

INTEGRATED NATURAL SCIENCE AS A SCHOOL SUBJECT

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ABSTRACT

This article handles with main ideas, pros and cons of natural science teaching. We reflect the situation in Germany, while we want to give some information for the upcoming Vietnamese situation. Natural Science as school subject is not a new idea but the current development shows that educational political efforts is big in order to implement integrated natural science teaching in school system. An historical insight shows that integrated natural science teaching has always been focused by education scientists, natural scientists, pedagogies, psychologists and education administration.

Keywords: Integrated teaching, Natural Science education, Natural Science teaching.

TÓM TẮT

Dạy học tích hợp môn khoa học tự nhiên

Bài báo này bàn về các quan điểm chính, các thuận lợi và khó khăn của dạy học khoa học tự nhiên. Chúng tôi xem xét lại tình hình ở nước Đức, đồng thời chúng tôi muốn cung cấp thêm thông tin cho tình hình sắp tới ở Việt Nam. Khoa học tự nhiên như là một môn học trong nhà trường và không phải là một ý tưởng mới mẻ, tuy nhiên những phát triển hiện nay cho thấy các nỗ lực chính trị và giáo dục lớn trong việc thực hiện dạy học tích hợp khoa học tự nhiên trong hệ thống trường học. Nghiên cứu sâu trong lịch sử cho thấy dạy học tích hợp khoa học tự nhiên luôn luôn được xem trọng bởi các nhà khoa học giáo dục, khoa học tự nhiên, sư phạm, tâm lí và quản lí giáo dục.

Từ khóa: Dạy học tích hợp, giáo dục khoa học tự nhiên, dạy học khoa học tự nhiên.

1. Situation in Vietnam – Challenge for the Vietnamese Education System

The education reforms will have an impact on the education system in Vietnam. Educational-political decisions concern structure, organization and of course the content of the curricula. There is careful orientation towards pupil's potential, wishes and needs. The reformation measures are seen as necessary in academic professional circles. In public media expert discussions focus pedagogical issues, on the background of the newest scientific developments and understandings.

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The planned implementation of the school subject “Natural science” affect in particular teachers at schools as well as academic lecturers at the corresponding pedagogical, methodological and all natural science institutes. That is our impression from our many researching and lecturing visits at the Ho Chi Minh City University of Education and the Hanoi National University of Education. In many discussions with lecturers of the chemistry departments we have seen that there is a desire to get an insight from another perspective. On this background we have compiled important thoughts of the German scientific community.

2. Situation in Germany – Developments and Tendencies since 1970 Base of our Assessment of Value

We concentrate the developments in Germany in aspects, which seems to be helpful and meaningful for Vietnam from our perspective. We consider relevant literature in German language that we have researched in our Database FADOK (University of Paderborn). FADOK documents and describes about 60.000 publications in professional journals concerning chemical education in the broadest sense since 1900. In our assessment of value we also consider our experiences from longtime profession as teacher, lecturer and researcher.

In the whole period segments the amount of publications concerning integrated natural science teaching have been almost constant (compare Tab). The period until 1980 was dominated by fundamental thoughts concerning integrated natural science teaching (legitimation, education, curricula, themes, implementation and so on). It was hoped to improve the image and the situation of the single disciplines. “Gesamtschulen” (an integrated school form) have been established in 1975. At these schools Natural science have been taught for the first time. Newest publications about theory of an integrated natural science subject focus intensively learning psychological and education theoretical findings. Publications since 2000 are dealing in particular with teaching relevant aspects. In this frame fixations and programs are tested, optimized, therefore reflected and perhaps implemented.

The amount of publications concerning the curricula since 1980 mirrors the political-educational decision. Curricula has been changed in the period between 1970 and 1975. Impulses from outside (USA, UK) have also been “handled”, but without reflecting.

Tab.: Publications in professional journals concerning integrated natural science teaching and curricula in our database FADOK (search term: integr)*

Period	integrated – teaching	integrated – curricula	N
since 1980	19	14	33
1981-2000	21	4	25
2001-2014	28	10	38
N	68	28	95

3. Inter-disciplinarity, Intra-disciplinarity, Disciplinarity – A Complicated Relation in View of Integrated Natural Science Teaching

The efforts for an integrated natural science teaching in Germany are – especially since 1970 – a sensitive indicator for changing educational-political programs and decisions. The “pros” and “cons” for an implementation of an integrated natural science teaching assess the learning psychological dimension of the relation between “Inter-disciplinarity” (Natural science) and disciplinarity (Chemistry, Physics, Biology, Geography,...) in a controversial way: Beginning from the “Entireness” is suitable to life situations and therefore to pupil’s needs but this makes it difficult getting access to the different single disciplines. Teaching the single disciplines is less close to real life and pupil’s needs but that makes it easier for pupils to learn the structure of the discipline, their terms, meanings as well as model imaginations. These arguments still stand opposed to each other in a dialectical and unconnected way. An “objective” decision is complicated and nearly impossible. In addition it is important to notice that integrated natural science teaching, concerning related disciplines, is mostly seen as intra-disciplinary teaching. In Germany the meaning of integration in a pedagogical way is wider, it means the fusion of all subjects with each other. Such a teaching would be an inter-disciplinary teaching in the right understanding of the term “integration”.

4. Main Content for an Integrated Natural Science Teaching – A Problem That Still Needs to Be Solve

An implementation of the subject “Natural science” relies on contents that makes similarities in the diversity learnable for the pupils. This is a very complicated mission, because the contents, the objects of the single disciplines are so different and heterogenic, although all single discipline focus on the first sight on nature and environment. A natural science education could be determined as “general education for all” by the researching methods and processes of the all disciplines, while a differentiation of the single disciplines shouldn’t be neglected. Such complicated issues has been focused in scientific-theoretical reflections since 2000 (compare Tab).

The subject “Natural science” must accent the similarities as well as disciplinary different structures. It would be possible to realize a “real” integrated teaching that mainly handles with the empiric orientated finding methods of the disciplines (experiments, experiences, realities, observations, perceptions, activities) as well as thinking methods in the meaning of model building and modeling. The interaction between research objects and modeling are the base of understandings, interpretations and prognoses. Empiricism and the thinking in models, finding activities of the single natural science disciplines like induction, hypotheses, deduction, hypothetical deduction, generalizing, analyzing, analogy forming, falsification, and so on must be conveyed for learners. Pupil will learn, how knowledge is build and how scientific knowledge is utilized and exploited. Application contexts are independent from cultural influences for example materials, technology, human-being (senses, perception, body, health and so on) occupation, production, environment (weather, universe), economy, ecology, daily life and so on. Meaningful projects in Germany for integrated natural science learning and teaching practice have had different key aspects: PINC (In German “**P**rojekt **I**ntegriertes **N**aturwissenschaftliches **C**urriculum”, in English “Project of integrated natural science curriculum”, about 1975-1980) has focused social, industrial and technological contexts, while the PING project (In German “**P**raxis **I**ntegrierte **N**aturwissenschaftliche **G**rundbildung”, in English “Practice of integrated natural-scientific general education”, started at 1995) has focused individual self-reliance and experiences of pupils.

5. Organization and Structure – In Practice

Each single state of Germany supports and implements the idea “Integration” indifferent ways through administrative measures that means by concrete curricula, school books, learning materials and so on. Integration was an answer to the low efficiency of the single disciplines, especially chemistry and physics. “Sachunterricht” (General studies) at primary school (From 1st until 4th grade) prepares pupils for a integrated natural science teaching. Integration of natural science has been most effectively realized for the 5th and 6th grade (elementary instruction) at a new school type in Germany called “Secondary schools” (since 2010), where integrated natural science teaching bases on tested conceptions and topics. The conception of PING (see above) determines teaching curricula, teaching structure and also teaching practice. At secondary schools integrated natural science has been mostly taught additive in the past: Single subjects has been taught isolated side by side and they have been connected ideological by with common preamble and guidelines. In the frame of model experiments a few schools in Germany have the possibility to develop and modify suitable curricula. The amount of designed curricula has increased in the last past years. That has strengthen the natural science teaching at those schools. In this context science teachers have cooperated successful with each other.

Teacher training - especially for the primary school – must face the challenge training students for “Natural science”. In the past students had to study all academic single disciplines, that means also additive. It is feared that such a model could strengthen the role of the teacher as a scientist, because science teacher must have solid knowledge and competences in every single discipline. But findings show that studying “Natural science” could also boost reflecting competences and the interests in didactical issues of the teacher students. In the last past years several universities have established study programs that adapted the reformations, while their evaluations are also base of the research projects. Educational Politics invest a lot in further education for natural science teacher. There is a lot of additional support by Chemists, Chemical industry, Economy, Teacher organizations, foundations and so on. They all invest a lot of efforts to the MINT-program (**M**athematics, **I**nformatics, **N**atural science and **T**echnology) an out-of-school project. But there are also specific professional associations that criticize this as well. They are afraid, that special standards of the single disciplines will be neglected.

6. Theory and Practice–Research and Teaching

The idea and realization of integration lives on the interaction of theory and practice. In the period since 2000 (compare Tab.) a lot of feedback out of the practice has been used in order to face the didactical theory with the teaching reality. The findings are discussed at didactical expert conferences – e.g. 2013 for the last time.

There are findings that show integrated teaching

- has an positive emotional effect on pupils
- can stimulate learning in a constructivist, dialogical and dialectical sense
- strengthen self-reliance and self-awareness of pupils
- expand the method repertoire of the pupils
- boost experimental competences of pupils
- stimulates cross-linking competences of the pupils
- minimizes gender differences in learning science.

In connection to PISA 2000 it has been indicated that integrated natural science teaching can improve learning results. Other studies have shown that teaching single disciplines is more effective than integrated teaching. Several universities have initiated research projects in order to test curricula in a scientific way. But finding suitable themes is still a big challenge. In practice “Natural science teaching” has been seldom offered additionally and parallel to the single disciplines.

7. Impulses for the Teaching Practice – Chances for Integration

In the daily teaching reality teachers in Germany always had and have the opportunity to connect specific contents with any topic that belongs to another subject - and therefore integrative - but without an independent subject “Natural science” (compare Fig.). This can be documented by a high amount of publications (more 5000

in a raw research) in professional journals since 1945 listed in the German database FADOK. It has been always usual to extend the subject teaching intra-disciplinary (with chemistry, physics, biology) or inter-disciplinary (with history, art, geography, and so on). In fact this is a well known didactical principle, because such a connecting teaching can show the meaning and importance of single disciplines in a meaningful relation to contexts and daily life. School should prepare pupils for this.

We want to list effective measures realizing integrative aspects in teaching at schools without fixed curricula for a “Natural science” subject. Suitable measures are (compare Fig.):

- realizing of projects (more than 3000 publications documented in FADOK)
- teaching of/about holistic topics (nutrition, cleaning, washing, cooking, energy, environment, health, and so on)
- connection to daily life and also perspectives for occupation and occupation groups
- special integrated elective subjects

These “soft” ways –so called integrative principle (see above)- ways in order to integrate single disciplines has a long tradition (see above). Such publications haven’t been considered in this article (see above).

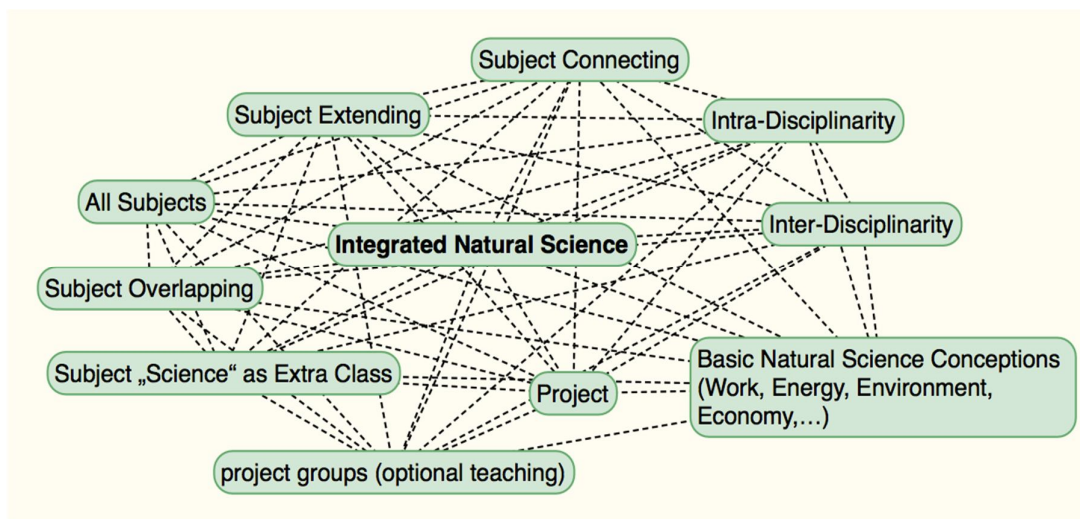


Fig.: Possibilities for integrated natural science without an extra subject “Integrated Natural Science” (From German perspective)

8. Integrated Natural Science Teaching - Conclusion

An integrated natural science teaching is theoretically legitimated – no doubt. Natural science teaching makes pupils aware of what they experience unconsciously everyday: All life realities and everyday life relations are complex, and complicated due to a versatile interaction of different disciplines. In order to implement these perspectives into teaching reality a lot of effort, “special” curricula and a suitable

teacher training is needed. From our perspective an only intra-disciplinary integrated teaching, that just handle with chemistry, physics and biology, is about to isolate natural science more. Therefore it is necessary to regard non-natural science disciplines as well. Natural science would be presented more lifelike. Regarding the personal development pupils would profit by that much more.

The efforts in Germany to find a suitable place for integrated natural science teaching in school or to make natural science teaching equal-ranking to the single disciplines are massive – on every level (education administration, university, school). It has been shown that integrating practicing teacher into research projects is very effective. From our perspective this is necessary. Practicing teachers can give useful impulses when they are participating research projects: Such a process will be very creative, because science teacher cooperate with each other. Many model experiments in Germany utilize this and they research about this also.

The trend natural science as an idea and approach has a lot of potential, it gives a lot of possibilities to create teaching. But exact determined curricula (content, goals, methods, experiments, didactical principles) also could have a undesirable effect, when this full planned teaching neglects situational learning of science, which focuses the interest and needs of the pupils.

The questions,

- how effective is an integrated natural science teaching,
- which standards of integrated competences of the pupils can be measured,
- which goals can be reached in a long term and
- which image can integrated natural science teaching generate for the often criticized science in general and chemistry in special

haven't been answered sufficiently in Germany yet.

Experts are working on it.

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Notes to the literature:

Like our article has shown discussions concerning integrated natural science teaching have had a long tradition. The article has also marked temporal highlights of the educational policy discussions. A selection of the great diversity of articles is problematical. From our perspective we list trend-setting contributions – especially in the period until 1990 and from 2010:

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Shortcuts of the journals:

- DS = Deutsche Schule (In English: German School)
- NS = Neue Sammlung (In English: New Collection)
- NiU - PC = Naturwissenschaften im Unterricht – Physik/Chemie (In English: Natural Science in Teaching Physics/Chemistry)
- NiU – C = Naturwissenschaften im Unterricht - Chemie (In English: Natural Science in Teaching- Chemistry)
- MNU = Mathematisch-naturwissenschaftlicher Unterricht (Mathematical-Natural Scientific Teaching)
- GDCP = Gesellschaft für Didaktik der Chemie und Physik (Society for Didactics of Chemistry and Physics)
- CuS = Chemie und Schule (In English: Chemistry and School)
- JchemEduc = Journal of Chemical Education
- Chim.did. = chimica didactica (In English: Chemistry Didactics)
- PdN-C = Praxis der Naturwissenschaften-Chemie (In English: Practice of Natural Science – Chemistry)
- Csch = Chemie in der Schule (In English: Chemistry in School)
- SMP = Sachunterricht und Mathematik in der Pimarstufe (In English: „General Science“ and Mathematics in primary school)

On request we will refer to literature which concern specific themes or arrangements for teaching. For research requests please contact: hbecker@mail.uni-paderborn.de

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