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Implementing the Learning Assistant Model in European Higher Education

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Abstract

The Learning Assistant (LA) Model is a widely used and researched model for institutional and course transformation towards research-based instructional strategies. The LA model leverages learning assistants, pedagogically trained students, to facilitate student learning in active learning environments. However, although the LA model has shown significant results when implemented in university contexts in the United States, there has as yet been little documentation of similar implementation or results in European higher education. In this study, we present the results of a three-semester design-based research project to implement the LA Model in a Scandinavian physics department. The three core elements of the LA model (pedagogical training, course content meetings, and teaching in active learning environments) were implemented and iteratively refined, with necessary adjustments due to the specific institutional and cultural contexts documented. Throughout all three semesters, data was collected on how participation in the LA model affected LAs' buy-in to research-based instructional strategies using focus groups, pre/post surveys, and teaching observations. A thematic analysis of these data showed that participation in the LA model helped ensure LA buy-in to both the interactive engagement methods and goal of cultivating conceptual understanding that underlie most research-based instructional strategies, and that the combination of teaching practice and pedagogical training seminars were key to this buy-in. We argue that these results demonstrate the potential usefulness of the LA model for creating institutional and cultural change in European higher education.

1. Introduction

Research has shown that active learning methods—also known as interactive engagement methods—produce superior learning outcomes to traditional, transmissive teaching methods (Crouch & Mazur, 2001; Deslauriers et al., 2011, 2019; Meltzer & Thornton, 2012; Theobald et al., 2020). These methods, which are part of a more comprehensive set of pedagogical practices known as Research-Based instructional Strategies (RBIS), are consistently cited as key to improving STEM higher education (American Association For The Advancement of Science, 2009; Association of American Universities, 2017; Norwegian Ministry of Education and Research, 2017; Olson & Riordan, 2012). However, research has also shown that institutions are slow to shift, especially when they have little history of implementing active learning pedagogy (Henderson et al., 2011, 2012; Henderson & Dancy, 2007; Stains et al., 2018). Over the last several decades, several models of institutional change have been developed (Corbo et al., 2016; Dancy et al., 2019; Foote et al., 2016; Henderson et al., 2011; Quan et al., 2019; Reinholz et al., 2019). Among these, the Learning Assistant (LA) Model, developed by the University of Colorado, Boulder, has been especially successful in transforming undergraduate physics instruction (Barrasso & Spilios, 2021; Otero et al., 2006, 2010; University of Colorado at Boulder LA Program, 2016). The LA model uses pedagogically-trained undergraduate students, known as learning assistants (LAs), as its agents of change. When the model is implemented into existing courses, academic teaching staff are implicitly encouraged to modify their instruction towards interactive, discussion-based models that can be facilitated by LAs.

The LA model has been used widely in the US, and its effects are well documented in this setting (Barrasso & Spilios, 2021). However, outside of US settings the LA model has seen little documentation. This is a significant gap in the literature, as even within the United States different universities use varying course structures, educational models, and educational philosophies—differences which will necessarily lead to varied implementations of the LA model. Outside of the United States, universities have an even greater range of educational traditions, student demographics, and desired learning outcomes. Thus, a thorough description of an implementation of the LA model outside of the US can inform other universities on how to successfully implement the LA model.

Additionally, there is a significant need for studies of what factors contribute to the success (or lack thereof) of different implementations of the LA model. Although one of the four primary goals of the LA model is institutional change (Otero et al., 2010; University of Colorado at Boulder LA Program, 2016), there is relatively little research on the mechanisms by which it achieves this goal. This makes it difficult to understand how to develop or implement new LA programs for the explicit purpose of institutional change.

The contribution of the present paper is two-fold: first, we present a study of a novel implementation of the LA program in a non-US context. Over the course of three semesters, a new LA program was built and refined at the University of Oslo (UiO), a major research university in Norway. Second, the present article also aims to contribute to the literature by looking more closely at one of the central "mechanisms" in the LA model, namely the LAs' reception and interpretation of the central ideas underpinning the model. We do this by explicating the views on teaching and learning that are implied in the model and by studying the LAs' "buy-in" to these—that is, the ways in which they embrace, and aim to put into practice, the central ideas underpinning the LA model.

The study was conducted using a design based research (DBR) approach. Design based research is a paradigm that focuses on simultaneously developing new educational interventions *in situ* and explicating new theoretical dimensions of learning (Cobb et al., 2003; The Design-Based Research Collective, 2003). This makes it well-suited for the goals of the present study, which aimed to simultaneously build a functioning LA model (the intervention) and explore how it affected the learning assistants' buy-in to active learning pedagogy and methods. Accordingly, our research questions for this study were as follows:

1. What adaptations were needed when implementing the US-developed LA-model to a Scandinavian institution for higher education?
2. How did this implementation affect LAs' buy-in to different aspects of the LA model?

In line with the DBR tradition we present our study as follows: first we describe the local context where the LA program was implemented, the theoretical frameworks that we use as a foundation for our study, and the process of iterative data collection and development used in the DBR work; next, we present our results in two sections, corresponding to the design aspects and the theoretical aspects of the developed educational intervention; finally we discuss the implications for future adoption and use of the LA model.

2. Context and background

In this section we describe the core elements of the LA model, the institutional context at the University of Oslo, and the first implementation of the LA program at the University of Oslo physics department.

2.1 The LA Model

Figure 1: Core components of the LA Model

The LA model consists of three main components, which act as key features of the LA experience:

1. **Practice:** LAs facilitate student learning in active learning environments, for example by assisting students in group discussions and problem-solving sessions
2. **Pedagogy:** LAs attend weekly pedagogy seminars where they are introduced to research based teaching strategies in line with interactive engagement methods
3. **Content:** LAs participate in weekly content preparation meetings with the rest of their teaching team in which they plan discuss teaching challenges, course content, and upcoming activities

These three "pillars" of the LA model are depicted in Figure 1.

Researchers have shown that courses using LAs provide increased learning gains, for example on concept inventories (Otero et al., 2006, 2010; Talbot et al., 2015), and decrease rates of students dropping, withdrawing, or failing courses (Alzen et al., 2017, 2018; Van Dusen & Nissen, 2020a, 2018). LAs have also been shown to develop a stronger physics identity (Close et al., 2016) and increased interest in a teaching career (Otero et al., 2006, 2010) as a result of participation in the LA model. Professional teachers who have served as LAs have a higher probability of using research-based teaching strategies than their peers (Gray et al., 2016).

However, in addition to these specific benefits, the LA model can also serve as a method for transforming teaching in higher education from a traditional, transmissive model towards an approach that emphasizes active learning. This goal of institutional and cultural change is foundational to the LA model (Otero et al., 2010; University of Colorado at Boulder LA Program, 2016). For example, the modular nature of instruction in higher education at large institutions allows reforms to be implemented into different parts of a course independent of one another. This means that LAs can be used as a "ground zero" for reforms that would be much more difficult to implement in other parts of a course, such as small-group, interactive problem-solving or discussion sessions (Goertzen, Brewe, Kramer et al. 2011). Moreover, LAs are requires less resources to train than tenured academic staff, and can be trained with a relatively low time investment of 1-2 semesters.

2.2 Institutional and Departmental Context

The research presented in this article took place in the physics department at the University of Oslo, a large research-intensive university in Norway. The university's Faculty of Mathematics and Natural Sciences was, at the time of study, focusing heavily on developing and improving teaching and learning. This happened by, among other things, revising all bachelor level education programmes (Mørken et al., 2015); implementing computational approaches in all undergraduate science and mathematics departments (Malthe-Sørenssen et al., 2015); and arranging biannual teaching seminars for members of academic staff and teaching assistants (TAs).

Teaching Assistants (TAs) at UiO include bachelor, master, or PhD students; PhD-level TAs often contribute in the grading of midterm and final exams, otherwise there is little distinction in their teaching duties. A standard teaching contract involves 1-2 two-hour recitation session(s) per week, plus preparatory time, and grading. In a TA-led recitation session, TAs are typically expected to answer questions the students might have regarding the coursework. Additionally, TAs are responsible for grading homework problem sets.

Physics teaching at UiO has, historically, been predominantly traditional, often consisting of 1-2 weekly lectures paired with optional TA-led recitation sessions where students could receive homework help. However, a project was initiated in 2018 to

implement the LA model within this existing course structure and thereby increase uptake of active-learning pedagogy.

2.3 Oslo LA program: Initial implementation

The University of Oslo LA program was built on the existing physics course structure and departmental practices at the UiO, in concert with the existing resources and methods made available by the LA Alliance (University of Colorado at Boulder LA Program, 2016). In other words, for our initial implementation of the LA model we co-opted the existing structure at UiO for hiring and supporting physics TAs, adding or developing additional elements as necessary to bring it into alignment with the LA model. We began by targeting courses that already included TA-run recitation sections. Many of these courses also already held weekly course meetings between course instructor and the TAs. This allowed us to reduce the overhead in implementing the model, since (with the instructors' cooperation) we were able to make relatively minor adjustments to these courses in order to implement the LA model.

The primary adjustments were as follows: first, we required TAs in participating courses to attend a 1-semester weekly pedagogical training seminar,. Although their attendance was not tracked, TAs were incentivized with additional paid hours (for those paid on hourly contracts) for any time spent in pedagogical training. Second, we asked that instructors develop and add a small number of conceptual, discussion-based questions to any problem-sets or homework assignments used in recitation sections, if they had not already, in order to facilitate conceptual discussions. These questions were either co-opted from existing materials (e.g., McDermott et al., 2002) or developed by the instructors themselves. Third, we asked that instructors ensure that they held weekly course preparatory meetings, and further asked that those course meetings include some time for the group to discuss content-based questions the TAs might have. In this way, we were able to implement all three pillars of the LA model, thereby effectively converting our existing TAs into LAs.

This approach necessitated our first adaptation of the LA Model: whereas in the US there is a clear distinction between LAs (typically undergraduate students) and TAs (typically graduate students), in our context we made no distinction between bachelors, masters, or PhD students, asking them all to take part in all three aspects of the LA model. Thus, in this paper, we use the term LA broadly, to refer to students at any academic level who fulfill the three primary criteria of the LA model: pedagogical training, active learning practice, and attendance of weekly course meetings. . We return to the implications of this choice in section 5, Results and Discussion.

The development of the University of Oslo LA program unfolded iteratively, over the course of three semesters, all of which took place prior to the COVID 19 pandemic. The trial phase took place during the fall semester of 2018, and began with two courses, a first-semester numerical modeling course in the department of mathematics and a third-semester electricity and magnetism course in the department of physics. The second phase took place during the following spring, and incorporated three physics courses: mechanics, waves & oscillations, and quantum mechanics. The third phase took place during the fall of 2019, and included the same two courses as the previous fall, with the addition of the 5th-semester thermodynamics course from the department of physics. During each of the phases, in accordance with the principles of the Design-Based Research methodology, we collected several forms of data, maintained notes on implementation, and made adjustments to our initial design in response to the challenges we encountered and the feedback we collected. We describe these challenges, adjustments, and our final design in Section 5: Results.

3. Theoretical Frameworks: LA Buy-In to Active Learning

Although it sometimes goes unstated, a key goal (and assumption) of the LA model is that learning assistants buy into the key principles of the research-based instructional strategies

that underlie the model. These principles, briefly summed up based on the Learning Assistant Implementation Guide (University of Colorado at Boulder LA Program, 2016), include:

- Giving students opportunities to articulate and defend their ideas and interact with one another through inquiry-oriented, student-active instruction
- Using student discussion about conceptual problems as an activity for learning
- Providing LAs with an active role in facilitating small-group interaction
- Providing learning opportunities for both students and the learning assistants themselves
- Facilitating reflection and experience-sharing around teaching and learning
- Provide a motivating, inclusive, and supportive learning environment

These principles are also in line with the wider research base supporting active learning methods in physics (Fraser et al., 2014; Meltzer & Thornton, 2012).

It seems fair to assume that if LAs do not buy in to these principles—that is, if they do not see the purpose of active learning—they are less likely to use the pedagogical techniques they learn in an effective or authentic way. For this reason, it is important to attend to this factor when adapting and evaluating LA programs. Thus, our conceptual framework for this study is based on the established body of research on TA buy-in. Although this body of work primarily focuses on graduate teaching assistants, in our context there is sufficient overlap between learning assistants and teaching assistants that we see no need to make a theoretical distinction between the two.

Within this body of research, the term *buy-in* is generally defined as "the alignment of the TA's stated set of beliefs about how physics should be taught compared to the beliefs of the curriculum developers/course designers" (Goertzen, Scherr, Elby 2009). There are several theoretical dimensions to this construct: for example, one key distinction made by the literature is the difference between belief-level buy-in (stated views and beliefs about teaching and learning) versus practice-level buy-in (the degree to which one actually implements pedagogical ideas or techniques). These two aspects do not necessarily correlate — that is, in some cases TAs may exhibit high degrees of belief-level buy-in, but low degrees of practice-level buy-in (Goertzen, Scherr, Elby 2009; Spike & Finkelstein 2016; Wilcox, Yang, Chini, 2016). Theoretically, it has been argued that belief-level buy-in is necessary, but not sufficient, for TAs to employ active learning methods in their teaching (Goertzen et al., 2009; Wilcox et al., 2016). However, certain factors can contribute to both belief-level and practice-level buy in. These include prior educational experience, course design, and institutional environment (Spike and Finkelstein, 2016; Wilcox, Yang and Chini, 2016). That is, the context within which LAs are teaching and learning has a significant impact on the degree to which they take up the mindsets and practices promoted by the LA model.

4 Methods

4.1 Design-Based Research

The Oslo LA program was iteratively developed using a Design-Based Research approach (Anderson & Shattuck, 2012), which aims to bridge the gap between educational research and practice. According to Sandoval and Bell (2004), DBR "simultaneously pursues the goals of developing effective learning environments and using such environments as natural laboratories to study learning and teaching" (p. 200). Thus, in the Oslo LA implementation, we have collected data and experiences allowing us to 1) iteratively improve and develop the form and content of the LA model with particular emphasis on the pedagogy course, and 2) arrive at research results concerning LAs' buy-in to the model.

DBR additionally relies on repeated rounds of implementation and data collection. The present article presents results from 3 iterations of the LA program at UiO. For each iteration, the first author, being in charge of the training course, gathered experiences through interaction with participants throughout the semester. In addition, questionnaire and focus group data were collected (see "Data collection"). These data sets allowed us, in line with the recommendations of Collins et. al. (2004), to modify the design, characterize the critical elements of the implementation, and articulate and justify these modifications. The data also allowed us to characterize the setting and the group of learners in the LA-Oslo program and to draw conclusions concerning their 'belief level buy-in' to the LA model and their learning and development.

4.2 Data collection and analysis

We focused our efforts in collecting data on how the LAs' views on teaching and learning were affected by experiencing the LA model. We measured these effects in several ways, including pre/post surveys, end-of-semester focus group interviews, and observations (both informal and structured) of the LAs' teaching during the 2nd and 3rd iterations. We describe each of these measures in greater detail below:

1. **Focus-group Interviews:**

In order to investigate the LAs' experience with the program, LAs were invited to take part in semi-structured focus group interviews at the end of each semester, incentivized with pizza. A total of 25 LAs participated across the three semesters (see table 2 for details), separated into different focus groups based on the course they were teaching. Interviews were conducted in Norwegian by one of the authors, recorded (with the consent of participants), transcribed, and anonymized by deleting all names and personally identifying details. All groups had the same interview guide. The Interview guide was centered on the LA's perception of their role as LAs, the weekly pedagogy seminar, and interest in a teaching career. These interviews were our primary source of data for both our research goals and to collect the feedback necessary to refine the LA program in subsequent iterations.

Semester	Focus group number	Course	No. Participating LAs
F18	1	Numerical modeling	5
	2	Electromagnetism	3
S19	3	Mechanics	3
	4	Oscillations and waves	3
	5	Quantum physics	6
F19	6	Thermodynamics	2
		Electromagnetism	3
Total			*25*

Table 1: Summary of focus group interview participants

2. **Pre/post surveys:**

In addition to focus group interviews, we administered a survey at the beginning and end of the semester. The surveys contained a mix of closed Likert-scale items and open-ended questions about the LAs' role as teachers in the recitation sessions. In the end of semester survey the LAs were also asked to provide feedback on the pedagogy seminar and weekly course meetings. These pre/post surveys provided a secondary, individual, form of data for use in assessing the effects of the LA program and refining it over subsequent semesters. Although the survey was administered to all LAs as a part of the pedagogy course, a total of 31 LAs provided consent for their surveys to be used in the study, 24 of which filled out both the pre and post survey.

3. Teaching observations:

During the 2nd and 3rd iteration of the design, research assistants conducted teaching observations on consenting LAs using the Real-time Instructor Observation Tool (RIOT) (Paul & West, 2018; West et al., 2013), a tool specifically developed for conducting quantitative observations of teacher behavior in active learning environments. The RIOT includes numerous categories covering different patterns of teacher behavior, such as "listening to question", "open-ended dialogue", "closed dialogue", "clarifying instructions" and "explaining content". It also provides a web-based interface in which observers can press buttons corresponding to the different behaviors and groups, and thereby produce a quantitative map of instructor behaviors over time.

These observations allowed us to qualitatively and quantitatively gauge the degree to which LAs were taking up the practices and ideas discussed in the training seminars, which we interpret as reflections of their practice-level buy-in (Wilcox et al., 2016). 14 such observations were conducted on 13 LAs (10 in Spring of 2019 and 4 in Fall of 2019). One LA was observed twice; however, the first observation was used for calibration of the RIOT protocol and so was dropped from the final analysis.

After data collection was complete, the results were collated and analyzed using a thematic analysis methodology (Braun & Clarke, 2006). The bulk of the analysis concentrated on the focus group interviews, which were repeatedly coded by the second and third authors using Atlas.ti software. These codes were then organized into themes, illustrated by data excerpts from the transcribed interviews, which were discussed in joint research-group meetings and refined over several rounds. After the initial thematic analysis was completed, these themes were triangulated with the other sources of data to clarify or contest the emerging themes. For the pre/post survey results, this involved reviewing the open-ended responses using the categories that emerged from the interview analysis and using the longitudinal nature of this data, as well as the questions explicitly addressing the usefulness of the pedagogy and course meetings, to further understand the emerging themes. Due to the limited response rate, quantitative results were not included in the analysis. For the observations, we chose to combine the sub-categories of the RIOT protocol into two super-categories: *student-active modes of learning*, encompassing LA behaviors facilitating student activities (listening to questions, closed dialogue, open-ended dialogue, student presentations, and students talking serially) and *student passive modes of learning*, encompassing LA behaviors requiring students to be passive participants (clarifying instructions, explaining content). This choice was partially based on the difficulty of making fine-grained distinctions between certain categories during observations (for example, closed dialogue vs. open-ended dialogue) and partially based on the supporting nature of the teaching observations to our analysis.

Additionally, implementation notes, kept by the first author throughout the three semesters, were used to reconstruct the decisions made throughout the process of initial implementation of the LA model. These were compared to more standard implementations reported in the literature (Otero et al., 2006, 2010; University of Colorado at Boulder LA Program, 2016) to look for points of discontinuity, which in turn were used to compile a list of

adaptations and modifications made in order to implement the LA model in a European higher education context.

5. Results

In this section, we present the results of our iterative study. Since this was a design-based research project, we present these results in two parts. First, we present the final iteration of our design, including the choices made along the way and their justifications. We also discuss the ways in which this design does and does not align with the more standard US implementations of the LA model (Otero et al., 2006, 2010; University of Colorado at Boulder LA Program, 2016). This addresses our first research question, *what adaptations are needed when implementing the US-developed LA-model to a Scandinavian institution for higher education?* We then present the theoretical side of our analysis, which focuses on our LAs' belief-level buy-in to the views of teaching and learning underpinning the LA model. This helps address our second research question, *How did this implementation affect LAs' buy-in to different aspects of the LA model?*

5.1 Results Part 1: Adapting the LA model to a Scandinavian context

Our final design is shown in Figure 2. As shown, it incorporates the key structure of Practice, Pedagogy, and Content from Figure 1. However, all three of these components have been adapted from their original implementations (University of Colorado at Boulder LA Program, 2016). We would also like to stress that this design was iterative, in that all components were continually modified over time as prescribed by the DBR method (see the methods section), and all data sources contributed to these design choices and modifications.

Figure 2: Implementation of the LA model at the University of Oslo.

5.1.1. Pedagogy component

For the *pedagogy component*, we designed a pedagogical training seminar that ran for 1 hour every week throughout the semester, which was initially based on the example lesson plans from the University of Colorado (Learning Assistant Alliance, n.d.). Instructors strongly encouraged LAs to participate in the seminars and occasionally dropped by the seminars themselves to provide additional oversight and engagement. By the end of the third iteration, each lesson began with a de-brief period, in which LAs would discuss the previous week's teaching with their peers, and each ended with the assignment to "choose a new 'teacher move' to try out during your next teaching session." The learning goals for the seminar followed a defined trajectory, with the first few lessons aiming to "onboard" LAs into the desired behaviors and approaches to teaching and learning that were specifically-geared towards active learning environments using video case studies from the Periscope video collection (Scherr & Goertzen, 2018). In subsequent lessons LAs engaged with topics such as conceptual/procedural knowledge, backward design, sensemaking/answer-making, and the effects of stereotype threat on classroom practice. The seminar also included two "journal clubs", during which the LAs read and discussed short research articles, and a peer observation. Our final pedagogical training syllabus and one example session is shown in Appendix A and B, respecitvely.

Adaptations: One primary adaptation here was in the incentivization structure for participation. In other models reported in the literature (Otero et al., 2006) LA training is mandatory and LAs are required to take a for-credit seminar, including homework and projects. However, at the UiO most science and mathematics students have relatively strict

requirements as to which courses they take and when they are allowed to take them in their academic track. Adding additional coursework would have required a great deal of additional administration. So, we chose to incentivize participation in the LA training seminars by counting the training as an additional paid hour of work. Although this meant that the LAs faced no consequences for missing the training seminars other than the loss of a paid hour, attendance was relatively high with an average of 70-80% of LAs showing up to seminars. However, this also limited the amount of "out-of-seminar" work that could be expected of LAs. For this reason, during the two weeks when LAs were expected to read journal articles and the week when they were expected to do peer teaching observations, we chose to cancel in-person meetings.

Iterative Modifications: We made several modifications to the pedagogical training sessions across the three development iterations. For example, LAs repeatedly reported (in focus groups) that they appreciated concrete teaching strategies, since they were the most directly impactful to their teaching. In response to this feedback, we removed some learning theories and replaced them with workshops on practical skills, like giving a "micro lecture" and use of learning goals in assessment. After the first iteration, we also added a peer-observation session. Additionally, during the first semester we noticed that, although LAs had been given the assignment to try out one new "teacher move" each recitation session based on the theme from the previous week's pedagogical training, many LAs seemed to forget to do this in practice. So, in order to ensure that LAs actually tried out their chosen "teacher move" during their subsequent teaching sessions, we developed a system of memoing, in which LAs would record their chosen teacher move on two sticky notes: one which they would take with them, and the other which they would leave with the instructor. During the next session the LAs would use these notes as the basis for their de-brief discussions about their experiences teaching during the previous week. This small adjustment greatly decreased the rate of LAs forgetting to try out a new teacher move, and led to much more productive discussions.

5.1.2. Practice component

For the *practice component,* we worked with course instructors to design sets of discussion and calculation-based activities in the spirit of the tutorials designed at the University of Washington and University of Maryland (McDermott et al., 2002; Scherr & Elby, n.d.) and drawing on open-access materials posted by the University of Colorado and other universities. Since many UiO physics courses already included 2-hour recitation sections, we designed the activities to run over the course of the two full hours, generally starting with conceptual discussion questions and then moving into scaffolded, calculation-based, tutorial-style problems. For courses that already had designed such exercises, we worked with the instructors to refine them and better align them with the articulated learning goals for the courses.

Adaptations: As discussed, one primary adaptation in this component compared to the standard LA model was to include both undergraduate and graduate students as LAs. Inherent to this modification was some modification to the duties of LAs: notably, LAs generally took part in grading homework problem sets and, for graduate LAs, grading midterm- and final exams. This choice by necessity weakened the near-peer aspect touted by other LA programs that use undergraduate LAs alongside graduate TAs (Close et al., 2016; Talbot et al., 2015; University of Colorado at Boulder LA Program, 2016). However, these tradeoffs are offset by several advantages. First, as previously discussed, this choice significantly simplified the implementation by allowing us to build off of the existing course and personnel structure already present at the UiO physics department. Second, it allowed us to offer training in research-based pedagogical strategies to graduate students as well as undergraduates. From an institutional and cultural change perspective, we would argue that this model is superior since a significant amount of future faculty are likely to be drawn from

the current population of graduate learning assistants. Third, it allowed us to ensure curricular alignment—that is, it allowed us to make sure that all members of the teaching team were on the same "page" and that bachelor, master and PhD LAs had undergone similar pedagogical training. Finally, grading assignments offered LAs an opportunity to both see how their students performed on assessment tasks, giving them additional insight into student learning, and give them formative feedback.

Iterative Modifications: With regard to the practice component, one modification we made after the first semester was to hire additional staff to support the development and implementation of the problem-sets. Specifically, during the second and third iterations of our LA model we hired several pre-service physics teachers who worked with instructors to help refine the tutorials. These pre-service teachers were enrolled in a program which includes the standard undergraduate physics courses in addition to some pedagogy and practice elements. Thus, most of the hired pre-service teachers had recent experience with taking the physics courses themselves, in addition to being trained to facilitate learning. Each week, they met with an instructor and provided feedback on the wording of problems, their level of difficulty, and their alignment with the curriculum. These pre-service teachers also observed LAs, took observation notes, and provided them with feedback.

5.1.3. Content component

For the *content component,* we worked with course instructors, first to ensure that they held weekly course meetings and secondly to make sure that these meetings were focused on content as well as logistics. We attended initial course meetings to help facilitate them, and for certain targeted courses continued attending throughout the semester.

Adaptations and modifications: This component of the LA model required the least amount of adaptation from what was originally described in the literature (University of Colorado at Boulder LA Program, 2016). However, we made one small modification to the standard course-meeting implementation by leveraging the pre-service teachers we had already hired to attend the course meetings and help facilitate them. Here, the pre-service teachers were able to draw on both their own pedagogical background and the observations they had made of the LAs. As part of their problem-set development job, these pre-service teachers also compiled "user guides" for the problem-sets, which included learning goals and helpful implementation hints for the LAs. These user-guides featured prominently in course meetings, and were intended to continue to be used after the project was completed.

5.2 Results Part 2: LA belief-level buy-in to the LA model

Our thematic analysis revealed that as a result of participating in the LA model, LAs bought into research-based instructional strategies (RBIS) in several ways. More specifically,

1. LAs bought into the use of interactive engagement methods in the courses they were teaching.
2. LAs bought into the goal of helping students cultivate conceptual understanding as well as problem-solving skills.
3. Concurrent pedagogical training and practice facilitated buy-in to research-based instructional strategies

We unpack these themes and results below.

5.2.1 Theme 1: LAs bought into the use of interactive engagement methods in the courses they were teaching.

Despite having little exposure to interactive engagement methods (IEMs) as either students themselves or TAs in other courses, interviewed LAs expressed general buy-in to IEM-based pedagogy. More specifically, they expressed appreciation for the discussion-based tasks, feeling that they promoted student learning and allowed the LAs to respond to student ideas. The LAs would sometimes contrast, or compare, their view of their practice with their own prior experiences. For example, one LA explained that

> *I feel that the teaching assistant is somewhat less intimidating when you have a more—that it's expected that the teaching assistant will go around and ask "how's it going?" and follow up a bit more. But when I was a student it was usual for the teaching assistant to just sit at the front of the room. And I know, at any rate, that many of the other students almost didn't dare to ask for help because there was this kind of barrier, or… So I think that this is a very good thing.*

Here, the LA draws a contrast between the previous model of teaching, in which a TA's job was to primarily answer student questions on assignments, and the current active model of teaching in which an LA helps to facilitate student discourse. We interpret their positive evaluation of the current teaching mode as evidence of buy-in to IEMs. More specifically, the LA is expressing belief-level buy-in to the goal of responsiveness to student ideas, in which LAs actively seek out student ideas and "follow up a bit more".

LAs also noted that active student discussion and participation made it easier to understand what the students were learning and diagnose misconceptions and difficulties. For example, one LA noted

> *It is also a bit easier to catch misconceptions people have when they talk that much to each other.*

We again take these kinds of statements as evidence of buy-in to IEMs, given the centrality of active discussion and responsiveness to student ideas in these methods.

Beyond direct reflections on the pedagogy, LAs also expressed a belief that the students learned more—and learned from each other—by discussing in small groups:

> *There is always one [student] that knows more than the others, usually. So in a way, they can share knowledge and such things. In such small groups there is also maybe a little lower threshold for actually asking someone if they are unsure about things, [...] I imagine it is easier to ask others and therefore learn more, that way.*

Here, the LA points to two mechanisms for the effectiveness of IEMs: knowledge-sharing among students and a learning environment that makes it easier to ask questions. We take these as evidence for buy-in to the types of discussion-based tasks that feature prominently in most interactive learning environments.

Although LAs expressed clear buy-in to many aspects of IEMs they were also critical to certain aspects of these methods. Theoretically, we take these critiques as reservations to LA buy-in. For example, one source of reservation focused on not wanting to force certain students to participate in discussions:

> *There are some groups where there are some who are quite clever, and they usually just go through the discussion problems very quickly, and then I give them the calculation problems at once so that they—yeah—it seems like that is what they would prefer to do.*

For context, many of the recitation sessions run by LAs were structured such that students first discussed a series of conceptual questions, then solved analytical problems. This LA (as well as others in the data corpus) notes that certain students finish these discussion questions quite quickly, and thus feels hesitant about requiring them to slow down and actively discuss these questions with groupmates.

Despite these reservations and their lack of background with this type of pedagogy, LAs clearly perceived the value of interactive engagement methods, a key component of research-based instruction. Thus, we also interpret this as partial belief-level buy-in to the larger-scale goal, inherent to the LA model, of implementing research-based instructional strategies.

The LAs' buy-in to IEMs is also reflected in their post-surveys. When asked the free-response question "as an LA, what do you feel your most important role is?", LAs described their role in ways that aligned with IEM instruction, such as facilitating discussions and providing feedback. Examples of such responses included:

- *Make sure students learn as much as possible, but preferably from their own discussions.*
- *Facilitate group work*
- *Be someone they can pose "stupid" questions to. See the students. Be the part of the instruction that provides direct feedback.*

Both the pre and post surveys also included several responses in which the LAs acknowledged that part of their role was to be responsive to students' ideas, for example:

- *Listen and find out what the students are struggling with*
- *Identify the students' thought process*

Thus, these survey results provide additional evidence that LAs bought into the use of interactive engagement methods in instruction.

The results of the quantitative teaching observations complement the results from the focus groups and surveys, allowing us to gauge the degree to which LAs' practice lined up with their expressed views. Based on 13 observations of consenting LAs during the spring and fall semesters of 2019 (iterations 2 and 3, respectively), we found that the majority spent ⅔ or more of their time on student-active modes of engagement (including dialogue with students or student presentations), as shown in Table 1. Mean student engagement time was 71% (standard deviation, 14%) of the recitation session. One notable exception was an LA with pseudonym Clive, who was a professor being onboarded onto their course as a future head instructor and who did not attend the pedagogical training sessions; this LA spent approximately 50% of their session lecturing.

LA Pseudonym	Semester	Percent time in student-active modes (dialogue with students or student presentations)	Percent time in student-passive modes (lecturing, observing, instructing, logistics, other)
Kim	Spring 2019	57	43
Frank	Spring 2019	70	30
Roald	Spring 2019	77	23
Cassie	Spring 2019	85	15

Morten	Spring 2019	64	36
Clive	Spring 2019	41	59
Karl	Spring 2019	70	30
Øystein	Spring 2019	62	38
Georg	Spring 2019	74	26
Veronica	Fall 2019	95	5
Isak	Fall 2019	70	30
Alexandra	Fall 2019	89	11
Elizabeth	Fall 2019	68	32

Table 2: Percent time spent on student-active vs. student-passive modes of learning, based on observations using the Real-time Instructor Observation Tool (RIOT)

Thus, the belief-level buy-in to the use of interactive engagement methods expressed in the group interviews and surveys was corroborated by the results from the RIOT observations. These observations suggested that the LAs bought into interactive engagement methods at a practice level as well as a belief level.

5.2.2 Theme 2: LAs bought in to the goal of helping students cultivate conceptual understanding as well as problem-solving skills

In focus group interviews, LAs reported that their prior experience with learning physics came primarily through analytical problem-solving. However, after participating in the newly-implemented LA model, LAs also explicitly voiced support for tasks that were designed to help students build conceptual-understanding such as those that were developed for the revised recitation sessions:

> *When you study a subject it's both important to be able to discuss the subject. To learn the conceptual around it, which in a way are these recitation sessions that I and [LA name] have, which is more of a tutorial… guidance thing. While one must also have skills where one calculates and such. And there are of course tricks one can learn from other students, which one does in recitation sessions or on homework assignments.*

Here, the LA expresses buy-in not only for the discussion-based tasks, as discussed previously, but also for the overarching goal of helping students cultivate conceptual understanding. This goal, the LA feels, merits coverage alongside the more traditional goal of helping students acquire problem-solving skills.

Other LAs expressed similar sentiments:

> *I think they, in a way, understand more of the physics that way. In a way, before they may have, they could be better at doing integrals and those*

> *things. But now they understand, in a way, more the physics. What actually happens, I feel.*

Here, the LA draws an explicit contrast between the previous mode of instruction, which emphasized problem-solving often at the expense of conceptual understanding, and the current approach which balances the two.

Furthermore, LAs explicitly tied these reflections on different modes of instruction to differences between conceptual and procedural knowledge:

> *In terms of insight, at least, I have become very aware of conceptual vs. behavioral* [procedural] *or what it was. But anyway, that you have how some people learn based on trying to conceptualize a little, whereas others just learn by solving problems and being able to do it mathematically. I have become a bit more attentive to that.*

Here, we see the LA indicating a new, emerging awareness of different types of understanding, which they then tie to the commonly-expressed view that different students learn in different ways and that it is important to support this diversity of learning styles.

Other LAs were even more explicit on this point:

> *I think they gain a more, like, conceptual knowledge, maybe, from that discussion.*

Because conceptual and procedural knowledge was one of the weekly topics in the pedagogical training seminar, we argue that this awareness likely emerged as a result of the LA's experiences in both the pedagogy and practice components of the LA model.

Beyond the benefits to students, some LAs added that they themselves had started thinking differently as a result of their experiences facilitating these kinds of conceptual discussions:

> *Yes, I think I, at least, have to think in a different way in the group session – or at least during the discussion – than I do during the calculations, about how I explain things, because it is more about kind of the physics behind it than the mathematics. So you kind of have to actually understand what happens, so that has been quite useful.*

Here, the LA notes that these experiences had been useful for building their own understanding, since they had provided an impetus to "think in a different way" and construct explanations of the physics underlying the problems they had facilitated.

Beyond the courses they were teaching, LAs noted that they themselves now prioritized conceptual understanding in their own learning:

> *I believe I work harder now, to really get a proper understanding now than before I became an LA. Then I could get by with a half-way understanding, as long as I got [the right answers] on the exam. Now I study differently.*

However, as in the first theme, LAs also expressed some reservations to this buy-in. For instance, several LAs expressed concern that the focus on conceptual knowledge could come at the cost of students' procedural knowledge:

> *I think it varies, they probably learn concepts better. It probably weakens their calculating skills, that there are less calculation problems.*
>
> *I think it is a bit dangerous to lean over to the side where they are unable to calculate, and it seems to me as if it is leaning a bit too much in that direction now.*

These restrictions are unsurprising, given the fact that the LAs had primarily learned physics through problem-solving. Hence, LAs valued student discussion as long as it did not impinge on students' opportunities to learn problem-solving. However, several LAs also argued that building conceptual understanding could, in fact, help students to become better problem-solvers:

> *You often end up solving problems, and then you don't quite know what you're really solving. What you are finding out. So I notice, at least, that there are many who can ... those times where there have been problems to solve, there are many who can do it. But when it comes to that discussion about what it really is that you're solving and what you are actually looking at, people are more blank. And that discussion is important then.*

Here, the LA argues that the capacity to solve a physics problem does not necessarily indicate understanding of the underlying physics, and that many students develop problem-solving skills without necessarily understanding what they are doing. For this LA, the increased focus on conceptual understanding via discussion-based tasks helps address this gap in the course learning goals.

Taken together, we argue that these statements indicate that LAs bought in, at least partially, to the goal of helping students cultivate conceptual understanding. Because conceptual understanding is a key learning goal of most research-based instructional strategies (Crouch & Mazur, 2001; Meltzer & Thornton, 2012), we again take this buy-in to indicate larger-scale buy-in to research-based instruction.

We find additional evidence for this theme in the analysis of the pre/post surveys, although they also provided information on the LAs' initial levels of buy-in. For example, on the pre-survey LAs were asked "As an LA, what do you feel your most important role is?" Several LAs explicitly addressed conceptual understanding, stating:

- *Help students to develop good habits of mind and understanding in physics*
- *Help students to think through the subject, not just solve problems*
- *Help students to reach understanding/construct understandings themselves. Make sure that it isn't embarrassing to make mistakes*

This theme was also represented at the end of the semester; however, the language LAs used to express it changed. For example, in response to the same question on the post-survey, LAs stated:

- *Motivator. Facilitate sense-making. Clarify questions. Intercept and correct misconception. Create good learning atmosphere*
- *To bring out a deeper understanding of the subject and problems than students would have gotten with only lectures and calculation*

These responses, we argue, demonstrate that although LAs came in to the semester with some pre-existing buy-in to the goal of helping students cultivate conceptual understanding, their understanding of that goal became more sophisticated as a result of their participation in the pedagogical training seminars and their experiences with teaching in classrooms that explicitly prioritized conceptual understanding.

5.2.3 Theme 3: Concurrent practice and pedagogical training strengthened buy-in to research-based instructional strategies

Although some statements by LAs about their changing views on pedagogy and goals of physics instruction hinted at the effects of the pedagogical training seminars, LAs also spoke explicitly about the effects of these seminars on their views and understandings of physics

teaching and learning. For example, many LAs noted that the techniques they had learned had been directly applicable to their teaching practice:

> *And I notice that some of those techniques and that, that were discussed, I have used in group teaching here and it has worked very well, actually.*

Here, the LA is highlighting that they found the instructional strategies presented in the pedagogy seminars to be actively useful in their teaching. More specifically, LAs highlighted training in how to interact with groups of students and facilitate discussion (both physically and using questioning strategies) as being especially applicable:

> *But what I found very useful, was precisely that concerning how you approach the students and how you talk to them.*
>
> *Approaching the group and staying a bit passive too. It works very well.*
>
> *Yes, the result is completely different from just barging in and that.*

The LAs here are referring to training in strategies for facilitating student discussion, which involves listening in on students and making oneself available for questions without breaking the flow of the discussion. As shown, this specific strategy was frequently cited by LAs as one of the most useful outcomes from the pedagogical training seminars.

LAs also cited the pedagogy seminars as helping them become more reflective in their teaching:

> *I think it was very, become more aware of how you behave as a group teacher* [LA] *and that. We have had about open and closed questions and all that, but it makes you really think more about, «what am I really doing?» when I am a group teacher, «which questions should I ask?». It makes it easier to develop yourself, in a way.*

Here the LAs also report on being more self-aware of their behavior in front of students, tying this reflection to other strategies discussed in the pedagogical training seminars such as how to use open and closed questions to guide student discussion.

In addition to the pedagogical instruction, LAs highlighted the two research articles, read during the “journal club” weeks, as a useful aspect of the pedagogical training seminars:

> *... one neat thing, I think, with this approach is that we’ve been asked to read actual research papers on pedagogy and stuff. And they are quite relevant too. That legitimizes, in a way, the message we’ve been getting through the pedagogy seminars. Because, without it, it can seem a bit like, just feelings and opinions.*

Here, the LA underlines the importance of tying the strategies discussed in the pedagogical training seminars to actual educational research literature.

Taken together, we argue that these sub-themes speak to the importance of the pedagogical training seminars in facilitating buy-in to interactive engagement methods and research-based instructional strategies. Pedagogical training seminars provided an arena for development of new teaching skills, critical reflection on teaching, and engagement with educational research literature, all of which served to support the buy-in discussed above. However, key to this success was the fact that pedagogical training took place concurrent with teaching practice, affording the LAs numerous opportunities to engage in cycles of practice, reflection, and refinement of their teaching. We suspect that a pedagogical training model in which students receive all of their LA training in a single session at the beginning of the semester would produce significantly less effect.

LAs did express some critical feedback towards seminars, even after several iterative improvements. These criticisms focused primarily on content that was *not* directly applicable to their teaching practice, such as discussions of stereotype threat (Miyake et al., 2010; Spencer et al., 1999):

> *Because there is a take away now, but it is more like "ok, try to notice this" or "read this paper", "think about stereotype threat," for example. Yes, but is there anything I can do here?*
>
> *It has been a bit difficult to use sometimes. I haven't really quite known what to do with what I've learned.*

When asked for suggestions on how the pedagogical training seminars could be improved, LAs across all three semesters suggested more specific tools for teaching, and more observation and discussion. They also suggested things they would like to learn more about, for example, giving feedback in class and on written assignments:

> *... something we do is grade assignments. It would be possible to get some tips about how to grade assignments. Either like effectively or what comments to give. Or it is something we all do and that we spend a lot of time on. And that, specifically, is something I have not had any instructions on. There I just use what I have had ... been graded by others, and then I think "what do one want to hear?". But that is actually an important part. They are supposed to learn from the assignments.*

These reservations again speak to the value of tying the content of pedagogy seminars directly to the LAs' teaching practice.

Data from the pre/post surveys provides additional evidence for the key role of the pedagogical training seminars in securing LA buy-in. For example, in the post-surveys LAs were asked "Have the weekly pedagogical training seminars contributed to your development as a learning assistant? If so, how?". Several LAs explicitly stated that the pedagogy seminars helped them become more reflective and mindful around interacting with students:

- I feel I have become more aware of what I am doing, how I can do things differently, and what I am already doing well
- Yes. I have become much more aware of different sides of teaching and learning situations.
- They have provided different frameworks I can use to analyze myself when I am teaching and to analyze the students' misconceptions. Makes it easier to identify what the students need.

The LAs were also asked the question "Have the weekly course meetings contributed to your development as a learning assistant? If so, how?" The majority of the responding LAs stated that these meetings helped them in understanding the subject they were teaching, and some added that these meetings provided a forum where they could share and exchange their experiences with teaching:

- It has been interesting to hear how others are doing it. It has probably contributed to seeing that one can teach in different ways.
- Sometimes one gets tips on how other LAs are doing it, and can learn from it.
- It has helped me academically, which has made me more certain of what I am going to teach.
- They have helped me academically. Problems I did not fully understand were more clear.

Although the survey data is significantly more limited in scope and detail than the focus group data, they provide some evidence that the weekly course meetings also helped facilitate LA buy-in to RBIS by providing an arena for discussing course-specific challenges and experiences related to content and teaching practice. However, we note that responses to the question about weekly course meetings were mixed, with some LAs explicitly stating that they had not been helpful in their development as an LA.

In summary, we argue that the model of weekly pedagogical training running concurrently with teaching practice was a key factor in facilitating LA buy-in to the research-based instructional strategies discussed above. For example, training in how to facilitate student discourse provided LAs with the necessary support and preparation to effectively facilitate the discussion-based tasks discussed in theme 1. Their reflections on teaching and engagement with educational research and learning theory supported their evolving understanding of the different goals of physics education, as discussed in theme 2. Both of these aspects of the pedagogical training seminars thus supported LA buy-in to research-based instructional strategies and the goals of the LA model. However, this support was based on a structure that allowed LAs to learn new pedagogical strategies and ideas, try them out shortly after, and then reflect on the effects in both pedagogy-focused and course-focused weekly meetings. Even in cases where LAs were critical towards the more theoretical aspects of the pedagogical training seminars, we note that the language they used often included theoretical elements, suggesting that they had at least tacitly benefitted from this exposure.

6 Discussion and Conclusions

An extensive body of research literature has shown that the LA model can be an effective tool to improve physics teaching and learning in a US context (Barrasso & Spilios, 2021). Our example shows that the LA model can also be used in a Scandinavian (and by extension, European) context. However, it requires some adaptation. Thus, addressing our first research question, *what adaptations were needed when implementing the US-developed LA-model to a Scandinavian institution for higher education?,* we made several adaptations in order to implement the LA model in our institutional context. First, we implemented the weekly pedagogical training structure standard to the LA model (University of Colorado at Boulder LA Program, 2016); however, due to the rigid course requirements common to study programs in Scandinavia, we implemented pedagogical training as a paid preparation rather than a for-credit course. This meant that the amount of "out-of-seminar" work that could be expected of LAs was somewhat more limited than in the original model.

Second, we made no distinction between undergraduate and graduate students in either pedagogical training or their teaching role. Doing so involved de-prioritizing the "near-peer" aspect that others have highlighted as a strength of the LA model (Barrasso & Spilios, 2021; Close et al., 2016; Talbot et al., 2015). This also required that certain LAs retained some of the duties of graduate TAs, notably grading homework problem sets and, in some cases, midterm- and final exams, again deprioritizing the near-peer aspect of the LA role. However, we argue that this adaptation has some advantages. For starters, it allowed us to provide pedagogical training to both undergraduate and graduate students, helping to increase the overall level of buy-in to research-based instructional strategies in the department. Given the goal of introducing more RBISs into higher education (Foote et al., 2014; Henderson et al., 2011, 2012; Henderson & Dancy, 2007), it seems critically important to try to educate graduate students in modern, research-based pedagogy as early and often as possible and to thoroughly secure their buy-in to such methods. Furthermore, we suggest that only training undergraduate students in pedagogy sends unproductive messages around the value and status of such pedagogical training, and could cause problems with curricular alignment. Thus, we would argue that this approach is an improvement on the standard implementation of the LA model.

Third, we leveraged pre-service teachers to help with different aspects of the LA model, including development of activities and facilitation of course meetings. Although small, this modification suggests that pre-service science teachers may have several potential roles in the LA model, beyond simply serving as LAs themselves. Moreover, their role as facilitators in the LA model might contribute to raising the status of teaching as a profession in a physics department culture where teaching careers are often regarded as less attractive than research careers and where it is often assumed that good teaching arises unproblematically from having sufficient content knowledge (Larsson et al., 2021).

Addressing our second research question, *How did this implementation affect LAs' buy-in to different aspects of the LA model?,* we found that after participation in our LA model implementation, LAs demonstrated belief- and practice-level buy-in to use of interactive engagement methods, and belief-level buy-in the goal of cultivating conceptual understanding, both key aspects of most research-based instructional strategies in physics (Meltzer & Thornton, 2012). Furthermore, based on discussion of their prior experience with physics teaching and learning as well as how their perception and understanding of physics education had evolved over the semester, this buy-in seemed to emerge as a product of their participation in the concurrent practice and pedagogy components of the LA model. However, the LAs' buy-in was tempered by reservations related to concerns about balancing student comfort and different instructional goals. Notably, the third component of the LA model, weekly course meetings that include a discussion of content, did not significantly seem to affect LA buy-in, either positively or negatively.

Situating these results within the wider literature on Learning Assistants and TA buy-in, we argue that these results show how the LA model can be a driver of grassroots cultural and institutional change towards research-based instruction. As noted by Goertzen et al. (2011), the LA model can be implemented in many types of existing course structures, which allows reformers to circumvent instructor resistance that goes along with larger-scale course transformation. At the same time, the combination of ongoing pedagogical development, practice, and meetings with other instructional staff provide a powerful context for the kind of social and environmental contexts necessary to cultivate LA and TA buy-in to research-based instructional strategies (Goertzen et al., 2009; Spike & Finkelstein, 2016; Wilcox et al., 2016). In addition to the immediate effects on teaching practice, this approach also has the longer-term benefit of enculturating future faculty (that is, current graduate students) into student-active modes of learning and communicating the value of reflective teaching.

We note that there are significant limitations to the example we have presented here. The first major limitation is that this is a case study of LA implementation at one institution. It provides one—suggestive—data point. However, significantly more research will need to be done to see if other European (or other Non-US) institutions are able to implement the LA model in a similar way. This is an understood limitation of our chosen method, Design-Based Research, which explicitly focuses on individual contexts and learning environments. In some ways, this is an advantage, since it incorporates the details of the context in the theory and design of the intervention. However, it must be understood that the designs created using these methods are bounded by their originating contexts, and more work needs to be done to implement them in other contexts.

Additionally, we have chosen to focus our research questions and data collection on the LAs themselves. This is an appropriate first step, since they are the keystone of the LA model and if we are unable to secure their buy-in, it seems doubtful that other aspects of the LA model would function well. However, once these LA-level results are established, the important next step is to study student outcomes, as discussed elsewhere in the literature (Otero et al., 2006, 2010; Talbot et al., 2015; Van Dusen & Nissen, 2020b, 2018). Relatedly,

it is important to state that our data collection is limited to LAs who volunteered and consented to take part in focus group interviews. Our claims are thus bounded by this effect of self-selection. We feel confident that those LAs who chose to participate expressed the belief-level and practice-level buy-in discussed above. We cannot make claims about those who did not choose to participate

In conclusion, our results show a proof-of-concept that the LA model can be successfully implemented in a European context and can be used to cultivate LA buy-in to Research-Based Instructional Strategies. These results point to several natural directions for future work: first, implementing the LA model at other European universities, using a similar iterative approach and explicitly documenting their development and necessary adaptations. Second, examining the effects of these LA programs on students taking these courses, preferably using several different metrics (development of content knowledge, attitudinal shifts, etc.). Third, collecting additional data on LA buy-in at both the belief level and the practice level, across a variety of disciplines and course levels. Such studies, we hope, may add to the growing pool of research and expertise on the LA model.

Limitations

This study was conducted at one Scandinavian University with only 25 participating learning assistants. Although it is typical for the design-based research process to be confined to one or very few contexts, the research field would benefit if similar studies from European contexts were conducted and shared in the near future. It would also be helpful if our qualitative findings were complemented with quantitative measures of LA buy-in, belief-level and practice-level, in Europe.

Ethical statement

This study has been reviewed and approved by the Norwegian Center for Research Data (NSD), application #239953, and complies with all of NSD's ethical guidelines for the collection and handling of data on human subjects. All data reported here has been collected from participants who gave written, informed consent and anonymized in accordance with the NSD guidelines. The research was conducted in accordance with the principles embodied in the Declaration of Helsinki.

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