Learning as Action
A Social Science Approach to the Evaluation of Interactive Media

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Abstract:
After outlining some problems of evaluation methods that are commonly used in the attempt to assure the quality of interactive educational media, the authors present their heuristic model of the learning process. It has the advantage of bringing the social aim and situation of the learning process into focus. This model is the basis for a qualitative approach to software evaluation which helps to define appropriate and creative settings for the use of the software.

1. Problems of Educational Software Evaluation

The problem of quality in interactive ecuational media has accompanied the field since its beginnings. Numerous researchers tried to define criteria of software quality and to compile catalogues from them (see [Doll 1987], [Thomé 1989], among others). The idea was to translate these catalogues into checklists that could be of practical use for teachers and trainers in judging educational media.

Checklists have the advantage of being cheap and simple to use: no software users (= learners) are needed. But this is also their disadvantage: they cannot make predictions on the context, that is, the specific target group, learning goals, situations etc., in which the software can be more or less usable. What they are left to check are those aspects that can be tested and judged without context. These are, however, mostly those questions that can be applied to any kind of software, i.e. whether it is robust, error-free, well-designed, well documented, easy to learn and user-friendly. The specific character of educational media has to remain outside this method.

Empirical methods of evaluation, on the other hand, are costly and time-consuming. They are applied to only a few selected cases of software (often those programs developed by the researchers themselves). One well-known method is based on the comparison of groups of learners. One group works with media support, while the reference group - which has to be comparable in age and gender distribution, prior knowledge etc. - works without software support - with books, classroom teaching etc.). The comparison (most of the time by standard tests) of both groups is supposed to reveal the difference that results from the use of interactive media - be it positive or negative.

For all its complexity, this method has its pitfalls, too. What can be tested objectively is the memory of the contents learned. However, this amounts to an implicit reduction of learning to the mere reproduction of facts. Furthermore, test groups would be, strictly speaking, only really comparable if both traditional and technology supported teaching were completely identical in contents, goals and methods. But if new media are used in this way, they rightly provoke the question what, in these circumstances, is "new" in them.

The problem with both methods is that they reduce the learning process to a number of individual factors: lists of criteria consider the software without the learners, and comparative studies, while considering the learners, treat them as isolated receptacles of knowledge. Learning with software is, however, a social process in at least two ways: first, it takes place in a certain social situation (in the classroom, at work, at home) and is motivated by it. Secondly, any relevant learning process has as its goal the ability to cope with the social situation (professional or everyday tasks, etc.). The evaluation of interactive media then has to satisfy three conditions:

1. It has to take into account the social situation in which the media are used, and must not be limited to the media themselves
2. It has to take into account the goal of dealing with complex social situations and must not limit itself to the isolated individual learner.
3. It must take into account the specific forms of interaction between the learner and society. These interactions range from the passive reception of static knowledge to the active design of complex, dynamic situations that characterizes the "expert".

These requirements eliminate evaluation methods that can only pick out single factors. At the same time, they make an "objective" discussion of media quality difficult. In what follows, we will first outline a heuristic learning model that can be used to define and to design learning situations on the basis of these three conditions. We will then try to propose an evaluation procedure where the concept of absolute quality is replaced by relative values. These values are defined and determined in discourse - with the software, with the situation, and with the scientific community.

2. A Model of the Learning Process

The model that we propose is inspired by the work of Dreyfus and Dreyfus [Dreyfus and Dreyfus 1987] who studied the learning process from novice to expert:

1. A novice who does not know anything of the subject he/she is approaching has to start with taking in the facts and rules of it. The application of them to the novice's practice or exercise of the field has to be automatic: the novice cannot decide on which rules to apply and learns them as context-free. Practice is thus limited to imitation, to exercise.

2. The beginner can start to learn the context of the rules, i.e. that there are different rules to apply in different cases. The practice becomes more varied and more adapted to individual cases, but it is still impossible to act autonomously in the field.

3. At the third stage, the competent person grasps all the relevant rules and facts of the field and is, for the first time, able to bring his/her own judgment to each case. This is the stage of learning that is often characterized by the term "problem solving": the conscious and often laborious decision-making process based on the vast repertoire of facts and rules available to the learner.

4. Contrary to most learning theories, this approach, however, does not stop here and does not consider competence to be the final goal of learning. The fourth stage is called fluency and is characterized by the progress of the learner from the step-by-step analysis and solving of the situation to the holistic perception of the gestalt of the situation. Just like the situation, its solution also starts to present itself as a holistic pattern or gestalt together with the problem.

5. This ability of gestalt perception is brought to perfection by the expert, the final stage in the learning process. An expert identifies him/herself with the complex real-life situation in which he/she is bound to act. The "art" of the expert consists not in solving problems, but in constructing them out of the amorphous complexity of life. This act of creating the problem already contains its solution.

Most theories of learning stop - as we mentioned above - at the level of competence. Traditional Artificial Intelligence research with its focus on the representation of facts and rules and on problem solving [Baumgartner and Payr 1995a] has no small part in this narrowing of our perspective on learning. Practitioners and those who are concerned with their education, like Donald Schoen ([Schoen 1983], [Schoen 1987]) have never been satisfied with this view. Schoen's concept of the "practitioner", for example, shows close similarity to the "expert" characterized above, and his writings about the education of practitioners that have inspired so many educationalists offer an account not only of what it means to be a practitioner, but also of what it could mean to "teach" them.

The problem that we saw was the gap between the view of beginners through to competent learners and the view of experts-to-be: There did not seem to be a hint of how learners pass from one level to the other, nor a unified picture of the strategies required for educating experts or practitioners. Out of this need, we developed the heuristic cube model [Fig. 1] that combines the (meta)contents of learning with the goals of the learner and the learning strategies (see [Baumgartner 1991], [Baumgartner 1992], [Baumgartner 1993], [Baumgartner 1995], [Baumgartner and Payr 1994], [Baumgartner and Payr 1995b]).

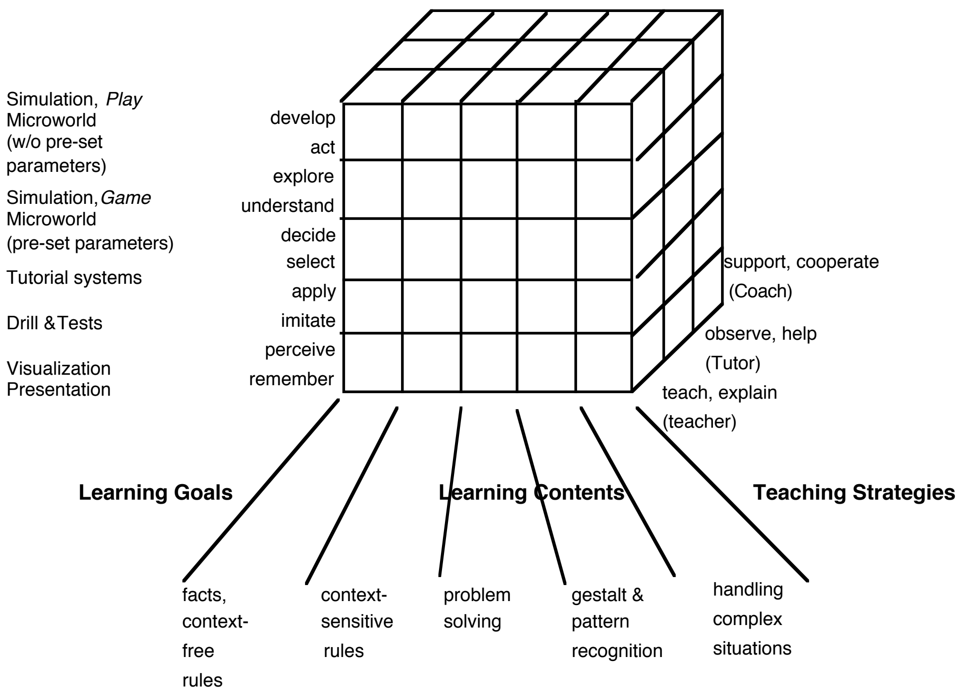

Figure 1: The cube model – a heuristics for defining educational (software) situations.

Learning Contents

From left to right, the cube diagram shows learning contents on the meta-level, i.e., not the "subject", but the task of the learner in a certain stage and situation. This dimension offers a fine-grained differentiation of the coarse subject description (e.g. "equations with two variables"). For example: Should the learners be able to solve the equations given a certain method, should they also be able to choose the adequate method, or should they even be able to extract the equations from an observation or a verbal description? In the first case, the contents of the learning process are context-free rules (like rules for transformation of equations). In the second case, they learn context-sensitive rules, i.e., they have to decide which rules are to be applied in what case. The third level (problem solving) deals with solving given systems of equations. On the more advanced levels, the learners first will have to construct the problem themselves out of a complex, real-life situation, before solving it.

Goals of learning

From bottom to top, the cube represents goals of learning in their order of complexity. This dimension characterizes the types and possibilities of interaction between the learners and the "world" (society, nature). It is based on the experience that novices cannot successfully deduce a solvable problem from a complex real-life situation.

This approach to goals of learning can easily be misunderstood as the reincarnation of traditional, hierarchic notions of learning, where novices had to progress slowly and painfully from rote learning of facts to mindless drill in order to finally be found "worthy" of more complex tasks. This is certainly not what we mean here: rather, this dimension reflects the common experience of learners in which they spontaneously choose those strategies of interaction with the subject that protect them from an overload of complexity. A novice of the language in a foreign country (= complex real-life situation) limits herself, in a first step, to grasping isolated words or idioms in the flow of speech of the natives. Only later will she be able to perceive and analyse longer parts of speech.

Teaching strategies

From the front to the rear, the cube model shows three different teaching strategies. This dimension attempts to outline the role of the teacher, but also that of the educational media: Are they "teachers" (= explaining, demonstratting), "tutors" (= observing, correcting) or "coaches" (= accompanying, participating)?

Learning goals and educational media

Beside the goals of learning (y-axis in the diagram), we put a certain type of educational software. This typology is quite traditional in itself, but, integrated into the general model of learning, it is a starting point for classifying software according to the types of educational interaction it allows, and not only according to design criteria, as is often done. This typology of educational media is done here for only one dimension of the "cube", but could be done equally well for the others. Doubtlessly, there is an affinity between a certain goal, certain contents and a certain educational strategy. For example, we cannot easily imagine how a learner can master complex situations (contents) without acting him/herself (goal) in a situation where the role of the teacher is that of a participating coach (strategy). But what we want to underline by listing all the possible varieties that can lead the learner from novice to expert is that each sensible combination can be justified in a certain learning situation. Contrary to researchers and developers who are mainly concerned with "interesting" cases of educational media and therefore prefer complex media (simulation, games, microworlds) to seemingly "old" and primitive media (tutorials, practice, presentation), we try to express, in this model, that each type and use of media can be justified and adequate, provided that their use is adapted to the situation - the current goals and contents and the appropriate teaching strategy.

It is therefore also important not to lose sight of the "final" goal of the learner, that is, to become an expert or at least a fluent practitioner in the field. This holistic view of the learning process helps to avoid the risk of a narrow and biased view of learning that is often to be seen, especially in the field of educational technology where the (restricted) potential of media often prompts an equally restricted view of learning.

3. Evaluating by Generating Questions

The relevance of this model for the evaluation of educational media lies in the support it gives to the teacher or evaluator in defining the learning situation from the viewpoint of the level that the learners have already reached. By applying it to classes of educational software, it also provides a first orientation not only on the type of media to use, but also on the type of use that could or should be made of this software: most modern educational software packages are complex enough to allow different types of use, e.g. as a pre-defined problem to solve or as an open scenario more or less restricted by pre-set parameters.

To pass from this static analysis of given situations and software functionalities toward a more dynamic approach to evaluation and didactic integration, we suggest a procedure in the form of so-called "generative" questions, as they are used in qualitative social research methods like "grounded theory" ([Glaser and Strauss 1967], [Strauss 1987]) These are questions that open up the problem space, draw attention to the problematic points and make solutions comparable. The "generated" concepts can be compared to the criteria that are used in check-lists. But, instead of being pre-defined, these critera are developed in the context of the given means (media) and ends of the learning situation.

As generative questions address the specific situation, they are not fully predictable. We will try here to define five families of such potential questions. This presentation can neither be complete nor equally relevant for each case:

1. Questions on the relation between different levels of complexity, e.g.: How does the way in which rules are learned prepare the learner for the task of problem solving?

2. Questions concerning one level of complexity: How is complexity increased inside one level? How can complexity be reduced?

3. Questions on (implicit) meta-strategies: How does the software support the aquisition of strategies to control the situation? How does the software help the learner to develop learning strategies (like diagnosis, planning, observation etc.)?

4. Questions concerning teaching strategies: Which methods are used to support the construction of mental models, the learner's own activities, or her growing involvement and responsibility?

5. Questions on the social situation: How is the social context integrated? How does the software prepare the step from virtual to real world? Are there slots for social activities, teacher intervention, and integration of other media?

The aim of the generative questions is to uncover the didactic strategies that underlie the educational medium. In this sense, they are instruments of evaluation or of comparison of different media. At the same time, however, these questions reveal what the medium cannot bring to the learning situation and what must be looked for elsewhere. Educational media, however sophisticated, play only a small part in the complex learning process. The main part - be it the transition to real-life complexity, be it the background of facts and rules - is left to either to the learner or to the designer of the learning process to provide. In this sense, these questions can help them both to put educational media into perspective and to find in them the clues to create a learning situation that is oriented toward the overall goal of educating experts.

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