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The Effectiveness of Physics Lab Reports and Practical Tests as Assessment Tools of Practical Skills

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Abstract

In Malta, at Secondary Education Certificate (SEC) level – equivalent to the British GCSE – candidates' practical skills in Physics are assessed through written laboratory reports. Despite criticism of this assessment mode by researchers, research studies into other assessment modes for reliable feedback on practical skills are non-existent. This study investigates the appropriateness of the assessment of practical skills through the current mode, and whether practical tests can be better assessment tools for such skills. The qualitative approach adopted was ethnographic and was carried out with two groups of Physics students: one group exposed to practical tests and written laboratory reports, and the other group presenting laboratory reports only. All 36 students underwent a practical exam at the end of the scholastic year, during which they used the think-aloud method; they were video-recorded. Data collection included students' written documents, verbal and non-verbal communication, for triangulation of data. This study showed that assessment based solely on lab reports does not give suitable feedback on students' practical skills. It was concluded that practical tests should accompany, and not replace, the assessment of lab reports for more reliable information about students' practical skills. The feedback regarding practical skills elicited from the students' written work was shown to be limited on its own.

Keywords: *practical work/skills, lab reports, practical tests, feedback*

1. Introduction

1.1 The Aim

The aim of this study was to devise and evaluate methods to assess practical skills better. Often, emphasis is placed on exploring new pedagogies for the acquisition and enhancement of practical skills. However, it is important to have a compatible mode of assessment. This research study sought to investigate whether practical skills are being properly assessed through the current mode of assessment, and if they could be better assessed through practical tests.

1.2 How are Students' Practical Skills being Assessed?

The introduction of the SEC examination system in 1994 included coursework (15% of the final mark) in the science subjects, to give importance to practical skills. Students are required to present a number of practical reports, assessed by educators against a set of criteria specified by the MATSEC Examination Board. The assessment of practical skills is included through the allocation of five marks for '*Actual conduct of experiment including handling of apparatus*', with no further 'specification' on the awarding of these marks. [8]

1.3 Reliability of Current Assessment of Practical Work

Prior to reviewing the reliability of its current mode of assessment, one must consider the primary aim of practical work: is it a reliable tool for what it is primarily intended? Throughout this study, the primary aim of practical work was held as acquiring feedback on students' practical skills and to enable the educator to scaffold students' learning and enhancement of practical skills. It is often assumed that participation in practical work automatically leads to gaining scientific skills. Students' grades for 'traditional' practical work may be incompatible with actual performance. [7] A student might copy results, follow instructions to complete the write-up and achieve a good grade – the grade would reflect the student's diligence rather than proficiency in practical skills. [9] Even when students achieve excellent results, they may feel uncomfortable without errors to discuss and may even introduce stray readings. [13]

1.4 The Need for Change in Assessment of Practical Work

The current assessment mode of lab reports led students to evolve into good cooks rather than good scientists. [15] As the report contributes towards the final grade, only a narrow range of students give it importance as a means of developing and enhancing practical skills. [7] Standardised, external assessment methods influence both students and educators. Behaviour will not change unless the assessment methods are also amended. [4] [7] We may need a more extensive, continuous assessment model during practical sessions throughout the year. [11] There is no simple solution for a valid and reliable method. The use of multiple formats offers more opportunities to demonstrate students' knowledge and skills; disadvantages in one assessment method may be compensated by advantages in another. [6]

2. Methodology

This qualitative research study focused on meanings and processes. The research method adopted must be compatible with the social actions present. In line with the research questions, observations were preferred over interviews since the former include participants' feelings, perceptions and opinions. [3] This study dealt with the assessment of practical skills rather than perceptions about them, and thus required a variety of modes.

The study was carried out in one school, with 36 participants taught by the same teacher: 22 Form IV and 14 Form III students. The two groups were exposed to different assessment strategies during their Physics course. Form III students carried out experiments and completed a lab report as required by the SEC exam, apart from being exposed to a number of practical tests throughout the year. The Form IV students compiled SEC lab reports but were not exposed to practical tests. At the end of the year, both groups had a practical exam, held under the same conditions.

The practical exam was held individually, where students used the think-aloud method. When students write their answer on completion of a task, it usually summarises the whole process. Decisions and discussions underpinning the final answer are often absent. Thus, final answers in the practical exam may not yield all 'information'.

The sessions were video-recorded to identify the students' thinking process and the practical skills used throughout the task. The method provided the verbalization of the students' mental processes. The recordings enabled the researcher to 'revise' the same student, increasing data reliability and validity.

3. Analysis of Results

3.1 Handling Data

Following organisation of the data, it was extracted and analysed. This process consisted of three parts, namely the analysis of: (i) verbal communication; (ii) non-verbal communication; and (iii) students' written results. The process adopted is schematised in Figure 1.

Throughout the extraction and analysis of data, coding as set by Strauss was adopted. [12] The steps marked in blue in Figure 1 represent open coding, where data is condensed into initial categories, themes and codes. The steps marked in yellow represent axial coding, where focus is on connections between themes and pattern formation. The modules marked in green represent selective coding, where the researcher scanned the links and themes and drew comparisons to recombine data and form conclusions.

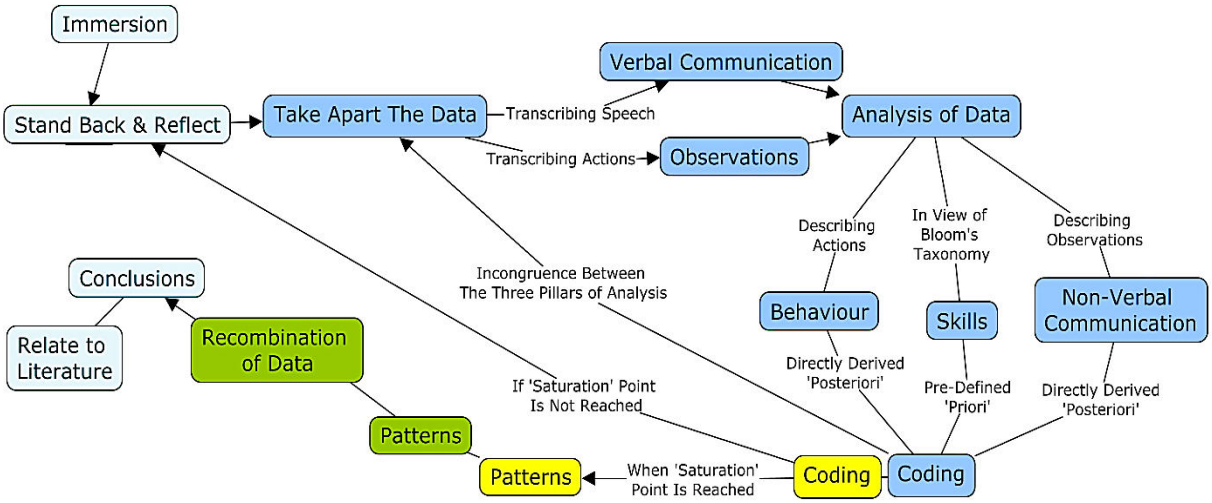

Figure 1. The process of extraction and data analysis (compiled from [1], [2], [10], [12], [14])

3.2 Current Assessment of Practical Work

This research study indicates that current practice in assessment of practical work does not promote the maximum potential in understanding scientific concepts since the feedback does not address the students' true weaknesses. Notwithstanding, the current practice should not be discarded, but rather be enhanced by supplementary practices. Even though some students did not possess 'good' scientific habits, they still managed to achieve good results in certain cases. The lack of understanding, thinking and behaving in a scientific manner alongside the learning of the scientific knowledge were almost 'undetectable' in the students' reports. Consequently, relying solely on the lab reports would hinder the valuable feedback for both student and teacher. It would not be possible to review pedagogies according to students' needs.

3.3 Assessment of Practical Work through Practical Tests

Students distinguished between objects that float or sink based on density values. But the 'succesful' students may still lack the practical, analytical skills and might only be comparing the density values and recalling the fact that denser objects sink, and vice versa. So, by reviewing only students' written work, it would be difficult to assess the competency in analytical skills. Through the practical exam, some students demonstrated their high proficiency in analysis during 'unexpected' occurences during practical work. Through feedback from the practical exam, the teacher would be able to re-evaluate the teaching pedagogy, which would have not been achieved through the assessment of laboratory reports only.

3.4 Promoting Practical Tests as an Assessment Tool

Evidence from this study shows that using practical tests as an assessment tool provides better feedback about practical skills. Integrating practical tests within the current assessment system may seem time consuming. It is recommended that educators have a form for each student throughout the three-year course. The teacher can conduct practical tests in various topics, where students are required to use practical skills. It would be impossible to assess each student on each skill during the same session. The teacher can organize practical tests according to what has been assessed and has yet to be observed. Should students fail to demonstrate a skill in one test, the teacher would plan: (i) sessions where students need to practice practical skills; and (ii) other tests where students can demonstrate these skills. Thus, students will be given the opportunity to work on their weaknesses and improve their learning. Such tests will consider students individually rather than in relation to others, and help to "identify strengths and weaknesses individuals might have so as to aid their educational progress." [5, p.8] The skill of writing a report and using technical vocabulary constitute a very small proportion of these skills. Thus, the frequency of written lab reports should be reviewed, whilst exploring alternative methods of assessment such as practical tests.

4. Conclusion

This research study indicated that the current assessment mode of practical work is not effective in providing useful feedback about practical skills. It exposed how students who do not own given practical skills can still 'conduct' practical activities and create 'good' laboratory reports – at the expense of very 'limited' feedback regarding students' practical skills and not being able to act on such lack of skills. Practical tests should not replace the assessment of lab reports (students also learn how to present a scientific report), but should rather compliment them for more reliable information about students' practical skills. The frequency of written lab reports should be re-evaluated and adapted according to students' needs by the teachers themselves, rather than 'imposed' by an external examination body. Better assessment of practical skills leads to better opportunities – for both students and teachers – to identify and work on the weaknesses, which is the primary function of assessment.

5. References

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