from this seminar."

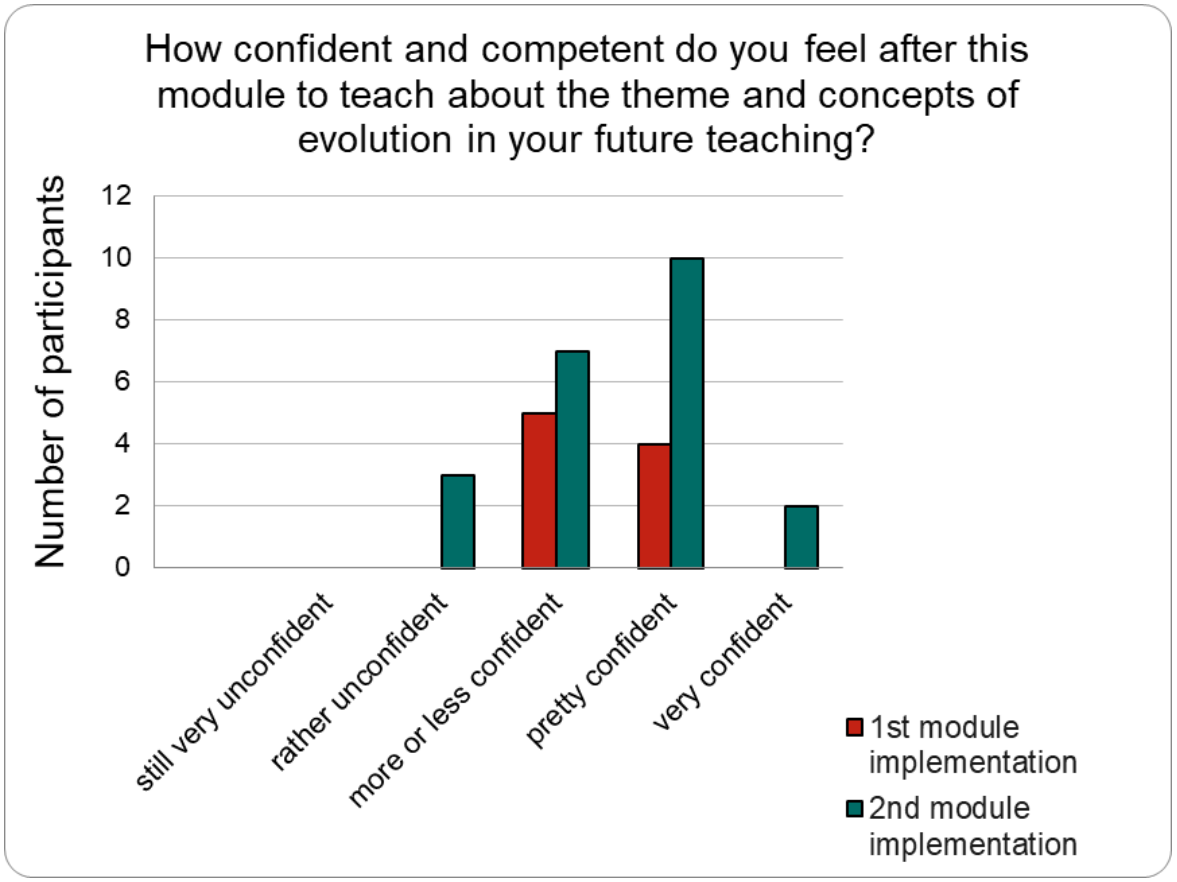


Figure S14. Participants' rating of confidence in teaching evolution in their future teaching after taking part in the module. Notes: Results from the first module implementation were collected within group discussions and not all participants participated. Two participants in the 2nd module implementation rated by themes, these were counted separately.

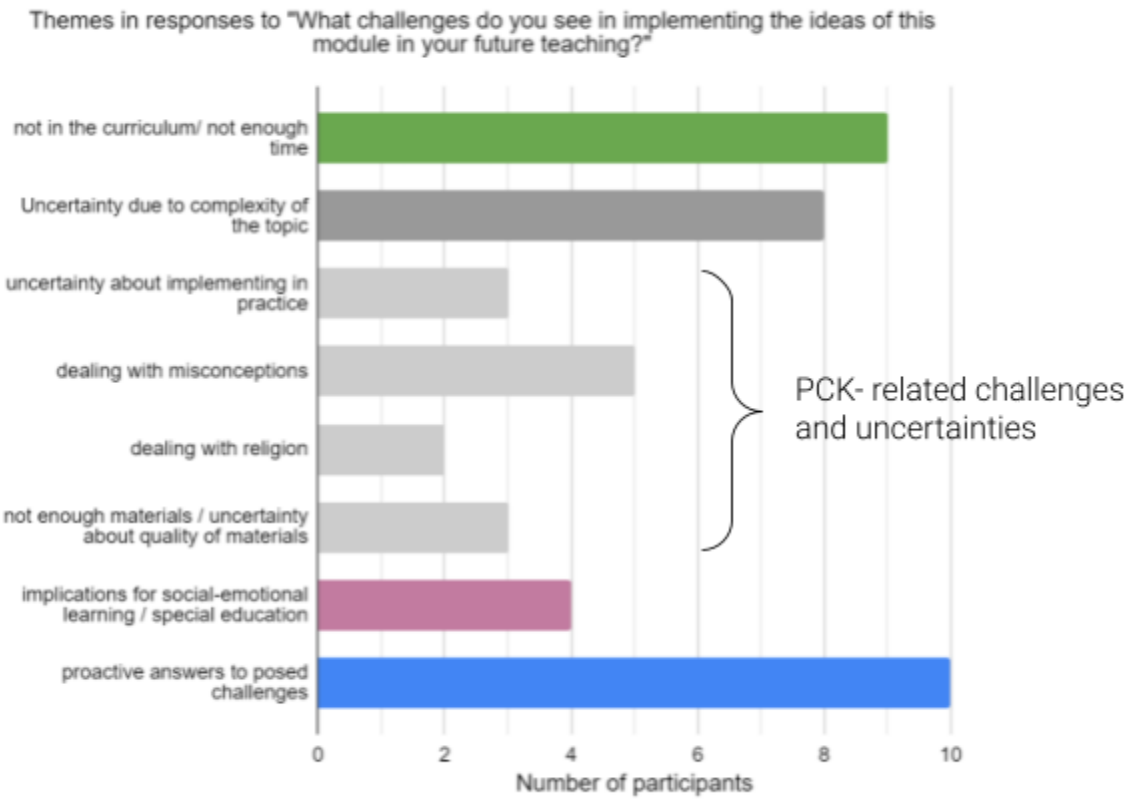


Figure S15. Quantitative distribution of themes in responses to “What challenges do you see in implementing the ideas of this module in your future teaching?" The category “Proactive answers” includes participants’ attempts to answer and resolve the challenges they mentioned.