‘Compensatory learning in Mathematics through additional supportive teaching for students with vocational-oriented knowledge background: An Action Research Project for Motorsport Technology students’

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I. Background and Aim of the Action Research Project (ARP)

The ‘Applied Analytical Methods’ (AAM) module is a Mathematical module addressing to first year undergraduate students of the ‘B.Sc. in Motorsport Technology’ course of the University of Bolton. Most of the students attending this course experience serious difficulties in Mathematics, which most probably originate from their vocational-oriented educational background. Motivated by this, an ARP was developed i.e., a process where the researcher tried to enhance their teaching practice through a ‘self-reflective enquiry’ and a continuous planning, evaluation and amendment of each step of this process (Infed.org, 2015).

This research project was developed during the first semester of the academic year 2014-2015 in the area of Motorsport Technology and explores whether learners with a vocational-oriented background can benefit from further support in Mathematics in order to successfully complete their undergraduate studies and possible measures that could be taken towards this direction. My concerns that have been raised since January 2014 and have brought this ARP forth may be summarised as follows:

1. The AAM module aims to provide students with the mathematical aspects and skills that are necessary for the second and third year engineering related modules of the course and
2. Internal reports of the University of Bolton state that the highest percentage of students that withdraw from their studies hold a Level 3 **National Vocational Qualification (NVQ)**.

Entry requirements for learners with vocational-oriented background

➢ The majority of students with vocational-oriented background who join the first year (Level 4) of Automotive and Motorsport related courses in HE hold either:

(i) a Level 2 qualification from the **Institute of the Motor Industry (IMI)** and they have also completed a HE **Foundation Course (FC)** (Level 3) or

(ii) a Level 3 automotive-related qualification from the **Business and Technology Education Council (BTEC)** and most of them have also completed a HE FC (Level 3).

II. NVQs in Automotives

(i) IMI qualification & HE FC

The mathematics educational material delivered to IMI students forms part of the **‘Functional Skills’ (FS)** module of the IMI qualification curriculum. However, FS is a module which is not dedicated entirely to Mathematics; specifically, it includes the following topics: a. Information and Communications Technology (ICT), b. Mathematics, c. English Reading and d. English Writing (IMI Institute of the Motor Industry, 2014).

➢ Therefore, in most cases, mathematical topics are not satisfactorily covered to the level required for a Level 3 Foundation course of Engineering in the HE. The Mathematics module(s) of the FC, succeeding those of the IMI qualification, are not often sufficient in order to rectify the learners’ mathematical weaknesses.

(ii) BTEC qualification & HE FC

Students may join Automotive and Motorsport related courses via a FC in HE holding any of the following BTEC (Level 3) qualifications: Diploma (120 credits) or Extended Diploma (180 credits) either in Vehicle Technology or in Vehicle Technology (Motorsports). Since these learners have reached Level 3 of the **Qualifications and Credit Framework (QCF)** they should be able to join the first year of a HE course directly. However, they tend to face difficulties in Mathematics since the mathematical-related modules namely, the ‘Applications of Vehicle Science’ and ‘Mathematics for Engineering Technicians’ of the corresponding BTEC courses are optional (Pearson Qualifications, 2014) and are not often selected by the BTEC students.

➢ Consequently, in most cases BTEC Level 3 students are either strongly encouraged to join the FC or are required to undertake a Mathematics Diagnostic Test and go through an interview in order for the academic admissions’ group to determine whether they should join year one directly or join the FC as a preparatory stage for their undergraduate studies.

III. ARP – Structure and Implementation

The ARP examined here aimed to enable learners with vocational-oriented background who have joined the B.Sc. in Motorsport Technology course to:

- Identify the topic(s) in Mathematics in which they experience difficulties and
- Strengthen their mathematical background via supportive teaching.

The tools used in the ARP towards the above aims include:

i. Mathematics Diagnostic Tests (DTs) (Appleby, 2003) **and Short Workbook Tests (WTs)**.

These Tests are used to identify the learners with the weakest background in Mathematics and to monitor their progress.

- The DTs and the WTs were completed by the learners during the academic Semester; approximately the time duration of each DT was 1 hour and of each WT 15 minutes.
- The material of each DT covered syllabus from GCSEs up to AS/A levels and the material of each WT was focusing on a certain topic in Mathematics, e.g. logarithms.

ii. Additional teaching of Mathematics and Homework.

The students who were identified with significant weaknesses in Mathematics were asked to attend teaching sessions of the ‘Foundation Mathematics’ module (Year 0) in parallel with the AAM (Year 1) module. Furthermore, additional homework was given to these learners in order to assist them in developing their background.

iii. Motivated Strategies for Learning (MSL) Questionnaire (Pintrich & DeGroot, 1990). These Questionnaires were delivered to the students at the beginning and towards the end of the academic semester. The MSL Questionnaire aimed to inform the teacher about the students’ learning approach as wells as whether this approach had been differentiated during the semester.

IV. ARP – Results & Facts

The most important Results and Facts related to the ARP may be summarized as follows:

➢ The educational material included in all three DTs (i.e. DT I, II & III) was similar in terms of mathematical content in order to monitor the progress of each student throughout the academic semester with respect to certain topics in Mathematics.

- The learners were allowed to use calculators for the DT II and the DT III.

➢ Based on the results obtained from the DT I, it was recommended that eight out of total number of students (fourteen students) of the AAM module should attend, on a weekly basis, a certain number of hours of the Foundation Mathematics module.

- However, the attendance of these students was very poor despite the teacher’s constant prompts to attend.

➢ Nine out of the total number of students participated in either two or three out of the three DTs; the majority of these nine learners had vocational oriented background.

- The mark obtained by each one of these nine students was increased each time; the overall average marks regarding the DT I, DT II and DT III were 34.1%, 49.2% and 57.7%, respectively.
- Five out of these nine learners had been selected to attend classes of the Foundation Mathematics module.

V. Observations & Conclusions based on the DTs, the MSL Questionnaire, the Factual Diary and conversations with the learners.

- **Transition from FE to HE.** The admission teams in HE should inform the students who have obtained a Further Education (FE) qualification and wish to join HE in more detail about the differences between these two sectors in terms of teaching, learning, independent thinking and intensive self-study requirements, as has also been reported by Voake *et al.* (2013). Moreover, potential HE Engineering students with vocational oriented background should be informed of the increased mathematical content of most modules (Hodgen *et al.*, 2014) and University staff should be in the position to verify that the potential students meet the requirements of HE regarding Mathematics (please also see Section II).
  The aforementioned observations are in line with the answers that the students gave to the MSL Questionnaire and the notes from the Factual Diary: students joining the HE from FE admitted that during the first academic semester they realized that the Mathematics related module was more difficult compared to what they had expected and hence, they were feeling anxiety about Tests and Exams.
- **Structured material and Feedback.** It is important to provide the learners who have a weak background in Mathematics with well-structured material in terms of theory and worked examples. The participation of the students in Phase Tests and the provision of feedback to the teacher are also very important parameters (Cole, 2009; Section IV).
- **Diagnostic Tests.** The role of Diagnostic Tests for all students joining the B.Sc. course in Motorsport Technology is crucial. The initial Diagnostic Test helps the teacher have an idea, an initial estimation about the mathematical level of the students in order to support each one of them individually based on their identified weaknesses; Diagnostic Tests delivered during the academic semester enable the teacher to monitor the progress of each learner (Hobson, 2009; Section IV).
- **Additional Supportive teaching.** The School of Engineering could recommend to the students with weak mathematical background to attend certain lectures of the Foundation ‘Mathematics’ module. However, it is important that these additional lectures should be agreed in advance with the learners, in order to suit their schedule (Factual Diary; Section IV).
- **Mathematics & FE.** BTEC Level 3 graduates from Automotive related courses who wish to join an HE course in Automotives should select and complete successfully the (optional) Mathematics- related modules delivered by their FE course. Similarly, IMI graduates should attend additional classes of Mathematics in order to reach the appropriate level before joining a FC in HE (Section II).
- **Mathematics Software.** The students should be introduced from Year 1 to a Mathematics software programme such as Matlab, in order to assist them in the learning process.

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