*Journal of the Foundation Year Network, Volume 8 (2026), pp. 75-88*

# *Toolkit for Educational Dialogue: Integration into a Foundation Year STEM Curriculum*

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*This paper details the integration of a Toolkit for Educational Dialogue (TED) within a foundation year STEM curriculum. Educational dialogue, the ability to articulate reasoning and build on others' ideas, is important for academic success. In this project, we developed the TED to provide structured opportunities for students to develop these skills through paired discussion sessions centred on multiple-choice questions with targeted feedback. The TED provides structured support and skills training for foundation year students in preparing for the oracy requirements of their undergraduate degree. The development and integration of the TED was part of a larger Nuffield Foundation-funded project involving six university partners and three subject disciplines. This paper aims to present the practical implementation of the TED within an engineering and physical science context, including the design of discussion materials, the training activities for students, and a reflection on the challenges encountered, providing practical insights for other teachers who may want to support students' educational dialogue in their disciplinary contexts.*

## Introduction

As teachers, we are all familiar with the moment a student gives an answer and we ask that crucial follow-up question: 'Why do you think that?' The responses that follow are often just as familiar: 'I'm not sure how to put it,' 'It's kind of like this,' or simply, 'I don't know.' While we encourage students to attempt questions they are unsure about, their frequent struggle to articulate their reasoning points to a specific challenge. These moments reveal a gap in a student's educational dialogue skills: the ability not only to know an answer, but also to make reasoning explicit, justify a position, and build on the ideas of others (Hennessy et al. 2016). This skill set is the bridge between surface-level recall and deep, lasting understanding, and is linked to academic attainment across disciplines, including the sciences (Amodia-Bidakowska et al. 2023). Educational dialogue, therefore, represents a 'social mode of thinking' (Mercer 2000; Hennessy et al. 2016) and its importance is increasingly being recognised across the educational landscape, particularly in primary and secondary settings (Mercer et al. 2017; Amodia-Bidakowska et al. 2023), and in higher education (Heron 2019; Heron et al. 2022), including a specific focus on the foundation year context (Baker and Heron 2023; Heron et al. 2023; Gamarra et al. 2025).

Foundation years represent a relatively unexplored context from the perspective of educational dialogue. This is notable given the growth of students studying on foundation year programmes across the United Kingdom, a tenfold increase in the last decade (DfE 2023). Whilst foundation years appear successful in encouraging students who may not have been able to enter a university directly without the foundation year

(Sanders et al. 2016; Wint 2022), there are concerns about student continuation rates for foundation year students compared to their direct-entry counterparts (Freeman 2024). One reason may be lower confidence in the oral language skills required in their studies (Klinger and Murray 2012; Baker and Heron 2023). The increasing prevalence of generative artificial intelligence (Gen AI) tools has led to the adoption of more oral assessments, which could compound these issues for foundation year students. One way to address these concerns is to support students' confidence and competence in oral language development. Students can be supported by targeted academic language development through structured opportunities to practise in class. Furthermore, by structuring these opportunities around peer interactions (Southall et al. 2016), relationships can be built and a sense of belonging for students at university can be developed (Becker 2022), which may bridge the cultural and social capital divides between foundation year students and their direct-entry counterparts (O'Sullivan et al. 2019), and increase students' self-efficacy in their studies (Reilly et al. 2024), both of which could positively impact continuation rates.

## Project aims

### *Wider context of the project*

The overall project aimed to develop foundation year students' use of educational dialogue in their disciplinary discussions. The project involved six universities and three disciplines: engineering, biological sciences, and psychology. Students were organised into control and intervention groups. All students participated in a total of ten peer discussions over the course of the academic year, with the intervention group receiving training in educational dialogue. The peer discussion activities centre on multiple-choice questions, with feedback that pairs of students work through together. These 'discussion sessions' are the core of the intervention, alongside scaffolded opportunities via the Toolkit for Educational Dialogue (TED), to support students' academic language development and develop a working understanding of what educational dialogue is and how to engage in it. The first and last discussion sessions were audio recorded so that transcripts could be coded and analysed to see how students' use of educational dialogue changed across these sessions. At the beginning, middle, and end of the project, students were surveyed about their sense of belonging and perceptions of self-efficacy.

### *Specific aims of this work*

The work reported on in this paper focuses on a case study of the implementation of educational dialogue within the Engineering and Physical Science Foundation Year programme (Dampier et al. 2019), open to the 200 students enrolled in the 2024-25 academic year. This case study exemplifies the TED used for training students, the design and implementation of subject-specific discussion sessions, and the challenges experienced at the practitioner and classroom level, contributing to practical recommendations and pedagogical implications for foundation year teachers.

## What a discussion session looks like

The discussion sessions were developed to facilitate educational dialogue between pairs of students. In some instances where it was logistically necessary, some students worked in groups of three due to uneven numbers or late arrivals. However, the use of pairs was deliberate to encourage dialogue, which otherwise becomes difficult as group sizes increase. The discussion was initiated by a multiple-choice question whose answer was not immediately obvious. Instead, students should have been able to identify the likely correct answer, or at least, develop a clearer understanding through discussion of the related concepts, agreeing on an answer, reflecting on the feedback for their attempt, and integrating that feedback into a subsequent attempt if necessary. In this case, the questions were written (or selected from existing resources such as past examination papers) to be relevant to the learning objectives of recently taught content and compiled into a booklet of ten questions per discussion session. Questions were written in this way to serve two purposes: (i) they make the relevance to examinable content explicit for students, and (ii) they build in a distributed opportunity to practise the learning objectives in a new setting, drawing on distributed practice pedagogies (Baker 2022). A separate booklet containing feedback for each answer, to each question, was written to provide students with feedback on whether their response was 'correct' or 'incorrect', along with a corresponding sentence or two offering additional context or insight. For correct responses, the feedback reinforced the logic or thinking to reach the answer, and for incorrect responses, the feedback explained why it was incorrect and provided hints or tips so students could reattempt their answer (see below for an example question and an example answer). Students who participated in the first and final discussions (Discussion 1 and Discussion 10) were audio recorded, and their transcripts were coded to determine what, if any, distinct elements of dialogue were being used. Hennessy et al. (2016, Table 1, page 21) provide complete descriptions of these codes and the indicators of their use.

### *Example question*

> Dimensionless quantities are calculated quantities which do not relate to a physical quantity. In an experimental sense, it means they do not exist! However, it doesn't mean they are not useful. Ratios and transcendental functions (functions that require an infinite series to describe them) are good examples of dimensionless quantities.
>
> Which one of the following would be a dimensionless quantity?
>
> A The permittivity of free space ($\varepsilon_0$)
> B π (pi)
> C The Planck constant (h)
> D The speed of light (in a vacuum) (c)

### *Example feedback*

A: [Incorrect] The permittivity of free space is a physical quantity which describes how easy it is for an electric field to establish itself in free space.
B: [Correct] π is a calculation of the ratio of the circumference of a circle to its diameter. As such, you cannot measure pi, but rather, you have to calculate it.
C: [Incorrect] The Planck constant, h = 6.63 x $10^{-34}$ Js, is the amount of energy a photon of a particular wavelength (or frequency) has. It is therefore a physical quantity.
D: [Incorrect] The speed of light in a vacuum, c = 3 x $10^{8}$ $ms^{-1}$, is a physical quantity. Note that it has units (dimensions), so it cannot be a dimensionless quantity.

### *Example discussion transcript*

| | |
|---|---|
| Student 1 | Dimensionless quantities are calculated quantities which do not relate to the physical quantity, an experiment in the sense it does not mean… It means they do not exist. However, it doesn't mean that they are not useful. Ratios and transcendental functions, functions that require an infinite series to describe them, are good examples of dimensionless quantities. Which one of the following would be a dimensionless quantity? They do not relate to a physical quantity (Express or invite ideas). |
| Student 2 | Yes, except, however, it doesn't mean they are not useful (Build on Ideas). Because they don't exist. They're not related to a physical quantity (Make Reasoning Explicit). |
| Student 1 | Pi. Is it…? (Express or Invite Ideas). |
| Student 2 | Dimensionless (Build on Ideas). |
| Student 1 | What does pi relate to, a physical quantity? Think about that (Express or Invite Ideas). |
| Student 2 | Isn't that a thing that's in real life? You always see that number everywhere, but… Like speed of light (Build on Ideas). |
| Student 1 | Okay, first of all, permittivity of free space, that makes sense (Build on Ideas). Planck's constant, I'm not sure. |
| Student 2 | That's the one with, what's it called, de Broglie's wavelength of matter (Build on Ideas). I don't know if that relates to that. |
| Student 1 | That's hm. |
| Student 2 | hm, yes. So I don't know if that's… That depends. |
| Student 1 | Functions that require an infinite series to describe them are good examples. Would that require an infinite series to describe them? Pi? (Express or Invite Ideas). |
| Student 2 | Functions that require an infinite… So obviously, we know D is not (Positioning and Coordination). |
| Student 1 | Yes, neither is permittivity of free space (Positioning and Coordination). |
| Student 2 | So we know both of them are… (Express or Invite Ideas). |
| Student 1 | I'm thinking it's either one of these two (Positioning and Coordination). |
| Student 2 | Probably B or C (Positioning and Coordination). |
| Student 1 | I think it's B (Positioning and Coordination). |

Student 2 Right, we'll go with you this time, again. Not this time, every time, and every time, we've got it wrong.

Student 1 What do you say? What do you think when you look at it? What do you think? What do you think?

Student 2 I don't know. This time, I don't actually know. I'll go with you. I'll agree with you.

Student 1 I like B (Positioning and Coordination).

Student 2 All right. So it's not A.

Student 1 Good thing.

Student 2 Let's look at D first. Also not D.

Student 2 Let's go to C first. Yes.

Student 2 Come on. Got it right.

## Activities in the Toolkit for Education Dialogue

The purpose of the TED is to provide structured activities that help students develop academic language skills, understand what educational dialogue is, and scaffold their engagement with it. For the research methodology used, training via the TED took place after the first discussion session. Our draft toolkit contained 5 activities:

### *1. Establishing the ground rules*

The purpose of the ground rules was to establish sensible rules for engaging in high-quality dialogue. Here, we provided some examples which students could build upon.

- We encourage everyone in the pair to contribute
- We treat all contributions with respect
- We ask for the reasons behind our thinking
- We are all prepared to accept challenges
- We discuss alternatives before a decision is taken
- We share all relevant information
- As a pair, we seek to reach an agreement

We found that students were generally satisfied with the examples and provided minimal changes. Specifically in this case, some students suggested changing 'We encourage everyone in the pair to contribute' to 'Everyone in the pair should contribute,' a change we adopted.

### *2. Self-evaluation*

These were rating sheets that students, in their pairs, could use to evaluate how well they worked together against a selection of criteria, which would indicate good use of

Educational Dialogue (see below). This activity was adapted from the Cambridge teacher research exchange (Camtree 2025). Students were prompted with '*When you have completed your discussion, with your partner evaluate how you worked together and used educational talk in your discussion*.' Students agreed on a rating of 1 – 'Not True', 2 – 'Partly True', and 3 – 'Very True' to the following criteria:

| Rating | Criteria |
|---|---|
| | We worked together as a pair. |
| | Most or all of our talk was about the task we were doing. |
| | We shared our own ideas and built on each other's. |
| | We listened carefully when the other person was speaking and took on board what they were saying. |
| | When we made suggestions or agreed/disagreed with our partner, we gave reasons. |
| | When we gave reasons, we used evidence from lectures or other sources. |
| | We challenged or commented on each other's ideas in a respectful and constructive way. |
| | If there was disagreement, we tried to reach agreement or find a compromise. |
| | Our discussions and disagreements helped us learn from each other. |
| | We enjoyed working together in a pair. |

Students were generally reflective of their performance and were sometimes overly critical of themselves, so a bit of reassurance was necessary, reminding students that it was a reflective exercise, not an assessment. Some students thought they had to complete the sheet individually about one another and needed to be reminded to complete it together.

### *3. Analysing transcripts*

Students were given copies of two extracts of educational dialogue from discussion sessions, based on multiple-choice questions in the biosciences (Heron et al. 2023). We felt it was unnecessary to provide subject domain-specific examples, given that the focus was on raising awareness of effective educational dialogue rather than content.

| Extract 1 | Extract 2 |
|---|---|
| **Craig:** Hello, shall we go through the answers?<br>**Gilly:** Yeah I think it'll be a good idea to get started<br>**Craig:** Yeah, so what do we think for question one, let me get the answers up - er the questions up even<br>**Gilly:** Yep, let me find it. the first one I got C, that's what I got, but I don't know really<br>**Craig:** I did B or A<br>**Gilly:** It's cause I didn't recognise any of the words like<br>**Craig:** Yeah, the calyx words are the ones that are completely different<br>**Gilly:** Yeah so I just wasn't sure where to put them<br>**Craig:** Where it says major and minor calyx, do you think it's the - no it's can't be the, it's not the vein is it, the renal vein and the renal artery<br>**Gilly:** Yeah I don't think it is but I don't know | **Frances:** Ok I'm ready to go whenever<br>**Nadia:** Alright cool so am I<br>**Frances:** Question one I put D<br>**George:** Yeah same<br>**Nadia:** Yeah I didn't put D but that sounds right so go ahead<br>**Frances:** I've put B because<br>**Nadia:** [interrupting] Oh B, sorry I thought you said D. Yeah I put B too<br>**Frances:** No, B<br>**Mohammad:** Same<br>**Frances:** Yeah it's B good job<br>**Mohammad:** Good job guys<br>**Nadia:** Good job team<br>**Frances:** Um question two I've put C |

| | |
|---|---|
| **Craig:** Well I just thought it would be A, B or C cause ureter would be at the end<br>**Gilly:** Yeah that's basically what I did as well, I put, I just thought maybe minor first and then maybe<br>**Craig:** [interrupting] actually yeah I think maybe you're right because ureter would be last, the pelvis would be second last probably, and then the duct and then the other two<br>**Craig:** Ok so we'll go for C, shall I put it in? | **Nadia:** Me too<br>**Frances:** Yeah, agree?<br>**Nadia:** Yeah if everyone's happy with it<br>**George:** Yeah I put C as well<br>**Frances:** It's not C<br>**Mohammad:** Unlucky, try D |

Students were asked three questions to answer within pairs or small groups:

- What is the purpose of the pair/group work? How effective is the pair/group work?
- Can you find specific examples of a) effective and b) less effective interaction?
- How might the students work more effectively together?

Other than some students taking this as an opportunity to begin their acting career, taking on the role of 'Craig' and 'Gilly', when discussing the transcripts, most could see that Extract 1 is a better example of educational dialogue than Extract 2, usually picking up on the lack of discussion, and the general sense of wanting to finish the task as quickly as possible in Extract 2. Students seemed to appreciate that the extracts were from authentic pair discussions based on questions similar in format to those they were using.

***4. Evaluating educational dialogue***

This activity gave students some hands-on experience with educational dialogue. They were asked in groups of 3 or 4 to discuss the statement: '*For foundation year students, speaking is more important than writing*.' Two or three of the students would engage in the discussion, and one student would make a tally chart of specific types of educational dialogue (a simplified subset of that used in Table 1), with a table given to them:

| **Code** | **Put a tally each time you hear a code being used** |
|---|---|
| Challenge | |
| Invite reasoning | |
| Make reasoning explicit | |
| Connect | |

Many students found this activity challenging, particularly the use of the coding scheme. Those who engaged with the discussion needed a bit of encouragement to begin. Some objected to the use of 'For foundation year students' rather than just 'students', which we encouraged them to discuss. The student coders found the activity challenging and often ended up just joining the discussion itself. More training on the use of coding transcripts would likely be necessary to make full use of this activity.

### *5. Using talk stems in discussions*

Talk stems were used as a static learning aid within discussion sessions, for example, left on a PowerPoint slide during a discussion session. This visual provided prompts for students to use in their discussions that could help facilitate the dialogue. This visual linked dialogic moves with specific examples:

| **Code** | **Example talk stem** |
|---|---|
| Inviting to build on ideas | Can you tell me ... ? Do you agree? |
| Building on ideas | I think ... It makes me think of ... |
| Challenging others | Are you sure? I disagree. |
| Invite reasoning | Why? Do you think? |
| Make reasoning explicit | I think ... because<br>If ... then ... |
| Coordination of ideas | To sum up ...<br>So what we are saying is ... |
| Connect | It reminds me of ...<br>In the lecture on X we discussed ... |
| Express or invite ideas | What do you think? |

Often, we found that when students struggled to start or to make progress on a question, they would look to their teacher. Resisting the temptation to engage in the question, sometimes simply reminding them of some prompts to get the discussion going was all that was required. If students struggled to engage in the discussion session, some help from their teacher to frame the question, link it to learning that had already taken place, or break the problem into sub-questions was suitable to differentiate the task for students. Typically, modelling the discussion with one pair of students was sufficient to demonstrate the process for other pairs in the room.

For logistical reasons, activities 1, 3 and 4 took place within a timetabled lecture which was part of the module that encompassed the topics of the discussion session. The activities were completed sequentially, which, whilst convenient, did miss opportunities to develop a deeper understanding or engagement with some parts of the TED, such as the coding in activity 4, which students struggled with.

## *Example of integrating educational dialogue in a curriculum*

Several key topics will be ubiquitous in foundation year engineering and physical science curricula. By liaising with colleagues in other institutions and comparing the overlap of topics covered in each curriculum, a suitable question and feedback set could be developed. The most common overlapping topics, also intersecting with many A Level physics topics, were identified as:

1. S.I. units, dimensional analysis, measurement theory
2. Electrostatics and magnetism
3. Electromagnetic induction
4. Thermal energy and ideal gases

5. Thermodynamics, static pressure and fluid dynamics
6. Scalars, vectors, couples and equilibrium
7. Material science, work and friction
8. Projectile motion, Newton's laws and momentum
9. Waves
10. Circular motion and SHM

For each topic, ten multiple-choice questions were written, or developed from suitable sources (such as A Level examination papers; known common misconceptions; inspiration from Gen AI tools), and feedback on each answer was written to help student pairs develop their answers (or guesses!), integrate the feedback into their thinking and discussions, and then attempt to correct their answer. Given the teaching sequence in this case study, this equated to approximately one discussion session every two teaching weeks across two teaching semesters, trying to avoid critical assessment deadlines or revision/examination schedules that might otherwise impact student engagement.

## Format and location of the discussions

The discussion was based on printed booklets of questions and answers/feedback. Students were asked to discuss the questions, choose an answer together and then consult the answer/feedback pages. The idea was that the feedback booklet was consulted after attempting a question. Each answer, A, B, C or D, was placed on a separate page, and the distribution of correct answers was stratified to avoid students looking ahead to the next question's answer while reviewing the current one. This is by no means optimal, but usually, we found that students avoided the temptation to look ahead for the correct answers. Alternatively, the use of 'scratch cards' was considered (Heron et al. 2023), which makes the selection of an answer more permanent, but requires additional resources. The use of a digital platform was briefly considered; however, the distractions it might bring, since it would likely be smartphone facilitated, as well as requiring students to log into a platform or prepare in some way for the session, were preferably avoided. Instead, the paper-based solution, one set per pair (encouraging the sharing of ideas), felt like a suitable compromise. As for the timetabling, there were several options, and indeed, different teachers used different methods. For example, a dedicated session for 'Educational Dialogue' alongside students' timetables is one option. Another is to integrate the discussions within existing timetabled sessions. In this case study, the first half of regular tutorial sessions (which distribute the cohort of around 200 students across five identical sessions) was spent completing the TED activities and pair discussions, and the second half of the tutorial was spent on other work. Since the discussion questions were mapped onto the taught curriculum students were studying, this made the buy-in easier by explaining it was 'additional practice', 'revision', or 'relevant to examinable content.' Whilst very large groups (e.g. taking place in a lecture theatre) might be difficult to keep students on track, too few students in a session made the discussions very difficult since pairs of students were very aware that their discussion might be heard by

others. A rough estimate of a minimum of seven pairs of students who are on task promoted a sustainable atmosphere for discussions to continue in a small teaching room (suited for a maximum of 30-40 students).

## Challenges

### *Attendance*

The number one challenge for the discussion session was getting the buy-in from students. Whilst after completing one or more discussion sessions, students were positive and enjoyed engaging in the content in a different way, the continued general low attendance and engagement woes felt by many colleagues in the higher education sector persisted (Moores et al. 2019; Menendez Alvarez-Hevia et al. 2021). Simply put, students who did not attend were unaware of the opportunities they missed. This not only put pressure on collecting larger sample sizes of recordings, but for those who attended, there was a certain inertia to starting discussions when there were few other students in the room. A negative feedback loop might have formed where students did not want to attend when they anticipated not many other students turning up, so they, in turn, did not turn up. Despite advertising the project, highlighting the relevance and usefulness to students, as well as there being essentially no preparation, the project was not enough to change the attendance patterns of our cohort of students. For instance, general attendance at a discussion session was approximately 20-30%, similar to that of any other tutorial session, with few regular participants. This suggests the low attendance was not because of the introduction of the discussion sessions themselves, but a consequence of the already existing attendance mode of the students, who often perform a utility-maximisation (from their perspective) to decide if something is 'worth' engaging in (Gomis-Porqueras et al. 2011). This mindset can differ between groups of students; for example, commuting students and part-time employed students may face additional pressures or constraints when deciding on attending something which is not mandatory. As previously mentioned, this can affect the classroom environment for the students engaging in the discussions, but any such irregular attendance also reduces the opportunities for practising educational dialogue.

### *Facilitating the discussion sessions*

There were some additional challenges in this case since there were data collection requirements during some of the discussion sessions, such as the audio recordings, which would not be necessary for other teachers who want to run such discussions. Similarly, the question bank used in this work is made available for use by others (see supplementary materials below). Running the sessions themselves requires training the students. This is done formally with a selection of activities from the TED (also made available for others), but students needed some instructions about how to use the booklets, including the requirement to work in pairs and to openly discuss their ideas and 'work together.' Otherwise, students would often default to a typical mode of engagement, which, for the engineering students, was completing what they saw as a

sheet of questions by themselves. There are, therefore, some disciplinary challenges to be acknowledged; for example, how to convince engineering students that educational dialogue is a form of engineering practice. For similar reasons, the facilitator must also be bought into the intervention, providing some of the time and enthusiasm to get the discussions going (or indeed, 'selling' the intervention in the first place). Regardless of the resources provided, there will be a time investment needed from facilitators to organise learning spaces, printing and compiling documents, choosing suitable questions from those provided (or adapting, enhancing, or writing alternative questions) and learning how to facilitate these sessions, which might be a new teaching format to them. Again, whilst beyond the scope of this study, several recent aspects of the higher education sector have caused many teachers to leave, change roles, or experience changes in commitment due to widespread restructuring (Marini and Meschitti 2025), which, at minimum, can have the knock-on effect of reduced staff morale and student buy-in (Joseph 2015).

## Concluding remarks

This case study on implementing the TED provides insights into the practicalities of embedding and encouraging dialogic teaching in a foundation year setting. Our findings suggest that structured, peer-led discussions can scaffold the development of elements of educational dialogue, such as communication and reasoning skills. The challenges we faced, notably inconsistent student attendance, disciplinary buy-in, and the disruptive effects of wider university restructuring, are significant and warrant further investigation as systemic barriers to pedagogical innovation. While this paper focused on the practical implementation, the collected data from audio recordings and student surveys will allow for a future comprehensive analysis of changes in students' use of educational dialogue and their self-efficacy over time. This will provide qualitative and quantitative evidence to address possible links between improved dialogic skills and student continuation rates. Ultimately, this work draws on the lessons learned so far in this wider research project to serve as a practical guide for teachers who may wish to embed elements of educational dialogue into their curricula.

## Supplementary materials

The Toolkit for Education Dialogue, discussion questions, and other associated materials are available at https://www.surrey.ac.uk/research-projects/educational-dialogue-improving-foundation-year-student-outcomes.

## Acknowledgements

This project has been funded by the Nuffield Foundation (www.nuffieldfoundation.org), but the views expressed are those of the authors and not necessarily the Foundation. We thank our university partners and student cohorts for engaging in this work. Lewis Baker thanks colleagues at the Foundation Year Network Annual Conference for several useful discussions.

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