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How Motivated are Irish Secondary Students to Study Science?

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1. Introduction

This paper presents the initial findings from a study on secondary school students' motivation in science in Ireland. The rationale for this project will be outlined first, before detailing the methodology and the significant findings.

Too many young students are being turned off science too soon. A *State of the Nation* report carried out by the Royal Society of Chemistry in 2008 stated that there are two main dimensions to this problem. [1] Firstly, there is an enduring concern that students are not being engaged and motivated by school science. Secondly, there is the problem of the participation rates of students in science. Students appear to have already "switched-off" from school science before the period of compulsory schooling has ended (age 15-16) and before decisions about continuing subject choices must be made. Furthermore, international studies, such as the *Relevance of Science Education* project, indicate that school science is failing in many ways, for example, where "school science is [regarded as] less interesting than other subjects" [2]. Similar findings have been published in Ireland. For example, a longitudinal study exploring Irish secondary school students' experiences through the junior cycle (lower secondary cycle), found that 2nd year students (13-14 years old) report liking subjects where the learning is organized in an active, project-like way, but, science was not listed as one of these subjects [3].

In addition to this, it should be emphasized that students' engagement and motivation towards science in school depends on age. Bennett and Hogarth's study in the UK found that young students enter secondary school with positive attitudes towards science, however, this positivity declines most sharply between the ages of 11 and 14 [4]. Similarly, the 2011 *Trends in International Mathematics and Science Study* (TIMSS) reported that 53% of the 4th grade students (9-10 years old) who were assessed agreed with the statement that they "like learning science". This is in contrast to only 35% of 8th grade students (13-14 years old) who agreed with this statement [5]. Again, more specifically related to Ireland, it has been noted that this stage (13-14 years old, second year in secondary school) is the critical point where students either engage or disengage from schooling in general [6].

On a final note, it must be acknowledged that schools, like their students, have their own culture: they have their traditions and legacies, their values, their ambitions and their accountability to parents and society at large. Against this backdrop, some retain a traditional structure, based on older practices, linked to a points-driven examination system which rewards passive, rote learning, and the mastery and retention of material in an uncritical fashion [7]. It is clear that understanding both the relations among facts and theories, and also the ways to find or generate facts and theories are the learning outcomes that are desirable in the 21st century. There has been little systematic research on the teaching methods employed in Irish secondary schools but existing evidence points to the dominance of more didactic approaches [8]. It has been found in many international studies, however, that young people favour experiential learning [9][10][11]. Students' views in Ireland on their education, are in keeping with those internationally, where they generally favour "more active learning approaches and lessons which are 'fun' and relevant to their lives" [12].

Hence, the focus of this project is to investigate the problem of students' decline in motivation in lower secondary science in Ireland and to develop an intervention programme to tackle this, through interesting learning environments using context-based and inquiry-based teaching approaches. The overall aim is to see whether a suitable intervention can prevent or alleviate the loss of motivation,

2. Literature Review

Although the term motivation has been alluded to already, it has not yet been defined. It is therefore necessary to clarify what is meant by motivation, particularly in relation to studying at school, and specifically to studying science. Motivation is often referred to as a "catch-all term" that embodies elements of interest, fun, enjoyment and engagement (see Abrahams [13].) On the other hand however, some theories of motivation view it as a unitary phenomenon, "one that varies from very little…. to a great deal of it" [14]. Even a brief reflection suggests that motivation is hardly a unitary phenomenon. It is, after all, a complex part of human psychology and behaviour which influences how

individuals choose to invest their time, how much energy they exert in any given task, how they think and feel about the task, and how long they persist at the task [15]. Motivation is the driving force by which humans achieve their goals [16][17]. It has been described by Bandura [18] that motivation is based on individual experiences or learning activities and that motivation is situational and context-related. Hence, it can be difficult to quantify or measure students' motivation. The Motivational Learning Environment Questionnaire (MoLE) which was designed by Claus Bolte, is one example of a valid and reliable measurement tool which assesses students' motivation in learning chemistry [19]. It is primarily based upon students' learning environments and measures the difference between students' ideal learning environments in science and their real learning environments. However, the learning environment is not the only factor that affects students' motivation in science. There are numerous orientations or conceptualisations of motivation. These include goal orientation, interest, autonomy, self-efficacy, adolescence, test anxiety, cognitive demand, control of learning beliefs, and many more. Four main orientations have been identified, which tend to dominate students' learning motivation: self-efficacy, individual's goal orientation, task value and learning environment [20][21][22]. These orientations were therefore given high priority when designing the tool used to assess students' levels of motivation in this study.

3. Methodology

The following research questions directed this study:

- What factors affect student motivation in Junior Certificate (lower secondary) science from the perspective of both students and teachers?
- If students' motivation during the Junior Certificate science course does decline, at what stage does this happen?

This investigation involved designing two questionnaires: a Student Questionnaire and a Teacher Questionnaire. The Student Questionnaire had four sections, which sought information about the students' attitudes towards science, the teaching approaches used in their science lessons, their motivation in science and their plans for careers in science. The Teacher Questionnaire contained one main section and aimed to discover the factors which they perceive to affect their students' motivation in science. Both questionnaires were piloted: the Teacher Questionnaire with 3 teachers and 2 science education researchers, and the Student Questionnaire with 100 students from a mixed second-level school, with the students ranging from 1st year (12-13 years) to 3rd year (14-15 years), paralleling that of the main sample.

For the main study a representative sample of 100 second level schools was selected from a list of the second-level schools (N=212) in Munster (which is a province in Ireland), using a stratified sampling approach. It was possible to use Munster as the sampling frame for this study as the schools in Munster are representative of the national cohort of schools (N=721). Three Teacher Questionnaires were sent to each of the 100 schools (N=300). In total, 50 Teacher Questionnaires were returned from 21 schools (16.7%).The Student Questionnaires were administered to 11 schools which showed interest in allowing their students to partake in the study. 1,427 Student Questionnaires were returned from 10 of the 11 interested schools (N=2330, 61.2% response). SPSS Version 20.0 was used to analyse the responses in the questionnaires.

4. Results

This section of the paper will outline a sample of the significant findings from the study. The results from the Student Questionnaire will be presented first, before briefly looking at the findings from the Teacher Questionnaire.

4.1 Student Questionnaire

The 1,427 lower secondary science students who took part in this investigation reported, using a five-point scale, that they do not find science in school particularly relevant (2.3), interesting (2.4) or difficult (2.6) (A median value, included here in brackets, greater than 3 indicates a positive response).With regard to the relevance of science in school, students' opinions about the 'point of studying science in school' differed significantly depending on the year group (p=0.001).The older the year group, the less "point" they saw in studying science in school. There was also a significant difference between students who feel that they "would enjoy school more if there were no science classes" and their year group (p=0.001). The older the year group, the more they agreed with the statement. Interestingly, there proved to be no significant difference between their year group and how boring students find science class (p=0.738).

From the second part of the Student Questionnaire, dealing with teaching approaches used in science class, it was found that students are most exposed to didactic learning environments (see Fig.1.)

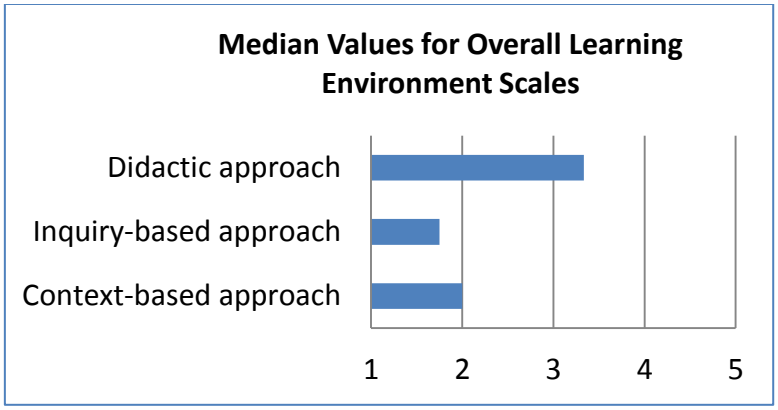

Figure 1. *Graph of the Median Values for the Overall Learning Environment Scales*.

With regard to the learning environments in science class, 80.5% of students stated, again using a five-point Likert scale (1= Never, 2= Hardly any classes, 3= Some classes, 4=Most classes, 5= All classes) that most/all science classes are spent listening "to the teacher explain science ideas". This does not differ significantly with year group (p=0.146). Furthermore, a mere 37.2% of students reported that they "think about a science problem before it is explained to [them] by [their] teacher" in most/all classes, and again, there was no significant difference with year group (p=0.466).
Focusing on the students' motivation in science class, results from this part of the questionnaire indicate that students show higher levels of extrinsic goal motivation than any of the other tested motivational variables (intrinsic goal orientation, self-efficacy and control of learning beliefs). It should be noted that there was no significant difference with their year group (p=0.145) or gender (p=0.133) for the statement: "My main goal in science class is to get a good grade". On a final note with regards to students' motivation in science, males show higher levels of self-efficacy than females, and there was a significant difference between the following statement and gender: "I am not as good at science as most of the other students in my class" (p >0.001).

4.2 Teacher Questionnaire

The consensus from teachers is that "students' interest in science declines as they progress from 1^{s} to 3rd year" with the most dramatic fall-off occurring during the first year, when most students have their first formal exposure to science (see Fig. 2). Analysis of the qualitative data from the Teacher Questionnaires is on-going.

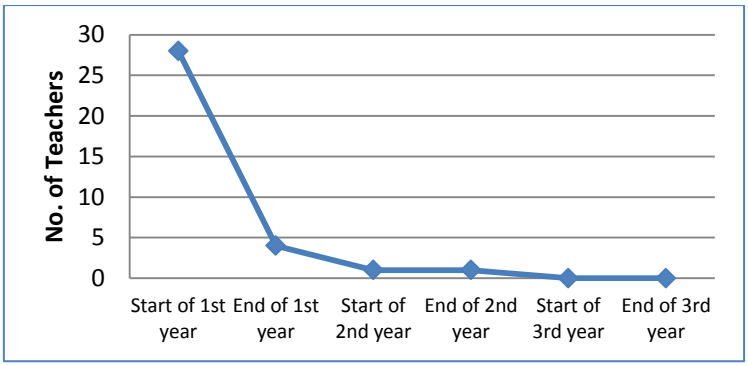

Figure 2. *Graph of the Stages when Students are Most Interested in Science as Perceived by Science Teachers.*

5. Discussion and Conclusions

The results from this study will be discussed with reference to the four main motivation orientations as mentioned above.

5.1 Task Value

Task value beliefs focus on the general question of "Why do I want to do this task?" In short, it concerns the beliefs about the importance and utility of the subject matter domain, in this case science [23]. The science students who were surveyed in this study do not see the relevance or importance of studying science in school. The older groups saw less value in studying science than the younger year groups, where the difference between the groups was highly significant ($p=0.001$). This is in line with the teachers' perceptions that students are most interested in science in first year and least interested in third year. Possible factors affecting this result could be that the teaching methods used in science classes do not engage and motivate students, and the "novelty" of studying a new subject may wear off as students progress through school. It is also possible that the course demands may increase with years in school as the focus in external examinations increases.

5.2 Learning Environments

In relation to learning environments, findings from this study are in accordance with findings from the TALIS study, which reports that the dominant teaching approach in Irish secondary schools is didactic [8]. A large majority (80.5%) of student respondents in our project stated that most and or all of their science class time is spent listening to their teacher explain science ideas. This is possibly one of the reasons why students' motivation in science declines as they progress through their schooling. The dominance of teacher-led instruction has been suggested as the cause of this decline by several science and mathematics education researchers [24][25][26].

5.3 Goal Orientation

Goal orientation theory proposes that there are two general goal orientations, which concern the purposes individuals are pursuing when approaching and engaging in a task [27]. For this study they were referred to as intrinsic (where individuals are concerned with increasing their competence for their own sake) and extrinsic goal (where individuals are concerned with gaining favorable external assessment of their competence) orientation. It was found that the students in this study were more extrinsically goal orientated than intrinsically. Students who responded to the statement that their "main goals in science class is to get a good grade" did not differ significantly by year group ($p=0.145$) nor by gender ($p=0.133$). It must be said that this is not surprising, given the importance that is placed upon grades and examination results in Ireland, not just in education but in society as a whole.

5.4 Self-Efficacy

Self-efficacy refers to the students' beliefs that they have the resources and confidence to do the tasks in the classroom. It concerns the specific social cognitive judgments of one's capabilities [28]. In this study, males showed higher levels of self-efficacy than females, where there was a very highly significant difference between gender and those that agreed with the statement "I am not as good at science as most of the other students in my class" ($p > 0.001$). While males do tend to show higher levels of self-efficacy in mathematics, they do not necessarily show higher levels of self-efficacy in science as shown in the 2006 PISA study [29].

5.5 Conclusion

It is clear that there is a need to inspire and motivate students in Ireland to study science at school. Students do not find science at school relevant or interesting, and are mostly motivated to study it for extrinsic reasons.

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