



INCORPORATING INTEGRATED APPROACH IN SECONDARY SCHOOL

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Abstract

Under considerations are topics related to the organizational planning and management of incorporating the integrated approach in the St. George Private Secondary School in Sofia, Bulgaria. As the theoretical base we step on the Altschuler's model but modified some parts of it according to the specifics of the educational management. E.g., we replaced the 2-dimensional antinomy matrix of the Altschuler's model by considering antinomies in higher dimensions. Another innovation is the processing matrix we designed to technologize the project-oriented initiatives. A new educational paradigm is offered in which the role and the place of the integrated approach is set up as a way to achieve the desired goal of the compulsory education – a competence of synthetic type. Several good practices are given to illustrate different perspectives of the entire process of establishing a new educational environment in St. George School. The key role of mathematics and informational technologies in these initiatives is justified. The integrated approach we announce here is coherent with the Bulgarian National Youth Strategy where the stream line is an integrated consideration of the global problems related to the young people. The authors' hope is that the described management schema could serve as model for regular educational practices not only in private schools but as a modus operandi to implement the National Youth Strategy onto the entire educational reform that is going on in Bulgaria.

Keywords: project education, synthetic competence, integral approach, Altschuler's model

1 INTRODUCTION

We determine the integrated approach in education as a way for mutual consideration of interdisciplinary topic via application of several subjects methodic that pursuit many-folded

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educational goal. Any particular methodic acts in its own domain and uses its own standards and evaluation. Students are urged to apply their knowledge and skills in new context and as a result they are expected to build a competence of synthetic type. Further we will give more details about the integrated approach and the competence of synthetic type. We consider the integrated education as a teaching-learning



process in which the integrated approach is the main didactical tool.

The integrated approach in education stands on agenda every time when the educational goals include transfer of knowledge from the learning context to applications. It is plausible the Berryman's view point that *individuals do not predictably use knowledge learned in school in everyday practice, nor do they use everyday knowledge in school settings. Perhaps most importantly, learners do not predictably transfer learning across school subjects* [as quoted by (Wicklein, 1997, p. 73)]. We believe that the secondary school should provide opportunities for the students to check their knowledge and skills outward the particular school-subject context in some activities of mixed type. However, the Bulgarian (and perhaps not only the Bulgarian) secondary school does not face the social demand on applicable knowledge. The status quo is subject partition of the curriculum which produces analytical knowledge and specific skills with no connections between subjects or real-life situations. The knowledge partition in secondary school causes complex problem in knowledge transfer, which includes the classroom organization, teachers' qualification, system of evaluation etc. This is why this problem requires complex solution.

The integrated education has its roots deep in the history but also a solid ground in modern times. For instance, the mathematical methods were applied in studying harmony by Pythagoras; he associated with numbers even some abstract concepts as *justice* (Van der Waerden, 1968, p. 132). Integrated education was organized in Bulgaria by the Problem Group on Education in 80's of the last century. The *integral approach* (quite different than our integrated approach) was applied via common methodic for consideration of subjects like *Language and Mathematics* (Sendov & Novachkova, 1985). The outcomes of this education were hopeful but unfortunately the program was closed in the early 90's. Multidisciplinary approaches to integrate mathematics, science and technology education were introduced in several states in USA in the first half of the 90's and a lot of positive effects were registered (Wicklein & Schell, 1995). Similar

program was held in Australia in the middle of the 90's and also significant improvement in reaching of the educational goals was reported (Venville, Malone, Wallace, & Rennie, 1998). The first decade of the new century gave more examples of good practices about implementation of integrated approach, mainly from the perspective of ICT enhanced teaching-learning (Faloon, 2010).

These experience (reported by a state institution or by a single teacher) did not help us very much to see the entire potential of the integrated approach for supporting educational process in our school: the states operate with more resources than a school and aims too wide target group; a single teacher or even a small group of teachers usually act in a narrow area, too limited to be representative for this style of teaching. So we decided to design our own plan for incorporating the integrated approach.

2 MOTIVATION AND METHOD

The new trends in Bulgarian secondary school education are focused on building competences. The European Commission stated a framework for the key competences in which it is said that:

Key competences represent a transferable, multifunctional package of knowledge, skills and attitudes (KSA) that all individuals need for personal fulfillment and development, inclusion and employment. These should have been developed by the end of compulsory school or training, and should act as a foundation for further learning as part of Lifelong Learning (EC, 2013).

As we mentioned above the transferability and multifunctionality of the package KSA is difficult and even impossible to be accomplished outward the context of learning. Hence a new context should be designed to provide opportunity for the students to check and to upgrade their KSA. Platforms for new educational context could be the extracurricular activities as circles, competitions, contests etc. As a rule these activities are in the scope of a particular teacher who uses didactical resources close to her/his routine teaching which

causes just slightly reinforcement of the desired transferability and multifunctionality of KSA.

Our standing point is that a more effective way to build student's competence is to implement some interdisciplinary activities as a part of the entire educational process. This means to build a system of bridges between subjects, coherent with the curriculum, but going in areas which are close to some real life situations. Thus the integral approach appears to be the methodology for putting into practice our ideas.

The methodology we use is based on a model proposed by Altschuler in 1964. This model is designed for management of implementing an invention – algorithm of the innovation (Al'tshuller, 1964, p. 88). Here we follow the description of this method given in (Genev, 1992).

3 PRECONDITIONS FOR INTEGRATED APPROACH IN SECONDARY SCHOOL

The teaching-learning process in primary school is implicitly organized as integrated education – one teacher teaches all subjects using similar methodic in different branches. Often the teacher refers to examples from one area to support her/his teaching in topics of another area. It is only a small step needed to go from this teaching style to the integrated approach. However, the explicit application of the integrated approach requires specific didactics (Martynova, 2003).

The picture dramatically changes in the first grade of the secondary school (in Bulgaria – the 5th grade). E.g., the apple which was just a fruit in primary school becomes a shape in geometry, a body in physics, organic conglomerate in chemistry etc. Such defragmentation of the objects goes along with a considerable increase of the number of concepts: the total number of mathematical objects that appear in entire primary school curriculum does not exceed two dozen but only the ones in the fifth grade are more than hundred. Often students cannot recognize the same characteristics or models in different subjects. E.g., recently a colleague who teaches both mathematics and physics observed that the skills in performing algebraic expressions are not applicable in solving physics problems. Similar

observations in opposite direction were made by mathematics teachers who try to use examples from music to support studying fractions – students cannot apply their knowledge in music notation in math problems.

The examples given above clearly show the necessity of bridges for transfer of KSA from one context to another. However it is risky for a single teacher to take the whole responsibility of organizing interdisciplinary education. For instance, the attempt to study the calendars during the lessons in history presented a narrow view on the topic and deprived the students going deeper in the matter because of specific mathematics and astronomy which lay in the ground of any calendar design. On the contrary, the teams of teachers manage to connect successfully quite distant topics as usage of letters in some alphabets for writing numbers.

Summarizing this section we point on two important needs to be satisfied in the beginning of the secondary school:

- to keep the big picture of the world as united as possible;
- to form equips of professionals who can carry out the interdisciplinary education.

Our view point is that if these two needs are met successfully than the educational process will be continuous and the package of KSA can be turned into competences more smoothly. In such a way we fulfill the first stage of the Altschuler's model – clarifying the problem. Here we skip the details about the second stage which refers to the specification of the required resources.

4 NEXT ELEMENTS OF THE ORGANIZATIONAL PROJECTING

The third stage of the Altschuler's model is Analysis. The desired output should be determined in this stage, as well as the factors which stand on the way this output to be obtained in full scale. Our new paradigm locates the integrated education as an upgrade to the traditional classroom style, i.e. the project-oriented forms are auxiliary to the traditional ones. However, our expectations are bigger. We see the outcome decomposed in three directions:

- For the students: to build the basis of a synthetic competence, relevant to their age, interest and abilities. This includes providing opportunities to any student to manifest his/her best in solving complex problems individually and in team work.
- For the teachers: to encourage their aspiration for innovative teaching and to support their professional growth. Also teachers are given chance to participate in conferences, they are urged to write articles being part of a team.
- For the administration: to have a closer look on the school problems and to be engaged in solving cases. This includes sharing the success but also the responsibility.

The eventual obstacles to obtain maximal positive effect can be diversified as well. This step in our plan refers to the fourth Altschuler's stage – operational. The original Altschuler's model includes a matrix of antinomies where the key factors are combined in pairs and the possible contradictions are described between elements of a pair (Genev, 1992, p. 206). Our experience shows that as a rule several factors are involved in a contradiction and the solution needs simultaneous consideration of all relations between them.

4.1 Example 1

Let us consider the interaction between the next three segments which are crucial for orchestrating integrated education:

- processing matrix design; the definitions of the concepts are given further in the text;
- individual educational trajectory planning;
- constituting groups with positive attitude.

The first two bullets refer to methodic and administrative area and the third one seems to be pedagogical. It is difficult to find solution to any of them separately. On the contrary, they found more than satisfactory solution when they are considered simultaneously in a particular initiative, included in the general annual schedule: the processing matrix of the project-oriented initiative is designed keeping in mind the specifics of any individual trajectory; the individual educational trajectory of a particular student is planned taking into account the other members of the team and

the requirements stated in the processing matrix; the groups of students with positive attitude are formed with respect to the individual educational trajectory and the type of the initiative.

The above example shows that the 2-dimensional matrix of antinomies is better to be replaced by at least 3-dimensional one. It is impossible in practice to compose such multi dimensional matrix, so we decided to consider any antinomy by itself. The approach we adopted was to separate the eventual antinomies in two areas of responsibility: general and particular. Problems as the theoretical frame (including school strategy), the annual plan (including time schedule and human resources) are of general type and the antinomies that appear are in the scope of the school decision-makers. The problems which appear during management of a particular initiative are in the competency of the staff responsible for it: teachers, class master, technical staff etc. Some antinomies of particular type due to more general problems (like the ones in the Example 1) were solved during the regular meetings of the crew. Such schema does not look very technological but it is flexible and it worked. It allows realizing the entire complex of recommendations in the fourth Altschuler's stage which are related to the possible changes in the school ecology, i.e. the interaction between traditional style of teaching-learning and the individuals, involved in the integrated education.

The final stage in the Altschuler's model – synthesis, requires estimating the effect of the integrated education on all affected structures, regulations, population. On this step of the organizational projecting we developed and applied a control system relevant to the entire teaching-learning process. The next example will give an idea of the control types we applied on the students' individual educational trajectories.

4.2 Example 2

The initiative **Music equations** took place in 2010/2011 scholastic year with students of 5th grade. This was a project-oriented interdisciplinary initiative which includes topics in mathematics, music and informatics. Students were separated in teams of three persons each. Any team was given a set of problems which includes a part of a

musical score (Figure 1). Students were expected to solve first problems individually, but the communications inside the team was allowed. A kind of mutual control was realized during the

discussions between the team members – the first level of control. A kind of self-control was done when the students compared the 'official' solutions with their own ones.



Fig.1.A task from the initiative Music equations.

The next level of control was performed by the math teacher when he checked the presented solutions – this was the first control on the individual educational trajectory. It included discussions and comments on the concepts

acquisition, solution routine, writing style. The individual educational trajectories were corrected by giving recommendations, as well as by stating additional problems and challenges (when it was necessary).

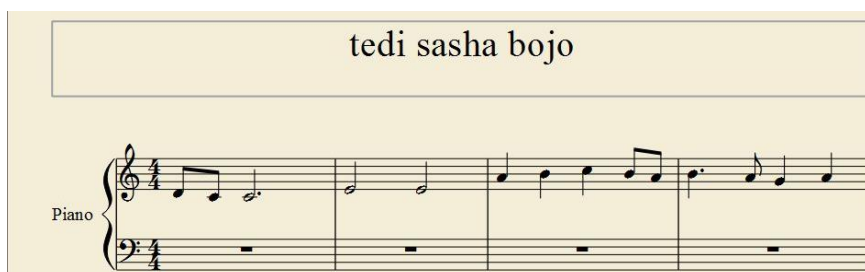


Fig.2 Solution presented as a MuseScore applet.

An external control was done by the software *MuseScore* 1.2 (Figure 2) that students used for performing the musical score. The wrong mathematical solutions or incorrect input of the notes led to false melody. Such mistakes gave reasons for detailed discussion on the corresponding parts of the students' work.

The final control was done during the last lesson when the teams worked together. Additional information about the effect of the initiative *Music equations* was collected during the math tests of the general term schedule.

We cannot give an exact evaluation (in percentages) of the integrated education effectiveness but we have enough observations and qualitative assessments that form a positive big picture. The examples in the next section are to confirm such pronouncement.

5 GOOD PRACTICES

In this section we are going to clarify some parts of the organizational planning and management by two examples.

5.1 Example 3

The initiative **Math that surrounds us** takes place in the second term since 2010/2011 scholastic year (Severinova, Lazarov, & Olejnikova, 2011). It is directed to 5th and 6th grade students and integrated mathematics and informational technologies (which are two independent subjects in Bulgarian secondary school) to examine the KSA in a real-life context.

Students work individually or by pairs. Their task was to collect data from real-life sources (Figure 3), to form a data-base in electronic spreadsheets, to process the data (Figure 4) and to work out a computer presentation. Finally the students were expected to perform their presentations at a school conference.



Fig. 3. The data sources - the initiative *Math that surrounds us*.



Fig. 4. Proceeding the data for the initiative *Math that surrounds us*.

This was the first project-oriented initiative held in St. George School where a *processing matrix* was put in practice. We designed it to technologize the entire process of planning, providing and performing the initiative goals, activities and results.

The processing matrix includes

- stating objectives, indicators of progress and benchmarks;
- selection of educational content, that is to be examined;
- schedule and methodic for didactical support of the students;
- methodic for data collecting and processing the data collected;
- template for presenting information and frame for presentation design;
- assessment system;
- providing resources and organizing a school conference;
- analyzing the outcomes of the initiative and drawing conclusions.

The processing matrix allows reconsidering the KSA which are build in the traditional curriculum

topics through the perspective of their potential application in a new context. Some antinomies related to the synchronization of the time, assessment, didactic instruments etc. find solutions in the processing matrix. Its proper design allows obtaining synergetic effect from the initiative, i.e. the resulting effect of the integrated education is bigger than the effect of the expected one of any subject if it acts separately.

The human resources are another key factor in the management of our strategy to incorporate integrated education.

5.2 Example 4

The initiative *Letters and numbers* started in 2011/2012 scholastic year for 5th grade students (Severinova, Lazarov, & Nenov, 2012). This initiative integrates mathematics and literature, including also elements of history education. The initial team of teachers was extended in 2012/2013 scholastic year forming a *group with positive attitude* to the integrated education. The essence of such group is the spirit of collaboration and partnership. Teachers, administration and the executive director of the school are involved in a general plan giving their best not only in creating a new educational environment for the students but also a new professional environment for the teachers. The teachers' activities went far beyond the routine work – they studied some existing theoretical findings but they put the theory into practice in their own way. It is not common in Bulgaria teachers to give talk at scientific conferences. This is why we find the participation of our teachers in such conferences (quite regular since 2011) as an indication of positive influence of the new educational environment onto their personal professional growth.

6 CONCLUDING REMARKS

The good practices of integrated education we gave here are not a flash in the pan but parts of the trend to modernize the education in St. George School – Sofia. As far as we know there is no other reported school strategy for integrated education in Bulgaria. This is why we cannot compare the outcomes of our practice with similar ones.

The management of incorporating innovative approaches we apply is based on the Altschuler's model which is originally oriented to some technical and technological matters and the solution of a problem is supposed to be long lasting. We clearly understand that the solutions we find are specific for the parameters of a particular class, period, staff etc. A very important factor is the ICT support of all initiatives we realized. Perhaps the next leap in the IT development will make another sense of the integrated approach (e.g. we do not exploit the smartphones as a didactical tool yet). However, the experience we capture today is very helpful to manage similar practices in the near future. Thus we believe that our strategy has its place in the modern education.

The Bulgarian National Yought Strategy (see http://mpes.government.bg/Documents/Documents/Strategii/strategy_youth_2012-2020.pdf) determines an integrated consideration of the global problems related to the young people. The authors' hope is that the good practices we offer in the article could be turned into regular ones not only in private schools but as a reflection of the National strategy onto the entire educational reform that is going on in Bulgaria.

7 TERMINOLOGY NOTES

The *Altschuller's model* is also known as *TRIZ method* – the abbreviation comes from the Russian *Teoriya Razresheniya Issledovateljskih Zadach*. See http://www.triz-journal.com/archives/what_is_triz/ (active in May 2014).

The *synthetic competence* is a personal and case dependent concept that means it depends on the age and the local-behavioral-environment (LBE) of the student. LBE is a complex socio-economical and cultural structure including:

- people related to the student's behavior (teachers, parents, classmates etc.);
- institutions that organize education and creative work (school, clubs etc.);

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- events that provides opportunities to manifest the achievements (tournaments, conferences etc.);
- system of values that form the cultural context of the student (motivation factors, anticipation about the future professional realization etc.). (Lazarov, 2013)

So the synthetic competence represents a multifunctional package of KSA that are transferable into contexts which are different than the one of building the KSA. The synthetic competence includes also some common deductive abilities and communication skills. Implicitly this definition assumes the student has math and IT abilities on a level that gives to him/her self-confidence and comfort in his/hers LBE.

We adopt the definition of the concept of individual educational trajectory (IET) as given in (Lazarov, 2013). IET is an organizational frame and plan for realization of a medium term educational process that is coherent with the individual specifics of the learner and provides opportunities for the optimal development of his/hers creative potential.

The concept of IET refers to the educational microcosmos of the student which is immersed into the global educational environment. The design and implementation of the IET is a complex process that includes the following components:

- formation of an individual informational environment;
- individualization of the didactical resources, including selection of the individual (re)searching instruments;
- individualization of setting the educational goal, including flexible approach to achieve it;
- individualization of the learning temps, investigation activities, layout style;
- taking into account the individual reflexive abilities and self-organization aptitude in searching a synergetic effect.

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