Working atmosphere in the secondary mathematics classroom: When things do not work according to the lesson plan

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In this paper we focus on a collaborative research and development project in which a team consisting of secondary mathematics teachers (newly qualified and experienced), researchers in mathematics education (faculty and doctoral students) and mathematics teacher educators work together on how to achieve balance between creating opportunities for high quality mathematical thinking and attending to classroom management and behaviour issues. To this aim we deploy Haydn's 10-point scale on the working atmosphere in the classroom. This construct was not devised specifically for the mathematics classroom and our study explores its potentialities for it: we ask whether a scale (Haydn-M) with mathematics specificity can provide meaningful insight into the working atmosphere in the secondary mathematics classroom. In this paper we provide examples suggested by newly qualified teachers in our team of such a mathematically specific use of the scale.

Keywords: working atmosphere; Haydn scale; mathematics teacher professional development; situation-specific task

Introduction

Novice mathematics teachers with very good pedagogical intentions and mathematical background often face challenges in the transformation of their commendable aspirations into classroom action (Biza, Nardi, & Joel, 2015). The work we present in this paper is the outcome of the collaboration of mathematics teachers, researchers and educators that aim to address these challenges in a research and development project supported by the Ian Hunter Prize-2015 in the context of the MathTASK programme on secondary mathematics teachers' knowledge and beliefs. Specifically, in this paper we focus on a research and practice based observation that classroom management often interferes with working towards commendable learning goals (e.g. Kersting, 2008). To this aim we deploy Terry Haydn's 10-point scale (Haydn, 2012) on the working atmosphere in the classroom, a construct that was devised with no subject specificity, to examine the question: *How does the working atmosphere in the mathematics classroom interrelate to the quality of mathematics teaching?* In what follows we present briefly the MathTASK project and we outline the Haydn scale on the working atmosphere in the classroom. Then, we draw on our collaborative effort to offer examples of our work in progress on how the Haydn scale can be adapted in order to describe the working atmosphere in the mathematics classroom specifically.

The MathTASK project

The MathTASK project is a collaborative research and development programme on secondary mathematics teachers' knowledge and beliefs and the transformation of these knowledge and beliefs into pedagogical practice. Research acknowledges the overt discrepancy between theoretically and out-of context expressed teacher beliefs about mathematics and pedagogy and actual practice (e.g. Speer, 2005) and a substantial body of work in mathematics education explores the use of specific teaching cases (e.g. Markovits & Smith, 2008) in teacher education. Our research associates these assumptions with the view that teacher knowledge is better explored and developed in situation-specific contexts. To this aim we design *situation-specific tasks* (see an example in Figure 1 from Biza et al., 2015) – i.e. tasks based on specific mathematics teaching situations – and then use them for research and teaching purposes (see Biza, Nardi, & Zachariades, 2007). These teaching situations: are hypothetical but grounded on learning and teaching issues that previous research and experience have highlighted as seminal; are likely to occur in actual practice; have purpose and utility; and, can be used both in (pre- and in-service) teacher education and research through generating access to teachers' views and intended practices.

Class X is a high attaining group which you have taken over at the start of Year 10. So far Class X has been taught mathematics as a list of rules and they have been practising the application of these rules in a range of examples. These students have learnt to perform well in a competitive classroom environment in which they work on tasks and they are rewarded for the correctness and rapidness of their work. In your teaching you aim to instigate a different approach that includes justifications for the used rules and the relations amongst them.

In a session on the sum of the angles of a polygon, you have asked the students to

- work with a Dynamic Geometry software in order to sketch polygons with 3, 4, 5, 6, 7, … sides and
- report the number of sides and the sum of the angles in a table, in order to conclude with a general rule about the sum of the angles of a polygon.

After a couple of trials the students conclude that the sum equals 180° multiplied by the number of sides minus two and verify this rule with trials of polygons with several numbers of sides.

At that point you ask the students to explain why this rule is correct and the dialogue below follows:

YOU: Why is this formula correct? Can you give any explanation?

STUDENT A: It works for all the polygons we tried.

YOU: How do you know that this will work for all polygons?

STUDENT B: It isn't necessary. What we need is a formula that works.

STUDENT C: Yes, we spent so much time playing with the software. If you had given us the formula and a list of problems to work on, by now we would have got more done.

STUDENT A: Practice makes perfect.

Questions:

a. What do you think are the issues in this situation?

b. What are you going to say to each one of these students?

c. Are you going to change your approach? Justify your response.

Figure 5: Polygon Task (Biza et al. 2015)

So far, seven mathematics education researchers from the UK, Greece and Brazil have been involved in this programme and the research we have conducted – and we anticipate to conduct in the following years – is divided in four strands: (1) *mathematical thinking* (e.g. pedagogical and didactical practices in relation to the teaching of specific mathematical topics) (e.g. Nardi, Biza, & Zachariades, 2012); (2) *classroom management and mathematics learning* (e.g. interference of classroom management with the learning of mathematics) (e.g. Biza et al., 2015); (3) *CAPTeaM: disability and inclusion in the mathematics classroom* (e.g. deaf and blind student mathematical strategies) (e.g. Nardi, Healy, Biza, & Fernandes, 2016); and (4)

emerging strands (e.g. meta-use of tasks and task development). The format of these *tasks* varies across the programme – e.g., monologue or dialogue; script or video clip format; one or more students; teacher intervention or not; etc. – in order to address the diversity of events in the mathematics classroom. The example (Polygon task) we use in this paper (Figure 1) is from the second strand. The *Polygon task* takes place in a Year 10 high-attaining class, with students used to "instrumental" and "competitive working environment". The teacher challenges this style by suggesting an investigative task, using Dynamic Geometry Software. To this aim, the teacher asks the students to sketch polygons with 3, 4, and 5… sides, work out the formula for the sum of angles and justify why it works for all polygons. However, the teacher is faced with the established culture of drill and practice: the students voice the claim that it would have been better if they were simply given the formula and then practise with problems using this formula.

Working atmosphere - the Haydn scale

Amongst the challenges teachers face in the classroom, although not always 'officially' reported, are pupil behaviour and classroom management (Haydn, 2014). For example, in the UK, classroom management is one of the four most important reasons for teachers leaving the profession (NUT, 2010). Terry Haydn (2012) introduced a practice-based descriptor of the classroom (not specific to mathematics), climate. The Haydn scale is a 10-level descriptive scale of the classroom atmosphere that ranges from an 'entirely uncontrollable' classroom (level 1), in which the teacher does not even start teaching, to a 'controlled' class (level 10), in which teacher and students work together and enjoy the experiences involved. This scale has been used extensively in research and Initial Teacher Education (ITE) but not with subject specificity.

Level	Description
Level 10	You feel completely relaxed and comfortable; able to undertake any form of lesson activity without concern. 'Class control' not really an issue – teacher and pupils working together, enjoying the experiences involved.
Level 9	You feel completely in control of the class and can undertake any sort of classroom activity, but you need to exercise some control/authority at times to maintain a calm and purposeful working atmosphere. This can be done in a friendly and relaxed manner and is no more than a gentle reminder.
Level 8	You can establish and maintain a relaxed and co-operative working atmosphere and undertake any form of classroom activity, but this requires a considerable amount of thought and effort on your part at times. Some forms of lesson activity may be less calm and under control than others.
Level 7	You can undertake any form of lesson activity, but the class may well be rather 'bubbly' and rowdy: there may be minor instances of a few pupils messing around on the fringes of the lesson but they stop when you ask them politely but firmly to behave. No one goes out of their way to annoy you or challenges your authority.
Level 6	You don't really look forward to teaching the class, it is often a major effort to establish and maintain a relaxed and calm atmosphere. Several pupils will not remain on task without persistent surveillance/ exhortation/threats. At times you feel harassed, and at the end of the lesson you feel rather drained. There are times when you feel it is wisest not to attempt certain types of pupil activity, in order to try and keep things under control. It is sometimes difficult to get pupils to be quiet while you are talking, or stop them calling out, or talking to each other at will across the room *but* in spite of this, no one directly challenges your authority, and there is no refusal or major disruption.
Level 5	There are times in the lesson when you would feel awkward or embarrassed if the head/a governor/an inspector came into the room, because your control of the class is limited. The atmosphere is at times rather chaotic, with several pupils manifestly not listening to your instructions. Some of the pupils are in effect challenging your authority by their dilatory or desultory compliance with your instructions and requests. Lesson format is constrained by these factors; there are some sorts of lesson you would not attempt because you know they would be rowdy and chaotic, *but* in the last resort, there is no open refusal, no major atrocities, just a lack of purposefulness and calm. Pupils who wanted to work could get on with it, albeit in a rather noisy atmosphere.
Level 4	You have to accept that your control is limited. It takes time and effort to get the class to listen to your instructions. You try to get onto the worksheet/written part of the lesson fairly quickly in order to 'get their heads down'. Lesson preparation is influenced more by control and 'passing the time' factors than by educational ones. Pupils talk while you are talking, minor transgressions (no pen, no exercise book, distracting others by talking) go unpunished because too much is going on to pick everything up. You become reluctant to sort out the ringleaders as you feel this may well escalate problems. You try to 'keep the lid on things' and concentrate on those pupils who are trying to get on with their work.
Level 3	You dread the thought of the lesson. There will be major disruption; many pupils will pay little or no heed to your presence in the room. Even pupils who want to work will have difficulty doing so. Swearwords may go unchecked, pupils will walk round the room at will. You find yourself reluctant to deal with transgressions because you have lost confidence. When you write on the board, objects will be thrown around the room. You can't wait for the lesson to end and be out of the room.
Level 2	The pupils largely determine what will go on in the lesson. You take materials into the lesson as a manner of form, but once distributed that will be ignored, drawn on or made into paper aeroplanes. When you write on the board, objects will be thrown at you rather than round the room. You go into the room hoping that they will be in a good mood and will leave you alone and just chat to each other.
Level 1	Your entry into the classroom is greeted by jeers and abuse. There are so many transgressions of the rules and what constitutes reasonable behaviour that it is difficult to know where to start. You turn a blind eye to some atrocities because you feel that your intervention may well lead to confrontation, refusal or escalation of the problem. This is difficult because some pupils are deliberately committing atrocities under your notes, for amusement. You wish you had not gone into teaching.

Figure 6: Haydn (2012) 10 point scale on the working atmosphere in the classroom

Although the teaching situation described in the Polygon Task contains only a snapshot of the classroom atmosphere, we can see teacher's attempt of a new-for-students activity to be under his/her "control" (level 8) at the beginning. However, when students are invited to justify the correctness of the formula, Students A, B and C challenge the teacher's "authority by their dilatory or desultory compliance with

[his/her] instructions and requests" (level 5). We invited 21 mathematics pre-service teachers to respond to this tasks and one of them wrote:

> The students are too used to being in a very instrumental learning environment. So, when asked to investigate and think more in depth about their explanations they struggle. I think that because they're struggling, and they're not necessarily used to not being able to answer questions, they start to undermine the teacher with their comments. (Biza et al. 2015, p. 192)

In this response we can see a connection between students' behaviour, especially in relation to undermining teacher, and students' previous learning experience and challenges. We seek the further investigation of these connections through the conjecture that we can adapt the Haydn scale by creating a scale with mathematics specificity that can provide meaningful insight into the working atmosphere in the secondary mathematics classroom. We investigated this conjecture with mathematics teachers as we describe in the following section of the paper.

Teachers, researchers and educators discuss teaching issues

The core team of our current project (supported by the Ian Hunter Prize-2015) consists of three newly qualified mathematics teachers, one teacher educator (the PGCE tutor of our institution), one experienced teacher, two researchers in mathematics education and two post graduate students who do research in mathematics education (all co-authors of this paper). The aim of this project was the preparation of materials for professional development events for mathematics teachers. The team had five two-hour meetings from December to April. In each one of the meetings the discussion was triggered by mathematics teaching situations (e.g. written by pre-service teachers, classroom videos, etc.). In the first two meetings we focused on three stories that address mathematics teaching issues (e.g. students' disengagement, classroom behaviour, mathematical challenge and students' motivation) and asked the team to read them in advance and think about these issues and how they would encounter them in the classroom. From our discussion we identified themes of mathematical and pedagogical interest, such as: behaviour management and its effect on mathematics teaching; reasons for students' poor engagement: pre-conceptions about students' own mathematical ability; public perceptions about mathematics and its need; parental influence; professional aspirations; and, lack of aspirations, ambition, also in relation to SES, class identity and social mobility; connection of mathematical concepts, also across disciplines; and, institutional pressure (e.g. monitoring, exams, preparation for GCSEs). In the third meeting we focused on the first item of this list with a focus on student disruptive behaviour and potential reasons and how classroom atmosphere can affect the quality of mathematics teaching. We drew on the 10-point Haydn scale (Haydn, 2012) on the working atmosphere and we asked the teachers to identify examples of how the different levels of the scale may mirror the atmosphere in the mathematics classroom. We discussed and elaborated these examples in the meeting towards the creation of a mathematics specific Haydn's 10-point scale – which we tentatively call the *Haydn-M* scale. The fourth and the fifth meetings were dedicated to the elaboration of the Haydn-M scale outcomes which we sample in the next section.

The Haydn-M scale

We asked the newly qualified teachers in our team to use the language of the 10-point Haydn scale to describe situations from their mathematics teaching. The excerpt that follows was suggested by one of these teachers from a class of Year 8.

> I felt I could undertake a risky lesson activity with the class, they were rather 'bubbly' at times and some pupils were not fully engaged 100% of the time but all pupils remained on task when I asked them politely but firmly to behave. No one went out of their way to annoy me or challenge my authority. The context of this lesson was a small but challenging class and I had them stationed around the room measuring various things, temperature of water, weight of a text book, height of a door etc. Since there was water involved it was a risk with the class but after firm words at the start pupils didn't overstep the mark. [Level 7, teacher's characterisation]

We can see in the description the thinking and the effort the teacher has put to establish and maintain a relaxed and co-operative working atmosphere especially towards the implementation of a "risky" activity. She successfully managed to keep students on the task sometimes by asking them "politely but firmly to behave". However, in her reflection about the same class the teacher acknowledges that there are cases in which she needs to change her lesson plan in order to anticipate students' "manic" behaviour:

> This class had itself a reputation around school for being very challenging which is what pushed me to give them the chance with a risky activity but also allowed me to make my expectations very clear before starting the activity. Sometimes the behaviour would be manic – i.e. the pupils were often very excitable in the lesson after lunch (Friday P3 especially) and so I would adapt my teaching and try and book laptops for these lessons where less teaching by me would be done but programmes like manga high were really effective with a class like this and would get them focussed and competitive and engaged where otherwise they might not be. [Level 7, teacher's characterisation]

We summarised the actions taken by the teachers in the situations discussed in our group by adding the mathematics specificity column next to the Haydn scale. In Figure 3 we present an example of this summary especially for Level 7 with the general descriptor of the level in the second column and the mathematics specific descriptor of action in the third column.

Level 7	You can undertake any form of lesson activity, but the class may well be rather 'bubbly' and rowdy: there may be minor instances of a few pupils messing around on the fringes of the lesson but they stop when you ask them politely but firmly to behave. No one goes out of their way to annoy you or challenges your authority.	• You adopt an approach that involves less teaching • You engage students with activities with very clear expectations expressed in advance • You use computers with software for mathematical activities in which students work individually (e.g. Manga High), this creates also competition for the students • You avoid the group work • Your expectations for what you think you can achieve during the lesson are lowered • You go less deeply into some topics/ methods/ reasoning behind methods than you would like • You put additional effort to plan the lesson in advance

Figure 7: Level 7 in Haydn and Haydn-M scale

Discussion

In this paper we discuss outcomes from a preliminary attempt of our team to adapt the Haydn scale of the classroom working atmosphere towards the creation of a descriptor with mathematical specificity (tentatively called Haydn-M scale). We are very interested in the specific actions mathematics teachers would take in their mathematics teaching in response to students' behaviour and in this preliminary stage of our study we have collected experiences from newly qualified teachers. The evidence we have so far indicates that classroom atmosphere affects lesson planning, the thinking and time invested in this planning as well as the type of activities teachers would engage their students. Additionally, the quality of mathematical

engagement might be affected by students' behaviour and teacher's reaction to this behaviour. For example, dealing with a rowdy class may lead to the replacement of more investigatory tasks (e.g. problem solving) with more repetitive activities (e.g. practising with familiar tasks). This is our first attempt of suggesting a descriptor of the interaction between the quality of mathematics teaching and the classroom atmosphere. We work currently with mathematics teachers towards the further elaboration of this descriptor through the collection of more teaching incidents.

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