CHARACTERISTICS OF MEANINGFUL CHEMISTRY EDUCATION

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ABSTRACT

In this paper we elaborate on three potential strategies to promote meaningful chemistry education: using relevant contexts, offering content on a need-to-know basis, and making students feel that their input matters. We illustrate that it is educationally worthwhile to incorporate these characteristics, through our work on a particular chemistry module. Such emphasis leads to concrete, empirically based designs of modules and to heuristic guidelines for educational design decisions. It also productively informs further theorizing, such as an improved conceptualisation of the relations between the three characteristics. We therefore suggest that the type of investigation discussed in this paper, and the scenario-based design method which goes along with it, deserves a more prominent place in science education research.

1. INTRODUCTION

From several analyses of science education, three main problematic features of student learning emerge: ‘rhetoric of conclusions’ (Schwab, 1962; De Vos *et al.*, 2002), ‘incoherencies’ (Roberts, 1982; De Vos & Pilot, 2001), and ‘lack of student input’ (Lemke, 1990). It is argued that these problematic features, which play a role at the levels of the entire curriculum, of one module, and one lesson, contribute to an experienced alienation and lack of sense of direction for students.

Several attempts have been made to pay attention to these problematic features by designing more ‘meaningful’ chemistry education, ranging from more or less isolated projects, designed as small-scale experiments or welcome additions to the existing curriculum, to projects that aim to reform the curriculum. Some well-known projects are: PLON, Salters’, ChemCom, Chemie im Kontext, The Wide River Project, and Chemistry in Products. Even if not explicitly labelled as such, in all of these projects three intertwined ‘characteristics of meaningful education’ generally can be seen to play a role: (1) context, (2) need to know, and (3) attention to student input.

We adopt these characteristics, at least tentatively, as offering potential solutions for the problematic features indicated. With respect to the *context* characteristic, it can be argued that a well defined, and, for students, recognisable context will motivate them and provide the concepts involved with a distinct function and therefore meaning. When the emphasis has shifted from ‘getting an overview of the conceptual products of chemistry’ to the ‘functionality of concepts in relation to a certain relevant, recognisable context’, the ‘rhetoric of conclusions’ and ‘incoherencies’ features can be avoided. Instead, a consistent development of

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concepts might be achieved. It can also be argued that addressing students' questions on a *need to know* basis will provide for an increasing involvement of students in the teaching-learning process, because they will see the point of what they learn every step of the way. This *need to know* characteristic can avoid 'incoherencies' and students asking 'why are we learning this?'. Together with the *context* characteristic, the development of a consistent emphasis might be enabled. The *attention to student input* characteristic is closely related to the *need-to-know* characteristic. If one proposes to incorporate a need-to-know approach in the design of a teaching-learning process, attention to input from students seems inevitable if the latter are to experience the functionality of 'what comes next'. Obviously, this characteristic addresses the problematic 'lack of student input' feature.

It is one thing to argue for these three characteristics as providing general design directions for meaningful science education. It is quite another to work out or incorporate these characteristics in concrete designs of science modules so that the characteristics contribute in an empirically justified and theoretically explainable way to solving the identified problems. In this paper we first of all illustrate, with our work on a particular chemistry module, that this emphasis on characteristics is educationally very worthwhile. It leads to non-trivial findings and challenges, and may also productively inform further theorizing. We close with a plea that this often neglected and underestimated area deserves a more prominent place in educational research.

2. GIVING CONTENT TO THE THREE CHARACTERISTICS OF MEANINGFUL EDUCATION

Research strategy

Taking as the object of our research 'to adequately incorporate the three characteristics of meaningful learning in concrete designs of science modules' has had several implications. Firstly, it has determined the questions we aim to answer. For instance, do students really experience what they are doing now, as enabling them to get a better understanding of this context (*need to know*), is the context really motivating enough to make them want to reach that understanding (*context*), and will they really feel that their input matters in reaching that understanding (*attention to student input*)? If the answers to these questions is yes, do they do this for the reasons we intended; and if not, can we understand why and improve matters? Secondly, if we want to answer such questions we need a specific, suitable research strategy: scenario-based developmental research (Lijnse, 1995). In what we call a 'scenario', we give an argued expectation about what will happen with respect to every step of the designed teaching-learning process. These expectations are described down to the level of expected answers, emerging discussions, questions raised with students, and so on. This includes an explanation of *why* this will contribute to the intended aims. In the case at hand, it concerns especially the steps in which we have incorporated one or more of the 'characteristics of meaningful education'.