"I'm trying to demystify mathematics": Exploring the goals for teaching mathematical models and modelling in interdisciplinary education

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Mathematical models and modelling are essential tools in interdisciplinary education, particularly in fisheries biology. This study theorizes the teaching goals for mathematical modelling in a graduate biology course, focusing on how these goals unfold in an interdisciplinary discourse. The course was selected for its potential to illustrate how modelling activities unfold in graduate courses which engage with similar expert-level professional modelling practices. The data collection consists of a semi-structured interview with a fisheries biology professor, as well as written notes from the lectures. Using the commognitive perspective, the study identifies three hierarchical teaching goals: fostering familiarity with academic fisheries discourse; promoting a sense of belonging to multiple discourse communities; and supporting the engagement with technical language and professional software. The findings are discussed in light of other research about teaching practices for interdisciplinary engagement with mathematical modelling.

Keywords: Mathematical models and modelling; teaching goals; pedagogical discourse; interdisciplinary discourse.

Over the past two decades, there has been growing attention to teaching practices of interdisciplinary mathematics education[1] (e.g., Doig & Williams, 2019). This focus is especially evident in tertiary biology education where mathematical models and modelling (MM) have become an integrated part of many courses given their extensive utility in describing and providing qualitative predictions. Whilst mathematics has long been intertwined with biology education (van Hemmen, 2007), there has been a paradigm shift regarding the emphasis that biology educators place on integrating MM into their teaching practices (e.g., Jungck et al., 2020).

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Tetaj, F. (2025). "I'm trying to demystify mathematics": Exploring the goals for teaching mathematical models and modelling in interdisciplinary education. *Nordic Studies in Mathematics Education*, 30 (4), 25–32.

Despite this, there is limited understanding of educators' intentions and pedagogical strategies regarding students' engagement with MM in interdisciplinary contexts. This study addresses this gap by analyzing the perspectives of a professor who teaches a course which integrates MM into a fisheries context.

In Norway and elsewhere, most university programs offer introductory mathematics courses for biology students. However, due to poor student experience and success in these courses, there are recommendations that biology students need "a breadth of skills that go well beyond the limited set of experiences that undergraduate biologists are exposed to in their traditional courses" (Gross, 2004, p. 85). In addition, many biology students struggle to see the relevance of introductory mathematics courses, which are not deliberately designed according to their needs, but rather are aimed at undergraduate STEM or mathematics students and use content from a wide range of fields, not exclusive to biology. To address this, there have been various initiatives and interventions to design teaching materials for biology students to supplement their learning of contextual mathematics (e.g., Metz, 2008; Chiel et al., 2010; Weisstein, 2011; Poladian, 2013; Hester et al., 2014; Hoffman et al., 2016; Ludwig et al. 2017, Aikens, 2020). In doing so, MM are seen as useful tools that have the potential to bridge between mathematical and biological discourses (Lofgren, 2016). However, modelling can be a rather indirect and unfamiliar genre of scientific inquiry for biology students (Lehrer & Schauble, 2010) and, there may be difficulties incorporating the specific subject viewpoints of each discipline (Dapueto and Parenti, 1999).

Diaz Eaton and colleagues (2019) propose a framework that addresses the challenges of integrating modelling into biology education. Specifically, they investigate how disciplinary differences in the use and interpretation of models often hinders effective interdisciplinary teaching. Defining a model as a "simplified, abstract or concrete representation of relationships and/or processes in the real world, constructed for some purpose" (p. 803), they categorize model representations into experiential, numerical, symbolic, verbal and visual. According to the authors, these categories are an extension of how mathematics community conceptualizes models, thereby extending the types of modelling activities occurring in biology courses. One can engage with modelling activities by moving from observations to abstract models (by developing or revising a model), by moving from one representation of a model to another, and by comparing models to each other or validating them. Thus, in this context, a modelling activity is seen as an interactive process similar to the modelling cycle (Blum, 2015) or "a finer more granular level that considers individual tasks (models and modelling activities) that, taken together, comprise a modelling process" (Diaz Eaton et al. 2019, p. 805). Despite the epistemological differences of mathematical and biological models, these two types of activities are similar to the two primary mathematical modelling approaches, holistic and atomistic (Blomhøj & Jensen, 2007). However, the authors emphasize the need for incorporating experimental models (which are usually neglected in mathematics) when engaging with modelling due to the central role of empirical data in biology.

Various studies show how mathematical modelling serves as a tool for interdisciplinary teaching (Borromeo Ferri & Mousoulides, 2017). Nikitina (2006) offers three potential strategies for developing modelling interdisciplinary teaching: contextualizing, conceptualizing and problem-solving which all serve different teaching goals. Contextualizing happens through embedding a discipline within a cultural, historical or philosophical context to triangulate knowledge. Meanwhile, conceptualizing involves identifying important concepts that are central to two or more disciplines and establishing connections between them. Whereas problem solving strategy involves applying tools from multiple disciplines to address context specific tasks. In this study, I seek to investigate the teaching goals for MM in a graduate biology course, focusing on how interdisciplinary pedagogical discourse are structured. Documenting the teaching goals can add to the body of knowledge on the nature of the interdisciplinary discourses expected from students working with mathematical modelling activities. For this, I use commognitive perspective (Sfard, 2008) which provides an analytical lens for analyzing the teaching goals and practices in higher education (e.g., Karavi et al., 2022) and specifically, MM in interdisciplinary context (Viirman & Nardi, 2021).

Theoretical framework

According to the commognitive perspective, human activities develop and evolve through changes in discourses. Discourse is defined as a specific type of communication distinguished by the repertoire of admissible actions and how these actions are paired with re-actions. Every discourse defines its own community, and individuals capable or incapable of participating in the given discourse are called, respectively, insiders or outsiders. Discourses can be identified and distinguished by the *use of wordings*, *visual mediators*, *routines* and the set of *endorsed narratives* (Sfard, 2008). Considering these four characteristics, one can distinguish between general discourses, e.g., mathematics discourse (MD), biology discourse, or more context-specific discourses, e.g., calculus discourse, fisheries discourse (FD), etc.

Due to the complexity of natural phenomena, most real-life tasks/problems cannot be framed nor explained solely through a single discourse; therefore, a combination or layering of aspects from other discourses are required. The exchanges between discourses happen to increase effectiveness or improve the outcome of an activity. Specifically, in our case, various aspects of MD, such as mathematical formulas, methods or artefacts are interwoven with biology discourse to investigate fisheries phenomena. According to Sfard (2008), a subsumed discourse develops when two or more discourses are integrated into a new, higher-level discourse. This process can occur in two ways: either discourse A functions as a meta-discourse of discourse B (i.e., it frames or analyzes discourse B), or discourse A incorporates an isomorphic reflection of discourse B by mirroring its structures while embedding them in a new context. In fisheries stock assessment, population dynamics models (e.g., the logistic growth model or Beverton-Holt stock recruitment model) are understood as a meta-discourse of mathematical modelling because they reinterpret mathematical objects within the context of biological phenomena. These models frame elements such as differential equations, optimization routines and equilibrium points in terms of fish populations, recruitment rates and mortality. Similarly, stock assessment models (e.g., virtual population analysis,VPA) can be viewed as an isomorphic reflection of MD because they mirror its structures and the relationships while embedding them in fishery-specific narratives. For example, VPA uses recursive calculations and matrix operations to reconstruct the size of each cohort and solve systems of linear equations to estimate historical fish stock sizes and mortality rates based on observed data. This mathematical framework reflects the actual life cycles and harvest patterns of fish. Thus, in this study, FD is understood as an interdisciplinary subsumed discourse that integrates aspects of MD and BD into a unified communicative framework.

Sfard argues that subsumed discourses have the property "to express in the [a] new language almost everything that can be said in any of the original discourses with their own special signifiers" (ibid., p.122). The act of transitioning from one discourse to another, therefore, creating a subsumed discourse, comes from the need to solve tasks, the solutions of which "cannot originate in the discourse that imposes itself when those questions [tasks] are first presented" (Sfard, 2008, p. 219). In FD, the development of subsumed discourse entails layering mathematical narratives into existing biological narratives within science, thereby enriching the discourse with analytical frameworks, quantitative and explanatory insights. Here, the process of modelling life-science phenomena is considered as the act of subsuming parts of the discourse about biological variables with the discourse on certain mathematical objects, whilst the FD is understood as a subsumed discourse, and as such, it is a product of the modelling process. In this sense, a mathematical model in a subsumed discourse is defined as a set of mathematical objects endorsed under certain conditions and subsuming certain non-mathematical (in our case, biological) narratives. Depending on the purpose or nature of actions during modelling, for the same parts of biological discourse, the subsuming process may lead to different mathematical models. Thus, how students engage with MM will depend on the learning objectives of the modelling activities.

In this study, I am interested in identifying the goals for teaching MM in the context of interdisciplinary discourses. In doing so, I identify the nature of pedagogical discourse the professor is participating in. A pedagogical discourse is understood as the rationale of "*what* to teach students, *how* to teach them, *why* certain teaching actions are more effective than others and, often not talked about but still very important, *who* can learn (or not learn)" (Heyd-Metzuyanim & Shabtay, 2019, p. 543, italics in original). Thus, in this study, I pose the following research questions:

> What teaching goals does a biology professor articulate in the context of MM, and how are these goals interrelated within interdisciplinary pedagogical discourses?

Methodology

This section describes the data collection and the context of the study and provides information about the data analysis.

Data collection and the context of study

This qualitative study employs a case-study approach using an exploratory-descriptive method (Yin, 2014). The primary source of evidence is a semi-structured narrative interview (Kaasila, 2007) conducted with a biology professor who teaches a graduate-level course on mathematical models in fisheries stock assessment. Supplementary data includes classroom observations. This data is part of a larger data set collected with the purpose of investigating the nature of biology students'engagement with MM. The interview, audio-recorded and transcribed verbatim, was conducted towards the end of the course to minimize interference with the professor's pedagogical decisions during the semester. The classroom observations took place during one semester and served as a tool for designing the questions of the interviews and providing evidence for the teaching practices identified during the interview. The present course was mainly lecture-based, wherein seminars consisted of sessions where the professor and the students co-discussed solutions tasks given after each weekly topic. The lectures consisted of slide presentations prepared by the professor. Considering the relatively small number of students enrolled on the course, joint discussions between the professor and students were constantly present. Students were very active in questioning and discussing the teaching materials.

The informant of this study has a doctorate in Fisheries Management and has a well-established career as a researcher and professor in this field. He was chosen to be part of this study because of his long experience of teaching biology courses which employ specifically mathematical models in fisheries, and of his interest in improving his students'understanding of mathematical modelling and models. In addition, the professor was the sole designer of the course that this study focuses on, and he had insights into all the teaching materials used and its objectives. Specifically, the course, named Ecosystem and Fisheries Assessment Models, elaborates mathematical models used in fisheries ecosystems and management. The course is intended for biology graduates enrolled in a two-year "master of Science in Biology" program specializing in Fisheries Biology and Management or Marine Biology. Very often, this course is also taken by students of other master's program or PhD'students who are interested in learning more about the types of models used in the field of fisheries stock assessment.

Data analysis

The purpose of the data analysis was to explore the pedagogical discourse that the teacher was participating in, with a focus on the nature of teaching goals for MM. To analyze the interview data, I employed thematic analysis (Braun & Clarke, 2006), and using an inductive approach, the data were coded to highlight specific ideas of practices expressed by the professor. For example, statements like 'teach classical training in fisheries'were coded as *teaching aims*; students struggling with mathematics'were coded as *student challenges*; and 'step-by-step teaching methods'was coded as *instructional strategy*. These codes were then grouped into three broader goals. First, *familiarity with academic FD* was identified as a key theme encompassing codes related to foundational modelling knowledge and professional practices. Second, *gaining a sense of belonging to multiple discourse communities* emerged as another theme which reflects the professor's effort to help students transition between mathematical and biological discourses. Third, *engagement with techni-*

cal language and professional software was identified as a theme related to equipping students with practical technical skills. Lastly, the themes were organized hierarchically based on how frequently a goal was mentioned, the emphasis placed on it during the interview (e.g., using phrases like 'critical'or 'essential'), and the context in which it was referenced during classroom observations (e.g., the time spent into achieving a specific goal in the classroom) – which were then categorized into primary, secondary and tertiary goals.

Results

Through the analysis, three overarching teaching goals were identified, each reflecting a distinct but interconnected aspects within the pedagogical discourse the professor participates in. These goals are organized into primary, secondary and tertiary categories based on their relative importance in the professor's teaching practice. The primary goal, familiarity with academic FD, highlights the importance of knowledge and practice students need to engage as members of the fisheries community. Building on this, the secondary goal emphasizes fostering a sense of belonging to multiple discourse communities, and the tertiary goal focuses on engaging the technical language and professional software by equipping students with practical skills essential for workplace environments. While these goals are distinct, the results show that they are also interconnected. Specifically, the familiarity with FD provides the foundation for transitioning into multiple discourse communities, which in turn facilitates meaningful engagement with technical tools. In the following, I explore each goal by providing examples and highlighting their hierarchical structure.

Become familiar with academic fisheries discourse

The first goal identified in the professor's pedagogical discourse "to enable students to become part of the fisheries community". As mentioned earlier, the course was a graduate course and after finishing the master program, students are considered as fisheries biologists. Therefore, as newcomers to the community of fisheries, students are expected to master routines and endorse narratives that should enable them to become insiders of the academic or professional FD. During the interview, the professor stated that he wanted students "to go through classical training in fisheries biology...I want them to be familiar with core ideas in fisheries science". This included two learning goals, which he presented students with during the first lecture-session: first, learn the mathematical methods and models of fish population dynamics, and second, develop a critical approach to the application and limitations of these models. In the following, I will elaborate on each aspect.

First, the professor intended to present the classic theory of fish population dynamics and teach scientific mathematical methods and models for fisheries stock assessment methods in connection to ecological knowledge. The professor considered this goal as an essential step towards being able to engage with academic FD. For example, the choice of assessment models was motivated by the professor's extensive experience and his scientific work as a fisheries biologist which provided him with what he calls a toolbox of models which fisheries biologists need in order to be able to become fluent communicators of FD. Specific models discussed during the course were von Bertalanffy model, exponential decay, two different stock-recruitment models, cohort analysis, predictive models and biomass dynamic models. In the interview, he stated:

> ”If you want to become a fisheries biologist anywhere in the world, read fisheries articles, follow the literature, do stock assessment... you have a toolbox of different models, then students should feel familiar with that...my aim is to give them tools so they can build.”

In order to facilitate students'understanding of models, the professor used different strategies. Although the classroom sessions were lecture-based, the sessions and the communication between the professor and students were very interactive. One of the reasons why this arrangement was possible was the small number of students enrolled on the course. Thus, when introducing and discussing the models, the professor posed questions for discussion and asked for input on specific key points of his discourse, and students were free to ask questions at any point. This was also used as a strategy of the professor to accommodate the needs of students coming from different academic backgrounds:

> ”Every year there are people that have never seen Excel and then those doing PhDs and bridging this is not easy....I cannot even plan my lecture. I want to do these topics, but exactly how it is played out I never know. You suddenly see that you have to explain something, but it's not planned.”

In addition, after every chapter, students were given mandatory assignments (counting towards 20% of the final grade), which provided opportunities to engage with stock assessment models. During the interview, the professor stated that his aim for giving assignments was to provide opportunities for students to work with models by taking a learn-by-doing approach:

> ”The majority of students will understand what I say in the PowerPoint or in the blackboard or whatever, but they will forget it 10 minutes after. When they do home-assignments, a lot of them are spending a lot of time just building the Excel sheet and, then, they do not have that much time to speculate about it, but my hope is that they learn by doing.”

Secondly, the professor wanted students to understand the application and limitations of stock assessment methods and to develop a critical approach to their scope and utilization. To achieve this, the professor used different approaches. In the lectures, stock assessment models were discussed with reference to the availability of collected information about fisheries. Although mathematically and computationally, models used in fisheries are evolving, in the workplace environment, fisheries biologists lack reliable data such as growth, mortality, catch and effort numbers due to difficulties collecting such information. In addition, many of the models do not account for environmental variables or the presence of other types of fish. They describe single-species population dynamics, assume all variables are known and fixed, and take into account such inaccuracies – all these aspects were mentioned by the professor during his lectures. Therefore, as fisheries biologists, students need to be aware of such limitations of models and be critical when estimating the reference point (which is used to decide if a stock is under or above a desired state).

To further address the limitations of the models, the professor discussed each variable of the presented models concerning how they can be estimated mathematically, as well as the role they play in FD and the difficulties in collecting information about them. In addition, during lectures, the professor brought to the students'attention various examples of articles (published in well-respected journals) wherein the reference point was estimated wrong and where there were biases regarding conclusions on overfishing or not in certain geographical areas. In doing so, he stated arguments about why certain conclusions were mathematically false, and he also exemplified how, in some instances, some models can be wrongly applied to obtain a desired reference point even though the collected data does not support such conclusions. Concerning this point, in the interviews, he stated that his goal ”is to be conscious about the limitations of the models that they (students) are using”.

Moreover, by encouraging them to think critically about the models and available data, he wanted students to ”discuss that this is not the best thing; or that this is not even the final answer, and this is just one answer and that there are many other possibilities... and to discuss if their results make sense to the real world”. This was also seen in the nature of assignments given to students, wherein being critical and assessing the limitations was a big part of the tasks (for more details about the tasks, see Tetaj & Viirman, 2023). For example, in the assignments, there were a considerable number of tasks that focused on verifying the validity of a model (graphically, mathematically or statistically) through reflection on assumptions or comparison between mathematical models, or engagement with mathematical modelling of a situation where in a given model was not the best fit. He defended this approach by stating that "I want them also to be critical…it is so easy just to go into the model world and forget about the real worlds. I want them to be critical all the time…Are these assumptions correct?".

Foster a sense of belonging to multiple discourse communities

In the professor's pedagogical discourse, the desire to increase students'sense of belonging to a mathematical discourse community (not only to the biological discourse community) and to facilitate the difficulties of transitioning from one discourse to the other was essential for motivating the professor's teaching. Since the professor had an education in biology and his background in mathematics was self-taught, he expressed that his transition to fisheries biology was not easy due to its different nature from traditional biological discourse: "I also knew in that time that it was quite a numerical field…so I knew that I would be struggling myself". However, he claims that this helps him to better understand students in their struggle as newcomers to FD: "I think this helps me to understand where students are struggling", and influences his pedagogical discourse. Thus, the professor's pedagogical discourse was characterized by a desire to "try to explain (the variables) in terms of their biological meaning" and explain the models in terms of "what does it mean biologically, does it make sense".

Regarding the goal of increasing the sense of belonging to a mathematical discourse community, I identified three subgoals in the professor's pedagogical discourse. First, in the community of fisheries, according to the professor there is a division between the community of mathematicians and biologists, which can influence how they approach fisheries problems:

> "My experience from working as biologist is that when a biologist meets a mathematician then there is an inequality in the relation between them…There is this belief that mathematics can solve everything… So, people who choose biology are people who like natural sciences, but they are not really confident about mathematics or this abstract thinking."

Therefore, his goal is to reduce the described feeling of not belonging to the mathematics community through what he calls ”demystifying mathematics”. He stated that he wants students to ”feel proud that they can combine mathematics and biology and see where it is useful and where it is not useful”. In this sense, he emphasized on several occasions during the interview and in the lectures in the classroom, the need to transition to MD as the only way to make sense of fisheries situations and do an assessment of fish stock:

> ”We can't conceptualize the dynamics of a population if we don't reduce it into a mathematical model...it would be impossible for fisheries biologists if they would not make mathematical models from their data.”

However, this being said, he wanted students to view the presence of mathematics in FD as subject-dependent with its limitations rather than as something that gives all the answers. This approach may reduce the imbalance between discourses by emphasizing how fisheries narratives count for shaping the nature of mathematical models. Regarding this point, the professor stated that:

> ”It is not simple if you want to combine all this (referring to the variety of models and mathematical methods) and you don't know how but each equation and each graph is basically quite simple... this is one of my motivations for the course, that we have to work qualitatively, we have to work with big data sets, but we have to demystify a bit.”

To do this, he acknowledged that modelling can be challenging for some students. Thus, one of his strategies to accommodate this challenge was to gradually and step-by-step discuss parts of each model, focus on how models differ, and reflect on how each model contributes to making sense of FD.

Another strategy was the choice of textbooks. The field of fisheries is relatively recent, and most models were developed in the last century. However, there are differences in how students are expected to engage with models now compared to when the professor was a student. According to him, ”when the book came (referring to the book Beverton & Holt, 1957) ...this is sort of the Bible of all fisheries biology, and this is just mathematics everything...you really have to be a mathematician here to read this book”. He talked about how ”mathematics was very influential in fisheries biology” and that ”it was very much about solving models... and everything was analytical by using derivation and solving these equations analytically”. However, due to recent computational developments, he believes that students should spend more time learning about the implications of mathematical discourse in fisheries, rather than learning how to apply mathematics per se. This belief also influenced his choice of textbooks and literature used in his course, which according to him, was ”a light version of stock assessment” where the mathematical models were introduced without going into too many mathematical details but giving the essential aspects of applicability of models.

The second subgoal related to the sense of belonging (or not) to a mathematics community was about cooperation between the community of mathematicians and biologists on an academic level. This goal was more oriented towards a workplace or professional setting. However, it showed his beliefs about how important such cooperation is towards progressing FD in the classroom and beyond.

> ”There are two kinds of people in fisheries...So, we have a lot of people who collect data in the field but don't know how to use it. Then, we have people sitting there making beautiful models but who never go into the field and don't have data to use them on. The ideal world is that these two people meet. That they sort of work together. So, this is one of my motivations for the course...”

The last subgoal in this category was related to the sense of joy students who struggle with mathematical discourse can get by becoming fluent participants of FD. During the interview, the professor reflected on his journey how he finds joy in being a fisheries biologist and that he is motivated to convey such sentiment and perspective to students:

> ”My wish is that students come through their struggles... and I want them to know that this is fun. I want them to demystify and say yes, I want more of this and this is what I want to work with...They have to go through these painful moments and understand that they are not so painful. You work a little bit and then you go through it.”

Engagement with technical language and professional software

Due to the necessity for collecting and analyzing field data, the use of professional software to understand biological systems and relationships is a common practice. Thus, students'engagement and familiarity with such tools was another goal identified in the professor's pedagogical discourse:

> ”Fishery biology is a lot about collecting data in the field... and you have to somehow to digitize them; ...If you are a fisheries biologist,

> then sooner or later you will sit with a large set of data and you need a tool to crunch it."

The choice of software was primarily motivated by its transparency and simplicity in use. During the course, students were expected to engage with three different pieces of software – Excel and two professional software packages (FiSAT[2] and Pasgear[3]). In Excel, students were expected to make calculations and put formulas directly into cells and make connections between different results (for more details, see Tetaj & Viirman, 2023). The argument for choosing Excel was to engage firstly with models through a step-by-step approach. The professor believed that "If you have a large data set, then Excel can do a lot of things for you...because I'm using difference equations and not differential equations". Thus, according to him, Excel was a useful tool which serves "as a first link to go from data to an equation to a model...and condense these observations". When working with Excel, students were expected to use a step-by-step approach which allowed them to navigate between models and calculations on a sheet template. The reason for this was to help students who lack experience with Excel:

> "I have modified my exercises to become more and more step-by-step guidelines... because my experience is that some people (students) do not know actually to operate with Excel...sometimes they write them straight to their equations, and there are a lot of things that are not necessary. I do it in order (as good as I can) to show them that if they make a good Excel sheet in the beginning is much easier."

Meanwhile, the other pieces of professional software had already built-in models, and students were expected to engage in putting their data into the software, apply model-commands, and then obtain value results or graphical/visual relationships between variables. The difference between such approaches was intentional by the professor since he claimed that he wanted students to engage with commands that are already expressed in fisheries technical language in professional software. For example, through exercises in FiSAT, he wanted students to interpret certain value results (below or above a standard point) or explain given graphical relations between variables. This type of engagement was intended for students who, in a workplace environment, will need to engage with such tools and vocabulary (rather than take a step-by-step- model approach). In this case, students were expected to be able to relate specific fisheries objects to certain underlying mathematical references.

Discussion

The aim of this study was to identify the goals for teaching MM in a graduate biology course and analyze how these goals interrelate in the context of interdisciplinary pedagogical discourses. In the following, I will discuss how these findings contribute to current understandings of teaching MM in interdisciplinary contexts.

Firstly, this study showed that the professor's pedagogical discourse was shaped by his own academic journey and gradual enculturation into FD. His personal trajectory, from a primarily biological background into a self-taught engagement with MM, influenced how he designed the course and articulated its goals. Similar findings have been reported in prior research (e.g., Hernandes-Gomes & González-Martín, 2016; Treffert-Thomas et al., 2017), which highlights how instructors' backgrounds shape their beliefs, strategies, and teaching priorities. As a consequence, the professor's teaching goals function as a mechanism that helps to navigate between familiar and unfamiliar discourses for students. FD, being a subsumed discourse, develops as meta-discourse and as an isomorphic reflection of mathematical objects. As exemplified through the first teaching goal, becoming familiar with academic FD, the professor deliberately used population dynamics models (e.g., logistic growth, Beverton–Holt) as a meta-discourse to frame mathematical concepts within biological contexts, while stock assessment models (e.g., VPA) served as isomorphic reflections of mathematical structures embedded within fisheries narratives. These two dimensions of engaging with FD highlight the potential pedagogical challenge of helping students operate within overlapping discourses while gradually becoming insiders of FD. This aligns with broader calls for designing modelling education that makes disciplinary integration explicit rather than assuming it occurs naturally (Campillay-Llanos & Cárcamo-Mansilla, 2025). In this sense, the teaching goal of becoming familiar with academic FD mediates students' discursive participation by scaffolding their entry into FD.

The second teaching goal – fostering belonging to both mathematical and biological communities – partially addresses a well-documented struggle of biology students who find mathematics abstract or intimidating (e.g., Jungck et al., 2020). The professor's demystification strategy (foregrounding biological meaning, using qualitative reasoning, and gradually building formalism) and working with authentic tasks seem to be used as tools for facilitating such struggles. Research shows that providing a familiar context where students can work with real-professional problems can facilitate engagement with MM. As Heilio (2011) argues, "maturing into an expert can only be achieved by 'treating real patients'" (p. 480). Similarly, Vos (2011) emphases the importance of authenticity

– in terms of problem situation, solution approaches, the use of models and computer software – in ensuring that MM activities are applicable to the professional fieldwork. This in turn may provide practical utility and value for MM in understanding fisheries narratives, thereby potentially lowering students'perceived barriers between MD and BD.

Lastly, the tertiary goal – mastery of technical vocabulary and professional tools – position industry-standard tools, techniques and software not only as a convenience for participating in FD, but as institutionalized artefacts of FD. In the professor's pedagogical discourse, students'fluency with these tools is seen as equivalent to their ability to participate in professional practice. This reflects a broader shift in modelling pedagogy wherein manipulating data, running procedures, and interpreting outputs are recognized as legitimate forms of modelling rather than mere steps toward symbolic mathematics (Diaz Eaton et al., 2019; Siller et al., 2023).

Conclusion

In conclusion, this study offers insights into teaching goals of MM in an interdisciplinary discourse. By identifying the goals in the pedagogical discourse of the professor, it was possible to provide practical insights for educators teaching mathematical modelling and models in interdisciplinary context. The study provides a model for structuring interdisciplinary courses illustrating the interconnectedness of teaching goals within the context of a subsumed pedagogical discourse. In addition, it brings attention to disciplinary divides and how one should cultivate a sense of identity and belonging across multiple domains – such that students identify themselves as active participants in interdisciplinary dialogues.

Acknowledgments

I acknowledge the support from MatRIC, Centre for research, innovation, and coordination of mathematics teaching, and bioCEED, Centre for excellence in biology education. I wish to thank the biology professor for his kind cooperation in this research.

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Notes

1 Here, interdisciplinary refers to the integration of concepts and methos from two or more disciplines with the aim of deepening knowledge and skills.

2 A professional package for conducting assessment of fisheries stock, see: https://www.fao.org/fishery/en/topic/16072/en

3 Similar package to FiSAT.

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