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# Coherent teaching of mechanics with an amusement park physics project

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**Abstract**

In preparing future physics graduates for tackling complex challenges, we need to equip them not only with expert knowledge but also a deep understanding of how concepts relate to one another and the ability to apply these in real-world contexts. However, in many university curricula, physics, mathematics, and programming are taught separately with only implicit connections, which could lead to a transfer problem: students' inability to apply the knowledge acquired in one course to problems in another course. Here, we report our attempt for fostering curriculum coherence using an integrated project connecting three parallel courses. Using a survey, interviews, and a reflective focus group with students, we examine how coherence is perceived by students as well as their learning experiences. The quantitative findings of the survey reveal a significant correlation between the integrated project and students' perceived coherence. The qualitative findings provide complementary insights that students valued the balance between autonomy and structure, the connections between theory and practice, and

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they reported developing both technical and professional skills. We conclude with teachers' observations and reflections on how to support students through guidance and plan teamwork to ensure engagement with challenging tasks.

Keywords: mechanics, authentic learning, coherent physics curriculum, project-based learning

## 1. Introduction

Physics as a discipline rests on three main pillars: experimental, theoretical, and computational physics. In all three, mathematics provides the language through which physical phenomena are understood (Redish 2006). A well-prepared physicist is able to move fluently between these disciplines, using mathematical tools to interpret experimental data, construct theoretical models, and implement computational simulations. However, in many physics programs, the fluency is not practised well: theoretical physics, experimental physics, computational physics and mathematics are taught in separate courses, often only being connected implicitly. Yet, the relationships between these disciplines require purposeful teaching to help students understand how knowledge across disciplines is conceptually linked (Roehrig *et al* 2021). Without such intentional design, curricular fragmentation can give rise to a transfer problem, that is, students not being able to use the knowledge and skills learned in one course to solve problems in another course (Karam 2014). For example, students may be able to use mathematical methods to solve problems in their mathematics course, but they cannot apply the same methods to solve analogous problems in physics courses (Zuza *et al* 2018, Dochy *et al* 2020). This transfer problem also manifests when students ought to apply conceptual knowledge during lab work or when performing project-based measurements, and between mathematics and experimentation, where students may find it difficult to use statistics to analyse and interpret measurement data.

Teachers often observe the lack of knowledge and skills of their students (Custers 2010). The challenge, however, is not about further deepening mathematical knowledge and skills. The problem lies in how to scaffold students to recognise when and how they can be applied in a new disciplinary setting. This may be due to university degree programmes compartmentalising knowledge, and students associating knowledge and specific methods with the course in which they learned them (Tursucu *et al* 2018). A range of educational interventions, such as spaced repetition, retrieval practice, and collaborative interleaving, can improve students' application of knowledge (Samani and Pan 2021, Zhou *et al* 2025, Danzglock *et al* 2026). Important as these strategies are, especially in the course level, they cannot fully compensate for a curriculum with courses designed and taught in isolation. The transfer problem is, at its root, a curricular problem. What matters, then, is not only what happens within individual courses but how the curriculum as a whole is structured to provide an environment where learning can take place progressively over time.

Curriculum coherence, understood as the deliberate linking of both parallel and sequential courses, plays a critical role in this regard. When courses address related knowledge explicitly and the connections between them are made visible to students, both retention and transfer of learning are facilitated (Schmidt *et al* 2005). The alignment of courses can enable students to construct progressive and integrated knowledge (Shin *et al* 2019, Roehrig *et al* 2021, Neumann and Nordine 2022). Such alignment across courses is not simply about covering the same content in different places, but about progressive deepening and continuity. For example, teaching should evolve from particulars, such as applying simple mathematical formulas, to 'an understanding of the rational number system and its properties' (p 528) (Schmidt *et al* 2005).

The need for a more coherent curriculum also comes from a broader issue in curriculum design: programmes are often organised in disciplinary silos that do not reflect the multidisciplinary nature of real-world problems. Responding to widespread concerns about declining student engagement, (Morales-Doyle 2018) argued that educational reform should prioritise

making curricula more relevant to students' lives and to the societal contexts in which they will work. Since physicists rarely solve problems that fit neatly within a single discipline, it is essential to design our curriculum where they can integrate theory, experiment, computation, and mathematics in the face of complex, ill-structured challenges (Schweingruber *et al* 2014). Integrated curriculum that uses authentic, real-world contexts has been shown to foster important academic and professional skills that enable holistic and multidisciplinary problem-solving (Kelley and Knowles 2016).

In this context, project- and problem-based learning is particularly effective. As a pedagogical approach, project- and problem-based learning uses a question or problem to drive learning activities. Through working towards a solution, answering the question, or creating an artefact, students strengthen their understanding of disciplinary concepts, mobilise knowledge from multiple courses, and develop key skills (Brassler and Dettmers 2017, Chen and Yang 2019). In physics education, project- and problem-based learning has been used to facilitate active learning that traditional instruction alone cannot achieve, as well as to support students' persistence in learning and developing important skills such as planning, execution, and collaboration (Langbeheim 2015, Julia *et al* 2025, Setiaji *et al* 2026).

## 2. Towards a coherent curriculum

In the educational programme of the BSc. Applied Physics at Delft University of Technology (TU Delft) , we encountered similar problems as often described in literature: students had difficulties in seeing how the different components of the programme were connected (Senel *et al* 2025). To address this challenge, amongst others, the curriculum has been redesigned. A notable example for inspiration is the Twente Educational Model (Visscher-Voerman and Muller 2017, Craig 2019), in which all courses are sequenced using a central theme and a project in which the students work together to apply the knowledge of the courses. The programme Applied Physics adopted the idea of a central theme per quarter, and only three parallel courses: a physics course, a mathematics course, and a practical course which includes an overarching project. The aim of such a curricular redesign is to foster a coherent curriculum that addresses the transfer problem discussed above and support physics students' development of both disciplinary and professional skills.

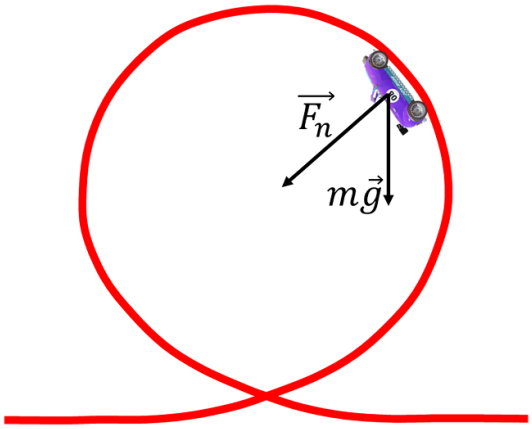



**Figure 1.** Physics is clearly apparent in many attractions in amusement parks. As an example we show the free body diagram for a carriage in a looping of a roller coaster.

Here, we present the overarching project aiming to connect the three parallel courses in the first quarter of the bachelor. The 5 EC physics course covers the basic Newtonian mechanics and special relativity. 3D-acceleration and 1D-rotation are included in this course. 3D-rotation is not taught, even though that would be applicable for the project. The 5 EC mathematics course covers the following topics: vector calculus, functions of a single variable, the concept of limits, limits, continuity, differentiability, integral calculus, complex numbers, and first- and second-order differential equations. Rotation matrices are not covered in the mathematics course. The practical 5 EC lab course focusses especially on Python programming (Pols 2024). The overarching project is part of the lab course. As the project should connect mechanics, calculus, and programming in a real-life context, we opted for amusement park physics in which mechanics is clearly observable as shown in figure 1 (Bagge and Pendrill 2002, Martensson-Pendrill 2021, Pendrill 2023, 2026a, 2026b). Moreover, several studies utilising amusement parks have reported positive effects on students learning, especially on their academic

performance (Tho *et al* 2015), learning motivation (Lim 2014), and students' ability to connect theory to practice (Natividad and Mistades 2012).

### 2.1. Integrated amusement park project as the research context

In total, 230 students participated in the amusement park project, which was embedded within a larger lab course. The learning objectives of the course were:

- To think and work like a physicist by developing critical thinking skills and by applying a range of approaches effectively, such as numerical simulation, model-based reasoning and experimental investigation.
- To recognise and articulate the limitations of physical models and to deal with these limitations when interpreting results, extending models, designing (simple) experiments and drawing conclusions.
- To work effectively in group projects by contributing constructively to the division of tasks, making shared substantive decisions and navigating group dynamics.

Although the project and the programming of the lab course supported different objectives, students described their learning often as one educational activity, even though the activities were rather different for the programming and the project.

Each Friday afternoon (mandatory sessions), students worked in 45 groups of 5 or 6 students on a part of the project. Each group had either at least 2 female students or none as women perform best in teams in STEM education where they are not the only woman (Niler *et al* 2019).

For each session, groups handed in a short report, logbook, calculation or other assignment to keep up the pace and allowed to monitor students' engagement with learning. The teaching assistants provided feedback well before the next session. The project was assessed on a pass or fail basis, where students would pass the course if they were actively engaged. This aligns with literature on project-based learning, which highlights the advantages of only providing formative feedback to support students throughout the learning process (Trauth-Nare and Buck 2011).

In a period of nine weeks the students went through the whole scientific process of: choosing a research topic, formulating research questions, learning to use their scientific equipment, modelling, performing measurements, analysing data, visualisation of their measurements and analysis, simulations, presentation of the project and collaboration. We give a short overview of the activities in each week:

Week 1 The students install Python on their laptops and phyphox (Staacks *et al* 2018, 2026) on their phones. They collect measurements of their liking with phyphox (for example: sliding their phones on the floor, swinging their phones in a bag, jumping from tables, running up and down the stairs, spinning office chairs) and submit a measurement report. The report should include photo's of the experiment, worked out clear graphs made in python of the measurements and a quantitative discussion of the results. Subsequently students participate in a workshop on collaboration.

Week 2 Students select an attraction of their choice from a list. They study, estimate or search the numerical values of important parameters of the attraction, develop a mechanical model to describe which forces act, draw free body diagrams and look for scientific literature describing the mechanics of the chosen attraction. All these elements have to be in a short report for this week.

Week 3 For the chosen attraction, the students sketch the kinetic and potential energy, calculate quantitatively, the accelerations and angular velocities they expect to measure and discuss relevant conservation laws. This weeks report should contain all these elements. Photographs witnessing the discussions of the students on their whiteboards are shown in figure 2.

Week 4 All students, teaching assistants and teachers visit the amusement park and collect data using the primary sensors of their phones. Some students in teams make videos and photographs.

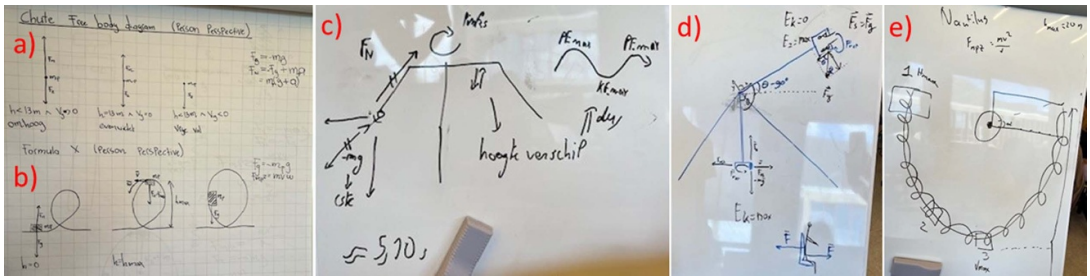



**Figure 2.** Photographs of the whiteboards the students used in week 3 to model and calculate the forces in various attractions. (a) Corresponds to a drop tower. (b) Describes a looping in a rollercoaster. (c) Represents a chain flyer. (d) Is a side view of a pendulum ride in which the seats are rotating around the rod connecting them with the top hinge. (e) Is a top view of the same attraction.

Week 5 In this lecture-free week students write a measurement report on their data. The report has to contain self made graphs and/or video analysis to obtain quantitative data on the attraction of their choice.

Week 6 The students write code to compare their data with models and simulations. To aid, we provided an example on how the Euler method can be used to calculate numerically with Newton's second law the acceleration from the force. Furthermore, we provide a description on how they can use rotation matrices to transfer the data from the frame of their phone to the frame of the carriage. This mathematics has not been treated yet in the mathematics courses, however, most groups are able to use it as a black box method. The status of the analysis has to be reported. Subsequently, they engage in a second workshop on collaboration.

Week 7 The students adjust the parameters of their models to get a proper fit to their data. They visualise the comparison and write a short report about the full modelling of their data. The report should contain graphs with comparisons of the measured data and their calculations.

Week 8 The students polish their simulations and make posters for the final day. The posters should include free body diagrams, graphs of filtered data and fits, a discussion about the numerical validity of the results, and conclusions.

Week 9 The students present their posters. An example of a poster is shown in figure 3 Prizes are handed out to the most beautiful poster, the clearest poster, the best simulations, etc. The students are themselves the jury.

More technical details on the educational activity can be found in one exceptional project (Bakker *et al* 2026).

To understand students' experiences with coherent teaching of mechanics with the amusement park physics project, we use a case study design to investigate students' perceived curriculum coherence and their self-reported skill development. Complementing these findings, the authors, some of whom are part of the teaching team, offer some practitioner observations and reflections on the design and delivery of the amusement park project.

## 3. Methodology

To describe the implementation of a coherent curriculum and to examine how students experience such curriculum design, a mixed method approach in a single case study was used (Yin 2018) focusing on the aforementioned first quarter, particularly the overarching project: the amusement park project.

### *3.1. Data collection*

In this study, we used a survey, interviews, and a reflective session with students to provide a comprehensive understanding of students' experiences.

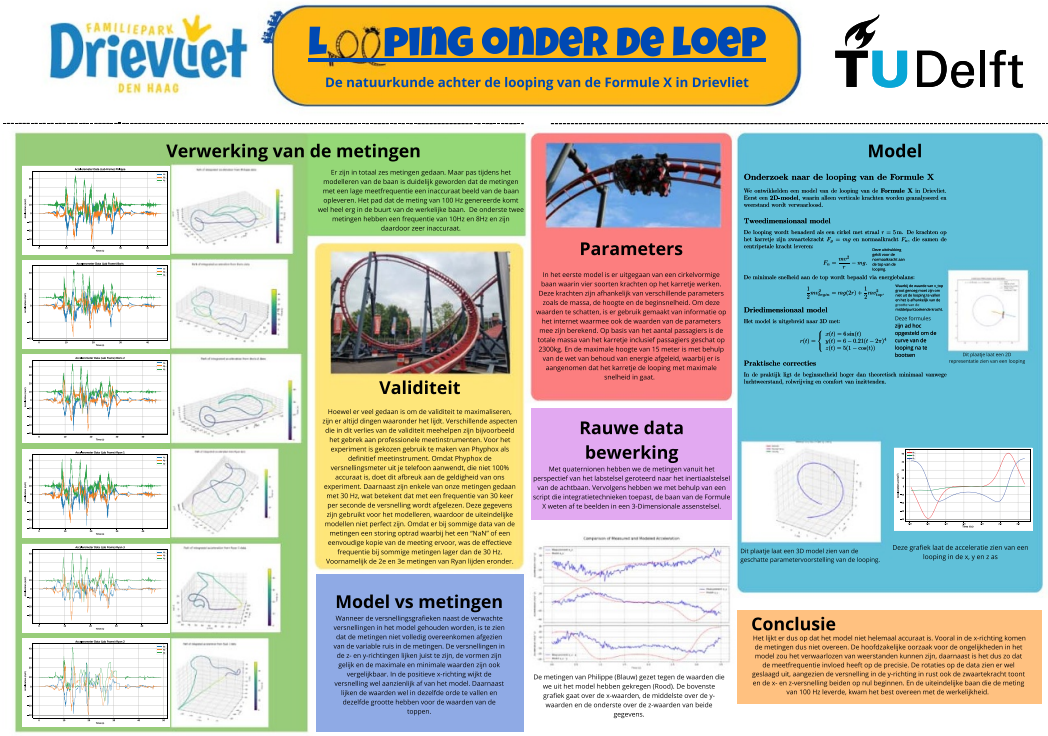



**Figure 3.** Example of one of the posters presented on the final day of the project (with the names of the students removed). This poster has all of the required elements present. This poster presents the reconconstruction of the trajectory of a roller-coaster (Bakker *et al* 2026).

*3.1.1. Online survey* An anonymous online survey was distributed at the end of the quarter, completed by 78 students (71.8% men ($n = 56$), 14.1% women ($n = 11$), and others not specified). The gender distribution approximately represents the gender ratio typical in STEM studies and to the actual percentage of 15.7% women in this year, according to the internal data. The survey included questions about students' demographics, perspectives on the three courses with particular attention to experienced coherence, and students' self-regulated learning behaviours. The survey combined Likert-scale items and open-ended questions to capture both quantitative patterns and qualitative insights. All Likert-scale items used a 1–10 scale, with 1 indicating strongly disagree and 10 strongly agree. The survey measured the following constructs:

- Perceived theme coherence (3 items): content alignment between mechanics and calculus courses, applied alignment of the project course and other courses, and holistic alignment between objectives, teaching, and assessment across the quarter.
- Course experiences for each of the three courses, including mechanics, mathematics, and practical (3 items each): relevance, motivation, and clarity of each course.
- Perceived support (2 items): clarity and timeliness of programme information, and ease of accessing support from teachers, teaching assistants, advisors, and academic counsellors.
- Self-directed learning behaviours (9 items): including keeping notes, preparing for lessons, self-assessing, monitoring progress, adjusting strategies, time management, concentration, planning, and retention of information.
- Intention to continue in the programme (1 item).

*3.1.2. Interviews* Individual interviews (approx.30 min each) were conducted with five

students who volunteered to participate. The interviews focused on students' learning experiences in the first quarter, their perceptions of connections between the three courses, and their reflections on the project-based learning approach, providing insights that could not be captured through the survey alone. Interviews were audio-recorded and transcribed for analysis.

*3.1.3. Reflective session* A reflective focus group session was organised with approximately 200 out of the 230 students to better understand their experiences of collaborative work in the project. The session focused specifically on the skills students felt they had gained and those they wished to develop further. In the classroom, posters displaying questions about the skills were placed on the walls, and students responded by attaching post-it notes with their answers.

### 3.2. Data analysis

Survey data were analysed using descriptive statistics to identify overall patterns in students' experiences and perceptions of coherence. For the interview transcripts and reflective session data, we used the thematic analysis (Braun and Clarke 2021), involving primarily inductive coding to identify key themes related to students' learning experiences, perceived coherence, and skill development. The first author conducted the initial coding, with the last author reviewing the raw data and coded findings to enhance reliability.

### 3.3. Limitation

This case study used survey and interviews as its primary data collection methods. As with any research involving human participants, self-selection bias is a potential limitation: students who chose to participate may be those most inclined to share their views. We had no access to the perspectives of those who declined to participate or who had left the programme. The findings are therefore not generalisable across the entire student population. However, rather than aiming for a statistical generalisation, this descriptive and exploratory study was set to provide a rich description of a project designed for enabling curriculum coherence, as well as a nuanced and contextualised understanding of students' learning experiences in such project (Yin 2018)(p 72).

## 4. Results

The results section presents students' perspectives on their learning experiences in the first quarter, with particular attention to the physics of theme park attractions. The findings are from the student survey with 79 students, five student interviews, and one reflective session with around 200 students.

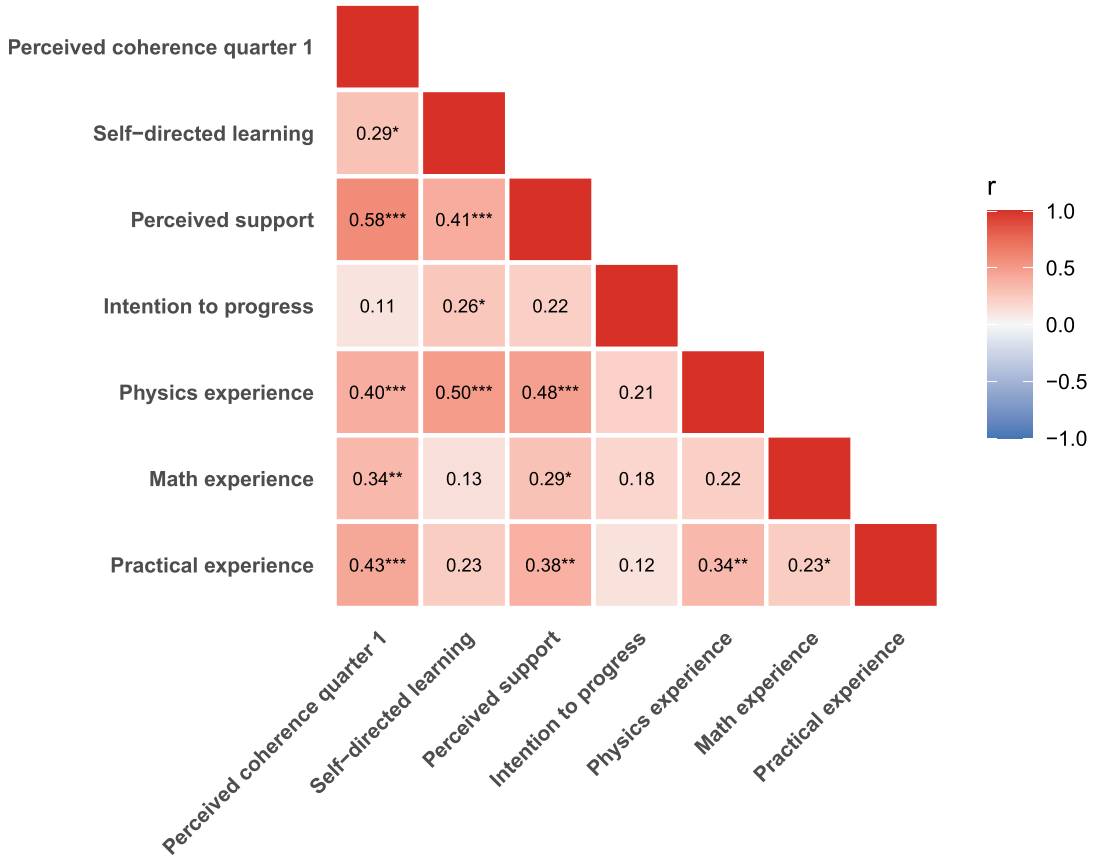
**Student survey.** Descriptive analysis uncovered students' perspectives on their learning experiences across three courses in the first quarter as well as their perceived coherence. We also examined correlations between key variables.

**Descriptive statistics.** Overall, students reported positive experiences across the three courses, in terms of relevance, motivation, and clarity of the course content (table 1). On a scale of 1 to 10, the mathematics course received the highest rating ($M = 8.31$, $SD = 1.05$), followed by the physics course ($M = 7.80$, $SD = 0.91$) and the practical course ($M = 6.48$, $SD = 1.31$). Students reported high levels of perceived support ($M = 7.49$, $SD = 1.45$), strong intentions to continue their studies ($M = 9.27$, $SD = 1.35$) but lower levels of self-directed learning behaviours ($M = 6.39$, $SD = 0.95$). They also perceived a moderate level of coherence across quarter 1 courses ($M = 6.68$, $SD = 1.34$). It should be noted that the practical course is related to both Python programming study and the integrated amusement park project. Thus, students' ratings likely reflect their experience with both components rather than either one in isolation, which may in turn shape their perceived coherence.

**Correlations.** Given the focus of this study on project-based learning, we examined correlations between quarter 1 coherence, students' experiences in the practical course, and other key variables—summarised in figure 4. Quarter 1 coherence showed significant positive correlations with all three course experiences, with the practical course showing a notably

**Table 1.** Descriptive statistics for survey variables as described in section 3.1.1. *N* refers to the number of answers, *M* to the mean of the score on a Likert scale from 1 to 10 and *SD* to its standard deviation.

| Variable | *N* | *M* | *SD* |
|---|---|---|---|
| Mathematics experience | 74 | 8.31 | 1.05 |
| Physics experience | 74 | 7.80 | 0.91 |
| Practical experience | 73 | 6.48 | 1.31 |
| Perceived coherence quarter 1 | 74 | 6.68 | 1.34 |
| Perceived support | 71 | 7.49 | 1.45 |
| Intention to progress | 63 | 9.27 | 1.35 |
| Self-directed learning | 68 | 6.39 | 0.95 |




*Note.* p < .10, * p < .05, ** p < .01, *** p < .001

**Figure 4.** Heat map of the correlations between key variables in the survey.

strongest relationship ($r = 0.43$, $p < .001$). Among the three correlation relationships, the practical course received relatively lower ratings compared to the physics and mathematics courses ($M = 6.48$ vs 7.80 and 8.31, respectively). In addition, the strongest correlation with quarter 1 coherence was perceived support ($r = 0.58$, $p < .001$), indicating that students who felt well-supported by the programme also experienced the curriculum as more coherent.

**Student interviews.** Thematic analysis of student interviews shows several key aspects on students' learning: students have genuine interests and engagement in learning physics; students appreciate the balance of autonomy and structure in the project work; students recognise learning transferable skills.

In particular, students expressed enthusiasm both for the appeal of amusement park visit as a learning context and for a learning approach that went beyond simply formula application. As a student explained: '*I was used to just getting formulas and be puzzling with them, and here you learn more from a grounds up perspective. [...] more integrating and differentiating to have a more global solution*' (Participant 1).

Next to students' appreciation toward the learning approach, they highlighted how the project work enables autonomy and structure for different students. For some, the given freedom to choose an attraction was a key motivating factor: '*you can choose what you want to do in that theme, that's more fun for me*' (Participant 2). Still, some students reflected on how they preferred more structure: '*But still, it is [the] first quarter in university, giving such a free project, I personally found it a little difficult.*' (Participant 3). Overall, the findings suggest that the project helped students' learning in enabling autonomy, though some students indicated they would have preferred more structure.

The interviews also emphasised students' perceived coherence between theory and practice. Students were able to identify connections between lecture content and practical work, suggesting that the project scaffolded the connection between conceptual knowledge taught and the application thereof in the amusement park project. For example, a student shared that the mechanics lectures and project were well connected: '*[we first take] lectures in the mechanics, and then for the practice, we went to the amusement park... they were pretty connected. [The teachers] would explain in the mechanics lectures what people would be doing during practice.*' Participant 4 also shared that the project '*was very well done in terms of keeping it to mechanics.*' These responses suggest that the alignment between conceptual instruction and applied practice may have contributed to a coherent learning experience for students.

Finally, students talked about the skills they gained through the project. A student reflected that '*the report writing, Python, data analysis, will all be very useful later on*'. Besides technical skills, Participant 4 also discussed teamwork skill and more intangible learning outcomes, to develop intuition and '*learn to see that the problem [in] a certain way and know [how to] dig down that route to get to the end*'. Participant 3 similarly mentioned researching as a key skill.

**Reflective session with students.** Along with the interviews, a reflective session was conducted in which students identified specific skills they perceived to have acquired and those they wished to practice more. Among 200 students, the most frequently mentioned skills included modelling and simulating, programming, collaboration, physics knowledge application, data analysis, and report writing. Interestingly, the skills students most wanted to improve were primarily the same ones they identified as having gained, with the top three (modelling and simulating, programming, and collaboration) ranking identically. This suggests that although students felt they had developed significantly, they also recognised the potential for learning. Taking collaboration as an example, two students reflected that: '*in the beginning, we were sloppy, but we learned a lot, and the approach/planning/structure in the end was much better*'; '*[collaboration was] difficult at first, but by getting to know each other better, we were able to work together increasingly well.*' These quotations on developing collaboration through a learning curve reflected how students saw room for growth with perceived learning.

## 5. Teacher's perspective

Below, the three mechanics teachers who are part of this author team, describe their observations on and experiences with the project. Students are typically accustomed to clear, well-defined, and smaller exercise problems with a single correct answer, as was the case in the tutorials. The project, however, confronted them with broad, open-ended problems that required them to use

physics in a 'different' way: they needed to formulate assumptions, identify unknowns, and iteratively refine their methods over an extended period. There was no immediate binary feedback on whether their answer was right or wrong. Instead, students were required to hypothesise, test, evaluate, and repeatedly adjust their ideas. This mode of working closely resembles authentic scientific practice, where complex questions rarely yield instant solutions, and progress is nonlinear. It was observed that the project facilitated deeper discussions about the interpretation of concepts in mechanics, considerably deeper than those typically found in standard lectures and exercise classes. Students' intrinsic motivation seemed to stem from their desire to gain a genuine understanding of mechanics within the context of their chosen attraction.

Also, the open-ended nature of the project appeared to be engaging for many students, stimulating curiosity and sustained effort to understand mechanics and to carry out complex data analysis. Some students already had or gradually developed a strong sense of ownership over their projects and exceeded expectations by investing more time and creativity than required to simply pass. This even resulted in a publication with two students as first authors (Bakker *et al* 2026).

However, it was also observed that some students experience feelings of uncertainty, with a few students having lower performance and even withdrawal from the more academically challenging aspects of the work, such as conducting simulations and quantitative calculations. Some differences in student works' quality and depth can be seen in their final poster presentations. For some students, judging whether their work met the expected academic level proved challenging.

The teachers also experienced a shift in their roles, differing from their usual teaching practice. None of the mechanics teachers had prior training in using acceleration and gyroscope data to interpret movement. Rather than acting as transmitters of knowledge, the teachers became co-investigators with the students. This shift from instructor to co-learner fostered equal dialogue and a shared sense of discovery, as the answer was not known to the students as well as the teachers. Teachers found this pedagogically enriching, as it brought this first-year, first-quarter physics project closer to authentic scientific practice. Moreover, it created different kind of connection to the students. The teachers did not only answer questions on exercises or provided additional explanation as is standard practice in many courses. The teachers enjoyed thinking and reasoning together about an open problem.

## 6. Discussion

What may be apparent from students' and teachers' perspectives above is that students and teachers alike genuinely enjoy engaging in the physics of 'daily life': not only visiting an amusement park and collecting measurement data but also getting better acquainted with the relevant physics in more complex, yet appealing contexts. Joy is only one but important component in project-based physics. The question that remains is what an overarching project contributes to connecting separate courses, and how it can serve as a route towards a more coherent curriculum.

Our findings suggest that an integrated project explicitly connecting parallel courses can contribute to a coherent curriculum, helping to address the transfer problem in physics education intrinsically and meaningfully. Students described how the amusement park project enabled them to apply theories and concepts from the mechanics course to a practical context, though connections with the mathematics course were perceived as less direct. This aligns with what (Karam 2014, Tursucu *et al* 2018) have argued for strengthening connections between mathematics and physics. Our findings extend this argument from the course level to the curriculum level through deliberate design of shared contexts across courses to enable students experience theory and practice as mutually reinforcing. We recognise that the amusement park project scaffolded the theory-to-practice connections by design rather than facilitating students' spontaneous and direct transfer. Still, these structured learning experiences are necessary precursors to independent transfer (Larkin 2001).

In addition, we found that the amusement park context offers a valuable enabling environment in which students developed key skills. Students reported developing a combination of technical skills, such as modelling, simulation,

and programming, and professional skills like collaboration and communication. This resonates with the goals of integrated STEM education, which aims not only to deepen disciplinary understanding but also to foster the broader competencies that graduates need in future professional practice (Kozminski *et al* 2014, Martin-Páez *et al* 2019).

It should be noted that the skills students identified as most developed (i.e. modelling, programming, and collaboration) were also those they most wanted to further improve. This appears to be paradoxical but it reflects a productive form of self-awareness: as students develop their skills, they simultaneously become better at recognising its complexity and the distance still to travel. This interpretation is consistent with prior literature on self-efficacy, suggesting that experiences strengthen students' confidence, but it also recalibrate their understanding of what proficiency means Bandura and Wessels (1997). As such, understanding students' perceived learning is an inherently nuanced and difficult task through quantitative measures alone. Future research could employ mixed-method or qualitative approaches, such as longitudinal interviews or reflective journals, to explore how students' self-efficacy and skill perceptions evolve as they progress through the curriculum and encounter increasingly complex project work.

## 7. Conclusion

The transfer problem remains a persistent challenge in STEM education, particularly in physics, where students need to integrate knowledge from physics, mathematics, and experimentation for complex problem-solving. To address this, a curricular redesign was introduced to the BSc Applied Physics programme at TU Delft, including an overarching project in which students analyse an amusement park attraction by applying mechanics, calculus, and programming in a real-world context. The project was designed to foster curriculum coherence by making the connections across parallel courses visible and meaningful to students. As such, we focused on examining students' perceived coherence and learning experiences in the first quarter of the redesigned programme, with particular attention to the overarching project. Data collection methods included a student survey, five one-on-one interviews, and a reflective group session with students.

In conclusion, this case study demonstrates that curriculum coherence can be used as a guiding principle for curriculum design to support positive learning experiences in undergraduate physics education. Students, in this case, perceived meaningful connections across courses and reported developing both technical and professional skills. While these connections were scaffolded by design, such learning experiences are valuable in fostering independent transfer abilities. From the author's teaching perspective, the collaborative teaching approach provided teachers with valuable opportunities to reflect on their roles, pedagogical approaches, and how to better support students in an open-ended, real-world learning context.

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## Data availability statement

The data cannot be made publicly available upon publication because they contain sensitive personal information. The data that support the findings of this study are available upon reasonable request from the author.

## Ethical statement

This study, carried out within the mechanics project course at Delft University of Technology, upheld the privacy and psychological well-being of the participating students. The students have given informed consent to participate in the study, and for the results to be published. The ethical approval for this study was granted by the Human Research Ethics Committee TU Delft.

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