Learning pathway for advanced science concepts approach: the study of magnetorezistive materials

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Abstract

Advanced science concepts approach requires specific teaching and learning strategies calling on constructivism pedagogy to do. As there are a lot of basic knowledge to be settled down in a short time, teachers need to change their strategies of teaching in favor of the most efficient ones such is using gradation teaching. For a complex perspective of the theme: “the study of magnetorezistive materials” we designed a learning pathway based on learning route of cognitive states. As for a good painting is needed a large scale of tinted bases, for a successful learning process we need to start teaching common basic concepts going to advanced ones through intermediate concepts. A learning pathway describes the function of human brain: “all concepts are stored in the mind like in a department store”. Based on this similarity teachers can build routes/pathways of learning using constructivist strategies. Magnetorezistive materials are used largely in up to date industry and they need more attention in the context of understanding science behind the gadgets we use.

Keywords: learning pathway; constructivism; knowledge construction; magnetorezistive materials; gradation teaching; progressively learning

1. Introduction

Advanced science concepts largely used in today’s language needs explanations to be received in a short time. There are needed new strategies to involve students in their own learning, to make them more interested in subjects as advanced science concepts necessarily to understand the new technologies developing day by day. Using learning pathways can be a solution to offer students the opportunity to view the whole panel of the topic and also the routes to follow as to approach advanced concepts. Even learning pathways are connected with e-learning activities; teachers may use them in a constructivist learning context as the control of choice moves from the tutor to the learner.

2. Constructivist paradigm in science education

Constructivism is one of the most quoted paradigms in pedagogical literature. Constructivist education is connected to Jean Piaget’s research concluding that students construct their own knowledge and values as a result of interactions with the physical and social world. The teacher’s role in a constructivist classroom is to guide students in their own construction of knowledge – challenge them to make predictions about the world, to experiment, to
rethink their own beliefs in light of new evidence. According to cognitive constructivist theory prior conceptions and knowledge structures are major factors influencing science learning (Dhindsa, Makarimi & Anderson, 2010; Anderson, 1992; Ausubel, Novak & Hanesian, 1978; Bodner, 1986; Novak, 1977). According to Ausubel’s theory the most important single factor influencing learning is what the learner already knows (Ausubel, Novak & Hanesian, 1978). Extending Ausubel’s theory Mitchell and Lawson (Mitchell & Lawson, 1988) found that general reasoning ability compared to prior knowledge is more consistent predictor in genetics, further emphasizing the role of active learning and plasticity of thinking in construction of knowledge. In the process of construction of new information, previous knowledge may undergo transformations including (a) conceptual growth (structures will be partly supplemented or broadened or (b) conceptual change (rearrangement of existing and/or development of new cognitive structures (Dhindsa, Makarimi & Anderson 2010). Duit characterizes the relation between conceptual change and cognitive development as follows: Learning is regarded as a process of cognitive development leading from certain pre-instructional conceptions i.e. already existing in the cognitive structure, to a scientific view (Leach and Paulsen, 1999).

3. Learning pathways

The sequence of intermediate steps from preconceptions to target model form what Scott, Niedderer and Goldberg have called a learning pathway. For any particular topic, such a pathway would provide both a theory of instruction and a guideline for teachers and curriculum developers (Clement, 2000). Learning pathways were introduced in discussion by Scott in 1992 (Scott, 1992). A learning pathway may be described as a route of cognitive states starting with prior conceptions and coming to intermediate conceptions during teaching. Intermediate conceptions may be new ideas with some stability and influencing of the further process of learning. According to the theoretical model of cognitive systems consisting of current constructions and a deep structure, the cognitive elements belonging to deep structure having already developed are stable during learning process. A learning pathway can be described by giving evidence to those “metastabile” intermediate conceptions as kind of stepping stones (Brown & Clement, 1992). Projecting a learning pathway starts with the prior conception (Niedderer, Goldberg, 1996). Then it continues with the intermediate conception/conceptions shows. That intermediate conceptions are possible new learning goals (Niedderer, 2001), or may be seen as “stepping stones” (Brown, Clement, 1992). Intermediate conceptions can be described as “conceptual dynamics” in the process of learning (Thornton, 1995). Learning pathways is “a crucial term” describing learning process (Duit, Goldberg, Niedderer, 1992). Intermediate conceptions may be seen as “cognitive attractors” (Duit, 1996). The learning pathway can be finalized to the development of a general argument and be divided in smaller, handle parts, meant for the pedagogical development of specific aspects of the general argument, sometimes referred in literature as Teaching / Learning Sequences.

4. Learning pathway for The Study of Magnetorezistive Materials

Magnetorezistive materials are largely used nowadays in Hi Tech and IT. The new storage devices need to have larger and larger memory, so they must be made of new materials. To be able to understand characterization techniques of magnetorezistive materials is necessarily to have basic elementary physics knowledge. We designed a learning pathway starting to the level 1 for the study of Electric Charge Carrier Phenomena, followed by Giant Magnetorezistence, ending with GMR Systems Characterization Techniques as seen in Figure 1. Going to level 2 students have to approach deeper the basic concepts. For example the study of electric charge carrier phenomena continues with the study of stationary electrical current, then to Boltzmann Equation in relaxing time approximation, Electrical conduction and Magneto conduction. The next step is to make the transition from the concept of resistance to the magnetorezistence (Iofciu, Miron, Dafinei, M., Dafinei, A., 2011). The study of GMR (Giant Magnetorezistance) can be approached as a graphic organiser, or as an interactive informatics tools (Iofciu, Miron, Antohe, 2011).
In Figure 2 are shown the steps to follow for a deeper understanding of the GMR Characterization Techniques (level1). The next step (level2) contains Morphological and structural characterization, Magnetic Characterization and Electrical conduction and Magnetococonducton Measurements Techniques. For the Morphological and Structural Characterization, in level 3 there are opening two paths: Microscopy and X-Rays Diffractionmetry. From Microscopy there are starting new paths (level4) Optical Microscopy and Electronic Microscopy. Finally, at level 5 there are mentioned SEM and TEM.
5. Conclusions

Using learning pathways in the study of advanced science concepts in constructivist approach allows students to learn with greater understanding, focusing on metacognitive processes (Flavell, 1979). As a large display of the whole knowledge content, learning pathways can be used together with graphic organizers to highlight the learning route. This help students reflecting upon metacognitive processes, called metareflection, is conductive to the construction of knowledge.

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