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Towards an engineering approach to quality in engineering education

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***Abstract*—Education quality is handled at many different levels in an education system, ranging all the way from external reviews of education programs at the top university level to the creation of effective learning conditions for students at the practitioners level. Each level has its own processes for quality assurance, and those processes are usually quite different. Here, I suggest one way of joining the different quality processes into a coherent model, which at the same time retain the main conceptual ideas of the already existing quality processes. The proposed model is presented as a flow diagram of an education system together with an idea about how to create both a trouble-shooting and a quality enhancement scheme based on this model. The model is inspired by the way engineers look at quality assurance in engineering systems and it can, hence, be particularly interesting for engineering educations.**

***Index Terms*—Engineering education, quality assurance, flow diagram, trouble-shooting, quality enhancement**

I. Introduction

In a complex activity such as a program education, it is often difficult to handle quality issues which leads to multiple models of quality [1]. However, a multitude of quality concepts slows down the basic requirement of any efficient quality system to be able to early detect errors and take swift actions to correct them. Also, real education quality systems should even go one step further and include quality enhancement processes where the continuous and active search for improvements is a built-in factor [2]. One major obstacle for developing quality concepts is that education quality evaluation often uses a management perspective based on compliance and accountability, which has turned out to have little to do with student learning experiences [3]. In addition, it seems that accreditation of educations is a poor mean to encourage improvements [4].

On the other hand, research studies on successful education programs indicate another path, where quality processes that are closely connected to daily work are important [5]. This is seemingly consistent with evidence that assessment of learning outcomes is one way for creating improvement [6]. In this paper, I suggest a structured way of thinking about these issues starting from a basic learning perspective.

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The model is based on the somewhat ad hoc assumption (based on teacher experience) that real education quality should primarily be related to student learning and its efficiency. This is seemingly consistent with the results mentioned before. In such a case, quality involves three main factors.

- Output quality – how much are students actually able to do when they leave their education.
- Enhancement quality – how much have students increased their learning during their education.
- Efficiency quality – what is the minimum study time needed to achieve this.

In the following, I will describe a model that promotes this and give a suggestion about how to implement trouble-shooting and quality enhancement processes within the model.

II. The proposed education model

We start by noting that the quality concepts described above are somewhat interrelated and concerns two maximizations (student ability and student enhancement) and one physical limitation (study time). Since student output quality is coupled to student input quality, the most relevant way to think about education quality is to look for enhancement quality under the constraint of fixed student time or in other words "how much do students learn per semester?". It is important to realize that institution economy should be kept separate from learning quality discussions and economy should, hence, be treated as a limitation in the problem, not a steering factor.

I represent the proposed model by a flow diagram describing how an education system could be organized today as shown in Fig. 1, where a clear distinction between planned learning flow (blue arrows) and actual learning flow (green arrows) is made. For the moment, this represents an idealized situation where all students meet all the planned assessment criteria at all checkpoints in the system and the assessment criteria are relevant for the chosen education program. The model consists of four levels with a top external level giving input from the society to the program (activities not handled by the university is marked by read). At the university, the overall education goals are decided at the program planning level and divided onto courses. The teacher's work lies at the course planning level and at the course running level.

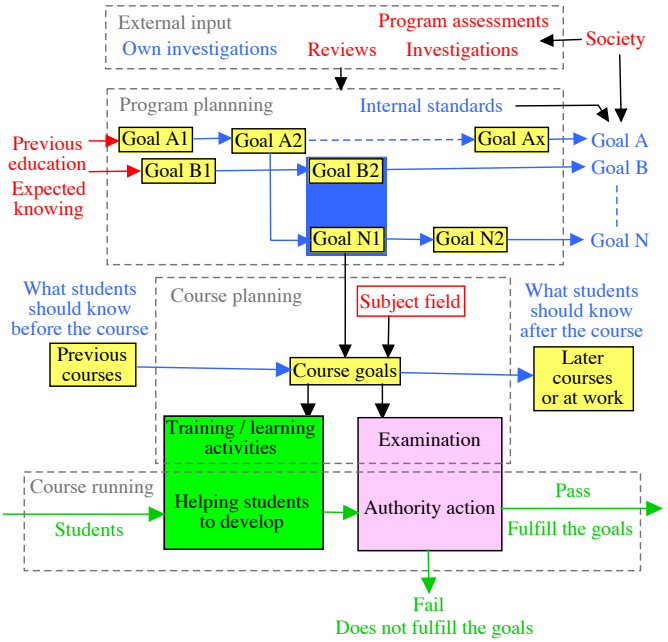

Fig 1. In the ideal education model, students have reached all the learning goals in previous courses when entering a new course. Here, red coloring represent external input where the university is not in charge, yellow boxes represent courses, blue coloring represent planning within university, green coloring represent student flow and black arrows represent directive input.

This flow diagram includes most of the already existing conceptual ideas for quality work at a university, including external quality reviews and assessments at the top level [7], a CDIO-like course planning structure at the program level [8] and constructive alignment at the course planning level [9]. An obvious advantage of the flow diagram in Fig. 1 is that it makes all this visible for faculty and puts quality work into its perspective promoting better student learning. It also clarifies the connection between program goals and course goals. Hence, it could probably be a good tool for faculty to use when they discuss education quality.

III. Trouble-shooting and quality enhancement

Let us now look at Fig. 1 and ask the important question how to use it for trouble-shooting and quality enhancement. Trouble-shooting turns out to be a relatively simple task – every arrow in the model represents a flow where a potential error can occur. Since an error in the system is represented by a deviation between the planned student knowledge and the actual student knowledge as shown in Fig. 2, it is rather simple to implement methods for trouble-shooting and corrections. If students know too little when entering a course, they have problems to cope with their studies and if they know too much, their study time is not used in the best way. Both of these cases are undesirable. In addition, if students can pass a course without achieving the desired knowing, errors will proliferate in the system and degrade the education program.

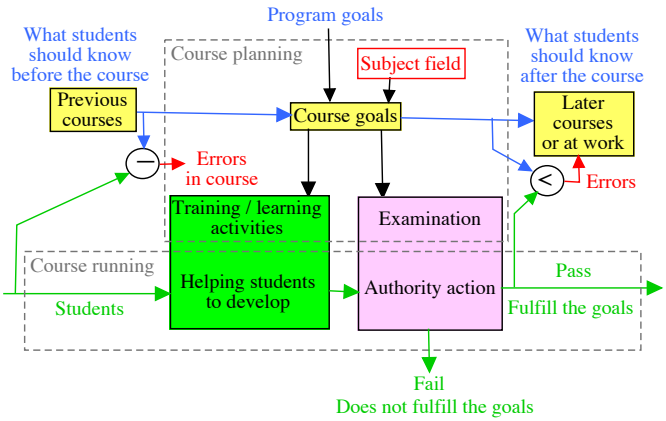

Fig 2. System errors occur when there is a difference between what students should know according to the planning and what they actually know. If students know too little, they have problems passing the course and if they know more than expected, education resources are not used in the best way.

Finally, the model could probably also be used to think about how to implement enhancement of student learning in the system. There are at least three system options to enhance student learning: i) by a better program design, ii) by a more efficient use of student time and/or iii) by a better alignment to course goals. To these factors should of course psychological factors related to students, teachers and the relation between them be added, like e.g. student motivation, teacher clarity or classroom inclusiveness.

This model is still under development and I welcome all comments and suggestions for improvements as well as suggestions for alternative models during the round-table discussions.

Acknowledgment

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