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A successful learning environment for biology teachers in higher education: Needs assessment

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Abstract

Teachers must enhance their teaching skills in accordance with institutional policies at higher education institutions. This research aims to determine effective professional development techniques for biology teachers in higher education. The modified OZON form (cro. obrazac za opažanje nastave, teaching observation form) facilitated self-reflection and assessed the impact of reflection-based actions on the learning environment. Teachers participated in workshops, experiencing both student and curriculum-designer roles. Proficiency in creating an engaging learning environment and using technology was well developed. However, teachers should improve their understanding of curricular aspects, constructive alignment, outcome-driven selection of activities and formative and summative evaluation. Our research suggests modifying professional learning strategies to align with biology teachers' needs in higher education. Combining extended learning time, implementation in teaching practice, ongoing expert support, and action research fosters positive changes in a constructively aligned classroom. The results indicate that biology teachers in higher education need the continuous support of experts in the didactic design of the lesson plan to improve the creation of a learning environment through positive alignment. This approach promotes active professional development management in a concise format.

Keywords: Assessment, Biology, Constructive alignment, Curriculum, Professional training, Learning Environment, Reflection.

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Contents

Contribution of this paper to the literature
This study focuses on the professional development of biology teachers in higher education, introduces a modified observation of teaching form that contributes to the development of successful professional development strategies tailored to the needs of biology teachers in higher education.

1. Introduction

The earliest theories of competency-based education emerged in the 1960s and 1990s. Competency-based curriculum as a new paradigm in higher education was introduced (Vizek Vidović, 2009). This paradigm implies learning outcomes as visible competencies, the use of appropriate methods to determine competencies, the acquisition of cognitive and practical skills, a clearer and more recognizable articulation of goals and the use of the credit system (Bowden, 2009). Different authors define competency differently but all of them agree that it essentially refers to an individual's capacity to complete a task in a given time (Mohamad Sharif, Zarirah Nizam, Abdul Rashid, Nor Ratna, & Mohammed Hariri, 2018), a set of cognitive, motivational, moral and social skills that are necessary for the successful accomplishment of goals (Weinert, 2001) and standardized forms of knowledge, skills and values (Račić, 2013). Subject-specific and general or transferable competences have been identified by the Tuning Project (González & Wagenaar, 2006). The definition of these competencies enables their explicit introduction into university curricula and their systematic development which represents a significant shift from traditional study programs to modern study programs that recognize the societal need for experts with adaptable expertise (Vizek Vidović, 2009).

Kovač and Kolić-Vehovec (2008) distinguish three levels of coherent and congruent curriculum design and development: curriculum at the level of the study program, curriculum at the level of the module or course and curriculum at the teaching unit (lesson) level. Learning outcomes are directly related to the choice of teaching approaches, learning strategies and self- assessment through constructive alignment (Biggs, 2014). The steps in constructive alignment include defining outcomes, creating a learning environment by selecting learning or teaching activities that promote the intended outcomes, assessing the outcomes using tasks and translating the assessments into standard grades (Biggs & Tang, 2007).

Although the changes described began long ago, the need to improve teaching knowledge and skills is still relevant (Saroyan & Trigwell, 2015). The coherence of the curriculum should be noticed at all levels when planning to enhance teaching. Formative assessment provides feedback for teachers to improve their teaching. It also provides teachers with an opportunity to reflect and think more deeply about the quality of the curriculum at other levels. Therefore, we focused on the lesson curriculum as a starting point for improving the quality of higher education institutions and the quality of teaching as well as an aspect of professional development for teachers in higher education. McNiff (2013) describes this model as a systematic process of observation, description, planning, action, reflection, evaluation and modification. The research aimed to determine positive changes in creating a learning environment through constructive alignment during the development of professional learning.

The term "professional training" refers to the process and learning activities through which teachers improve their academic skills and thereby influence student learning (Saroyan & Trigwell, 2015). In this study, we related professional learning to the creation of a learning environment with constructive alignment. Creating a learning environment is a complex process that requires careful planning, analysis, and assessment. According to Deibl, Zumbach, Geiger, and Neuner (2018), teaching is a lesson-level curriculum to achieve the intended outcomes including planning assessment, selecting learning content, and analysing teaching and learning (Kovač & Kolić-Vehovec, 2008), involving knowledge about different learning strategies that enable the acquisition of knowledge at a cognitive level (Anderson and Krathwohl (2001). It also provides knowledge about how and under what conditions these strategies are effective and how to adapt them to students' needs. Professional development alignment enables action research. It is a constructive approach to learning and professional self-determination where the learner's creativity and autonomy are respected (Soto Gómez, Serván Núñez, Trapero, & Pérez Gómez, 2019).

2. Materials and Methods

2.1. The Course of the Research

The research was conducted during the academic year 2021-2022 from March to June. According to the action research model, professional learning about the creation of the learning environment took place. The modified OZON form (cro. obrazac za opažanje nastave, teaching observation form) was used to guide self-reflection which was also used to assess the changes in the learning environment caused by the reflection-based actions.

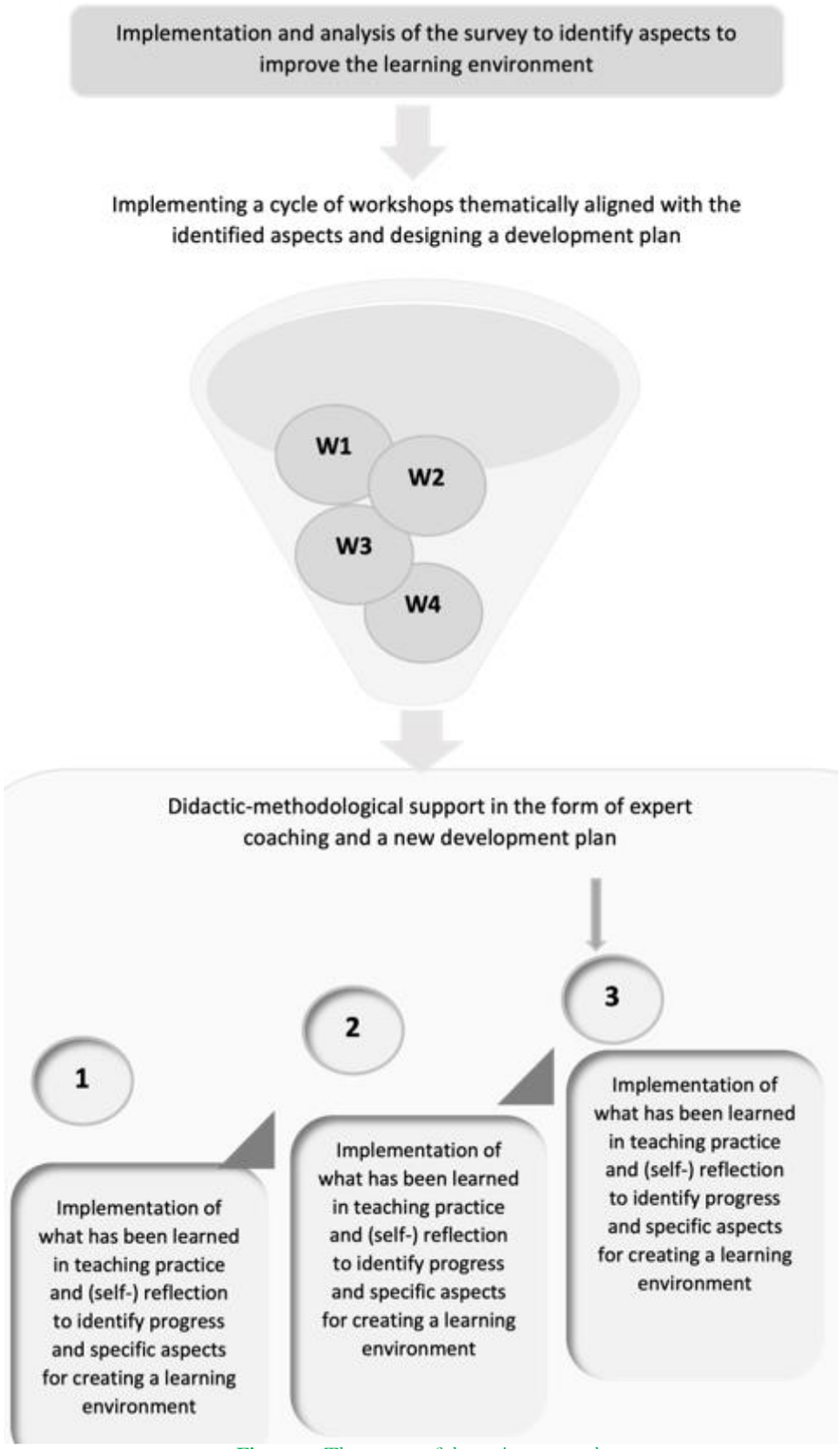


Figure 1. The course of the action research

The study began by conducting a survey by Pekkarinen and Hirsto (2017). Based on the results of the survey, the outcomes and topics of the four workshops in which the teachers participated were determined (see Table 1). The teachers implemented new concepts in their teaching after participating in the workshops. They used the modified OZON form for the self-reflection because these were first-time action research teachers (Bezinović, Marušić, & Ristić Dedić, 2012). For this study, the features related to the observation of the learning environment were divided into the segments that we explicitly developed in the workshops (see Table 2). Eleven teachers from the Department of Biology at J. J. Strossmayer University in Osijek (assistant professors, associate professors and professors with tenure) who deal with various branches of biology and whose scientific work is not related to educational sciences participated in this study. After the initial implementation and self-reflection, there was a discussion between the expert and the teachers. The teachers indicated throughout the conversation that they required assistance with the didactic-methodological planning of the lessons. For this reason, before the second implementation, they consulted an expert who provided coaching on planning the lesson unit curriculum. They created a new action plan (lesson plan) based on the reflections of the first implementation. In the second implementation, teachers again conducted self-reflection following the same pattern but the teaching was evaluated by students and an expert observer who led the workshops and coached teachers. After the lesson plan, each observed teacher noted his or her progress compared to

the first implementation. The expert (observer) and the observed teacher were identified through discussion. Student reflections also helped in this process. The observed teachers still expressed the need for support in the didactic planning of the lesson plan and the cycle was repeated. Thus, a new improvement plan was created followed by the third implementation and self-reflection. The progress in each teaching feature is shown in Table 2. If a particular feature was present in all teachers, a plus sign (+) was assigned, and if a particular feature was absent in half or all teachers, a minus sign (-) was assigned.

2.2. Workshops: Outcomes, Topics and Description

The workshop outcomes and topics presented in Table 1 were defined through the analysis of the survey. Specific strategies, methods and techniques of learning, teaching and self- assessment were defined based on the analysis of the mentioned learning, teaching and assessment activities in the course-level curriculum of the teachers who participated in the research.

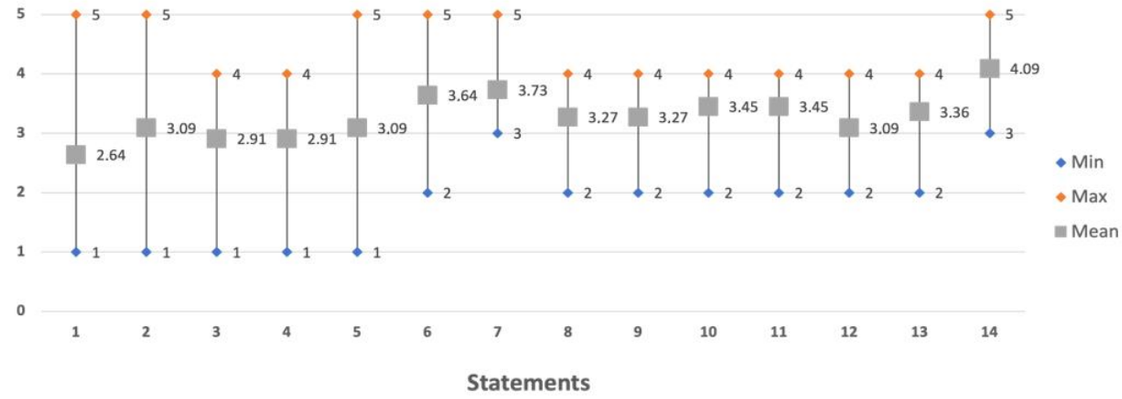
Table 1. Curriculum learning or teaching and evaluation activities at the course level and workshop outcomes and topics.

The most frequent learning and teaching activities listed in the curriculum at the course level	**The most frequent evaluation activities in the curriculum at the course level**	**Workshop topics**	**Workshop outcomes**
A guided discussion with the critical interpretation of scientific papers and case study analyses, independent laboratory work, section, identification, the analysis of results or experimental data, independent performance of experiments and field classes.	Monitoring work during learning or teaching activities and providing feedback. oral exam, written exam essay seminar paper.	W1. Coherent and congruent planning and design of curriculum.	1.1. Review the curriculum compliance of teaching units with the curriculum at the level of the course and study program. 1.2. Analyse the documents on which the creation of curriculum at the level of study programs, courses, and individual classes is based.
		W2. Creating a learning environment using the flipped classroom and collaborative learning.	2.1. Create an environment to successfully achieve results by using various strategies and methods of learning or teaching in a flipped classroom through collaborative learning. 2.2. Design lessons in which learning occurs through problem-solving. 2.3. To raise awareness of the need for self-reflective practice to guide one's professional development of pedagogical competencies.
		W3. Creating a learning environment using inquiry and collaborative learning.	3.1. Select inquiry-learning as a method for students' science education, developing skills and habits of self-regulated learning, 3.2. Support the development of critical and creative thinking.
		W4. Creating a learning environment through assessment.	4.1. Align course outcomes with content, learning or teaching activities, assessment of student process and learning, and student workload. 4.2. To support self-regulated learning and teaching by applying self-assessment during the learning orteaching process.

In every workshop, instructors gained knowledge in two different ways: first, as students and second as teachers who create the lesson-level curriculum. The first workshop allowed for self-reflection on coherent and congruent curriculum writing at all three levels. The other two workshops enabled teachers to acquire knowledge and skills in flipped classrooms, inquiry and collaborative learning. These teaching strategies and methods were selected based on insights into the learning or teaching activities that teachers had planned in their syllabus for each course level. The last workshop completed teachers' knowledge of implementing assessment which is an indispensable component when it comes to creating a learning environment. In this workshop, teachers learned about formative assessment. They learned about the importance of assessment criteria, their creation and the use of instructional strategies such as concept maps. They also learned about formative and summative evaluations. Teachers were shown how formative assessment can and should be used not only to modify and improve their teaching process but also to guide and monitor their professional development.

3. Results

According to the survey's analysis, most of the competencies for fostering a learning environment were regarded by instructors as in need of improvement (see Figure 2).



Statement list
1. I apply the principle of constructive alignment in my classes.
2. I am familiar with a lot of different teaching/learning strategies and methods.
3. I am familiar with numerous different ways of assessment.
4. I choose teaching and assessment strategies and methods depending on the learning outcome.
5. I recognize my understanding of learning and apply it in my teaching.
6. I can create a stimulating learning environment that supports learning.
7. I use information and communication technology (ICT) in my classes.
8. I know how to give individual feedback to students about their learning process.
9. I can guide students in taking responsibility for their learning.
10. As a teacher, I recognize my strengths.
11. As a teacher, I recognize my developmental needs.
12. I regularly self-reflect on my teaching.
13. I collect and know how to use feedback from students to modify future teaching.
14. I can use my experiences (e.g., my scientific field) in my teaching.

Figure 2. The distribution of respondents' answers to each statement corresponds to the subjective assessment of competency in creating a learning environment. The assessment was made on a scale from 1 to 5. 1 competency is not recognized, 2 insufficient competency, 3 competency in development, 4 well-developed competency and 5 excellent competencies.

The ability to use information and communication technologies and the ability to create a compelling learning environment are both considered well-developed competencies. Teachers also state that they are competent and that they can use their experiences in their scientific field in their teaching (see Figure 2). They also highlight the need for teachers to support them in teaching students how to be guided in their learning process and encouraged to be self-directed learners by teaching them learning strategies and methods that correspond to curriculum objectives at the course level. These strategies and methods are especially appropriate for formative assessments. Assessment is indispensable in the learning process. However, it is also evident that they need support and encouragement to guide their professional development and to use assessment for learning to change and improve their teaching practice.

After the first class, teachers started self-reflection according to the modified OZON form. The aspects they rated as those that did not improve and as those for which they needed expert coaching in didactic-methodological design are shaded and italicized in Table 2. Although teachers assessed their lessons as interactive, students did not ask questions which indicates that only teachers asked questions that did not elicit thinking at a higher cognitive level. All the features indicate that the use of formative assessment in the "assessment as learning" approach is marked as needing improvement (*the teacher asks students to evaluate their own work and progress; the teacher asks for a self-assessment of the results achieved after the lesson*). According to the teachers' self-assessment, the features that assess the "assessment for learning" approach also need improvement (*the teacher provides students with specific feedback on their work; the teacher highlights students' progress and learning (rather than their shortcomings); the teacher has prepared questions or tasks that test achievement of the outcomes*). Learning outcomes were presented to students at the beginning of the lesson. The presentation of this feature indicates that participation in the workshops introduced some changes but did not significantly affect the usual teaching practice.

Most of the workshop topics were new to the instructors before the first implementation. They faced difficulties in implementing what they had learned. They foresee potential challenges in terms of student reactions, expecting that students might lack motivation to engage in tasks that demand high cognitive activity and cooperation. Additionally, some students may view certain techniques, like concept maps, as unsuitable for their learning. Interestingly, the difficulties in designing the learning environment were not predicted before the initial implementation.

They received support in the form of coaching followed by a second implementation. The impact of the coaching on creating a learning environment is shown in Table 2 indicating that some teaching features improved while others remained unchanged. Coaching did not increase learning in the area of formative assessment. All observations are not related to assessment improvement except for the one in which the teacher highlights student progress and learning. The agreement between the self-assessment and the assessment of the observers is presented in Table 2. The only discrepancy is seen in the assessment of interactivity. The observed teachers provided many questions and answers during the lessons and the observer assessed this feature as unsatisfactory since the questions were mostly asked by

the teachers. The agreement in assessment between the observed teachers and the observers indicates awareness about what the features mean and how their presence is measured. The discussion with teachers after the second implementation indicated that they still needed support to improve the observed features. All features that improved after the second implementation remained unchanged after the third implementation. Some features were improved compared to the second implementation (see Table 2). These include the sharing of different targeted activities that achieve learning outcomes and the active involvement of students in the lessons. Progress has also been made in assessment and learning. Teachers have also prepared questions to assess the achievement of learning outcomes at the end of the lesson. They have not improved on giving students specific feedback on their work and adapting lessons to an individualized and differentiated approach.

4. Discussion

The results of the study show that biology teachers in higher education need support in the didactic design of their teaching. The teachers in this study underwent workshops to gain pedagogical knowledge for creating a learning environment. They then applied what they learned in teaching practice and conducted action research to identify areas for improvement. Additionally, they received expert coaching. As a result, they experienced positive changes in their teaching.

In our study, we used a combination of workshops and coaching using action research. Thurlings and den Brok (2017) define it as "collegial teaching" where an experienced person supports another person in their development with feedback. After participating in the workshops, teachers implemented what they had learned in their teaching practice. This implementation allowed teachers to identify their new and more specific improvement needs. The workshops themselves did not generate the desired changes. Positive improvements started to take place after the first coaching session, first in a few teaching areas before spreading to additional teaching areas and evaluation following the second coaching session.

Bates and Morgan (2018) in their discussion and review of the Effective Teacher Professional Development Report (Darling-Hammond, Hyler, & Gardner, 2017) highlight several features of professional development that have led to positive changes in teaching and student learning outcomes. The first feature is the focus on content. According to Darling-Hammond et al. (2017), content focus in professional development refers to certain areas of learning such as mathematics, science, and literacy. It aims to increase teachers' knowledge of content. According to Boston and Smith (2009), teachers need expert knowledge based on a deep understanding of how students learn a particular subject matter that will allow them to generate effective responses to students' thinking in the moment of teaching. Guskey and Yoon (2009) found that student achievement is preceded by teachers' professional development. In our study, biology teachers needed knowledge about the content. Darling-Hammond et al. (2017) highlighted active learning in their research. According to them, active learning implies the use of authentic examples, interactive strategies and the application of what has been learned in teaching to achieve essential changes. The authors describe active learning as an "umbrella" element that often incorporates the elements of collaboration, coaching, feedback, reflection and the use of models and modelling. This description of active learning is also consistent with applied action research. Nugent et al. (2016) describe one approach to incorporating coaching and experts in professional development. Teachers could improve their subsequent lectures with the support of coaches, which significantly improved their self-confidence. The results confirm the importance of incorporating coaching and other features of professional development, especially feedback as has been documented in other research (Kretlow, Cooke, & Wood, 2012; Matsumura, Garnier, & Spybrook, 2012). According to Darling-Hammond et al. (2017), feedback and reflection are critical components of adult learning theory. It is difficult to determine exactly how long quality professional development takes because the extended duration of an intervention that does not contribute to the quality of student learning could have the opposite effect. Kennedy (2016) found no association, in contrast to Desimone (2009) who discovered that professional development is most successful when it lasts at least 20 hours.

Table 2. Representation of teaching features that create a learning environment and changes in the representation with coaching as didactic-methodological support and regarding the development plan for curriculum design at the lesson level.

Observed key teaching features	**2nd implementation: the effect of the 1st coaching and the development plan**			**Change/progress regarding the 1st implementation**	**3rd implementation : the effect of the 2nd coaching and the development plan**			**Change/progress regarding the 2nd implementation**
	Students	**Observed teachers**	**Observer**		**Students**	**Observed teachers**	**Observer**	
The teacher clearly states the objectives of the lesson.	+	+	+	↔	+	+	+	↔
During the class, different purposeful activities of the students are alternated.	-	-	-	↙	+	+	+	↗
The teacher instructs the students to single out key concepts, main ideas or the main content needed to achieve the results by highlighting concepts or making simple representations.	+	+	+	↗	+	+	+	↔
Teaching is interactive.	+	+	+/-	↔	+	+	+	↗
Students are actively involved in the lesson.	+	+	+	↗	+	+	+	↔
Students cooperate.	+	+	+	↔	+	+	+	↔
Students participate with interest.	+	+	+	↗	+	+	+	↔
Students freely express their ideas and ask questions.	+	+	+	↗	+	+	+	↔
The teacher encourages students to present their examples.	-	-	-	↙	+	+	+	↗
The teacher assigns tasks of varying difficulty to students of different abilities or interests.	-	-	-	↙	-	-	-	↙
The teacher enables students to choose activities and ways of working.	-	-	-	↙	-	-	-	↙
The teacher asks thought-provoking questions.	+	-	-	↙	+	+	+	↗
The teacher encourages the students to express knowledge through words.	+	+	+	↔	+	+	+	↔
The teacher asks the students to assess their own work and progress.	-	-	-	↙	+	+	+	↗
The teacher provides specific feedback to the students.	+	-	-	↙	-	-	-	↙
The teacher highlights the progress of the students and their success in learning.	+	+	+	↗	+	+	+	↔
The teacher has prepared questions or tasks to check the achievement of the outcomes.	-	-	-	↙	+	+	+	↗
The teacher encourages self-assessment of the achievement of the outcomes after the lesson.	-	-	-	↙	+	+	+	↗

The constructive alignment model is one aspect to which teachers should pay attention in their professional development (Wang, Su, Cheung, Wong, & Kwong, 2013) and requires institutional support (Biggs, 2014). In order to use this model effectively, we advised teachers to significantly alter their usual methods of instruction and evaluation. Therefore, we used various strategies during their professional learning. Professional learning about constructive alignment was approached with the fundamental idea of the inseparability of evaluation, teaching, and the teacher-student partnership. Our professional learning was designed to motivate teachers to improve new principles, thereby developing their professional and pedagogical knowledge, their teaching and student learning, rather than a person who sees teaching as merely implementing constructive alignment Magnússon and Rytzler (2019). Reflection on oneself, one's teaching and student learning is a metacognitive dimension of pedagogical knowledge (Simper, 2020). In this research, we have focused on formative assessment in its two approaches: assessment for learning and assessment as learning (self-evaluation). By encouraging students to self-evaluate, their self-regulated learning is fostered (Croy, 2018).After the initial introduction, teachers identified areas of both evaluation methods that needed improvement and required professional coaching. They are supported in their assessment by Vingsle (2015) who notes that formative evaluation is a complicated process that is challenging to implement into teaching practise and needs psychological and practical assistance (Yan et al., 2021). The extended time and expert support in planning the assessment and designing the lessons provided changes in teachers' pedagogical knowledge which manifested as changes in the observed lessons. We also noticed characteristics related to the individualization and differentiation of instruction in conjunction with the assessment and fostering of the partnership relationship between teacher and student in the context of building a learning environment. In this context, we looked at how much the instructor varied the assignments' complexity depending on the students' interests or skills. This may suggest that teachers do not approach formative assessment in a way that identifies the individual needs of students in the learning process but rather rely on internal feedback. Teachers' focus on their own needs rather than the needs of students is explained by the complexity of formative assessment. Teachers used it to guide their professional learning in addition to incorporating it into lesson planning. It is also possible that teachers will initially need to gain confidence in teaching designs that alternate between goal-oriented and outcome-oriented learning or teaching and assessment strategies.

5. Conclusion and Limitations

Creating a learning environment through constructive alignment is a challenge for instructors especially those who are disconnected from the educational sciences due to their academic jobs. The modification of various professional learning strategies used in our research can be used to create a professional development environment for biology teachers in higher education.

Our research suggests that workshops combining extended professional learning time to identify improvements and new needs through action research as an active approach to managing professional development produce positive changes in creating a constructively aligned learning environment in the classroom.

There are certain limitations to our research which also represent guidelines for future research Effective professional development and the identification of the more challenging aspects of creating a learning environment need more attention and support. Another limitation is that only teachers whose academic work involves biology were included in our study. It would be more comprehensive if the research also included instructors from other scientific fields. Assessing students' knowledge before and after their instructors' professional development is lacking which would satisfy the continuous need for empirical data proving which professional development strategy improves students' knowledge.

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