

A Model for Instructional Design in Virtual Nordic Classrooms

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Abstract

In this paper we will report from an on-going EU-financed project aiming at developing innovative cross-border, virtual classroom instructional designs; that is designs where classes from three Nordic countries collaborate by means of technology to enhance teaching and learning. School management, teachers, students, and educational researchers from Denmark, Norway and Sweden collaborate since 2011 in three-country teams on all levels to explore and evaluate novel cross-border instructional designs in four subjects. The research approach is user-driven innovation by means of Action Research and Design-based research. The cross-border instructional designs exhibit several challenges: designs need to be aligned with all national curriculums with respect to 1) subject content and 2) learning goals, and in order to advance learning, we need to address 3) learning benefits due to the collaboration. In Mathematics, such cross-border learning benefits were particular elusive to identify, so some kind of guidance were needed. The model, first proposed for Mathematics but generalizable to other subjects, is a three-dimensional cube that categorizes an instructional design with respect to 1) subject-content, 2) aimed-for competence, and 3) learning-benefit. The subject contents and required competencies were derived and synthesized from the national curricula, whereas the learning benefits were inspired from previous cross-border designs. The model has successfully been used as a classification system for virtual classroom tasks, and also as an innovation tool to generate novel instructional designs where the expected learning benefits became explicit from start, which facilitates design evaluation.

Key words: Instructional design, Cross-nation collaboration, Nordic school, Virtual classroom

Introduction

Schools as well as the society in general, is becoming more and more digitalized. The increased awareness of the need for digital competence among students as well as teachers has resulted in reformulations of many national curricula along with numerous initiatives and investments concerning use of Information and Communication Technology (ICT) to meet these new requirements in education. For instance, the European Union currently supports a giant investigation of ICT usage in European schools, the "Innovative Technology for an Engaging Classroom" (iTec, 2011), the Swedish National School Board performs a corresponding study (ESSIE, Skolverket 2011), and in 2012 the Danish government invested 50 millions DKK for ICT use in Danish schools. In today's society, ICT is considered both necessary and a means to improve learning. Access to technology is a prerequisite, but does not necessarily imply productive usage; the individual teacher's attitude, digital competence and preferences highly determine the frequency of technology-aided teaching (Cuban, 2001; Sundberg et al 2011). Neither do ICT equipment in the classrooms per se create new teaching practices.

The project we report on here, is aligned with these initiatives. The GNU-project, an abbreviation for Cross Border Nordic Education [Gränsöverskridande Nordisk

Undervisning/Utdannelse] is an EU-funded project enrolling Danish, Norwegian and Swedish schools and educational researchers which began in 2011 and extends to 2014. The aim of the project is to develop innovative instructional designs for virtual Nordic classrooms in the four school-subjects native language, mathematics, natural and social science. By virtual Nordic classrooms we mean teams consisting of students and teachers from preferably one class in each country, who together plan and conduct collaborative tasks and common lessons mediated by technology in various ways. Here, ICT become a necessary mean to facilitate distant collaboration and communication rather than a goal per se.

In general many teachers, as well as many pedagogical ICT-applications, use new technology in a substitutive manner by “reinforcing old ways of teaching and learning” (Resnik, 2007; Cartwright & Hammond, 2007). According to Puentedura’s (2009) four-stage progression SAMR-model (Substitution, Augmentation, Modification and Redefinition), the benefits of ICT-based teaching lies in transforming learning to new forms and redefining the nature of teaching. The SAMR-model aims to inspire teachers to modify and preferably redefine the teaching task to something new (and implicitly better) with the use of ICT. A main idea in our project is that the novelty of the virtual Nordic classroom situation as well as the collaboration and negotiation with colleagues from neighbouring countries will inspire as well as require new models of teaching by the challenges imposed by the setting. It is known that teachers’ views, attitudes and values concerning teaching must be challenged in order to develop new ideas and ideals (Timperley et al, 2007; Harland & Kinder, 2006), and transformative learning will not occur unless such critical questions are posed (Taylor, 2008).

Research Approach

The project is grounded in a philosophy of user-driven research-based innovation. The development of new teaching models takes place in a co-design process where participating students, teachers and researchers collaborate to plan, implement and evaluate various collaborative, instructional designs in an iterative manner. The project enrolls about 100 educational researchers and school personnel and more than 600 students in 5th to 9th grade from 18 classes in 13 schools from 7 different municipalities in 3 Nordic countries. Cross-national and inter-disciplinary teams are organized on many levels engaging different constellations of students, teachers, researchers, school managers and IT-staff.

The overall approach combines established methods such as Design-Based Research (see, e.g., Design-Based Research Collective, 2003; Kali, 2008) and Action Research (see for example Adelman (1993) about the method's origin). Design-Based Research is a systematic but flexible methodology aimed at improving teaching practices through iterative analysis, design, development and implementation based on collaboration between researchers and practitioners in a real situation (Wang & Hannifin, 2005). It results in theoretically based, context-sensitive small theories of teaching practices.

Action research values the power of reflection, discussion, decisions and actions of practitioners’ who participate in collaborative research on their own everyday problems (Adelman, 1993). Action research and reflective practice (Schön, 1983) are considered to be critical dimensions for professional development of teachers (Leitch & Day, 2000). Holly and Whitehead (1986) points out action research as a powerful method when teachers work alongside a researcher over time. After 15 years of experience of action research in schools, López-Pastor et al (2011) claim that the method with its collaborative and empathic focus rooted in everyday practice, promotes a sustainable, effective development of quality teaching. The two methods have previously been successfully combined (Majgaard et al., 2011).

In our project we adhere to the advocated method to develop ICT competence among teachers, which require ICT-usage to be integrated as a natural ingredient in the didactic process (Hanafin, 2008; Harland & Kinder, 2006; Skolverket, 2011b). It is emphasized that collegial collaboration, continuity, classroom observations, involvement of outside expertise as well as reflection and experimentation are success factors in competence development (Hattie, 2008; Gustavsson, 2008; Mollberg Hedqvist, 2006; Wilson and Stacey, 2004).

In alignment with our research approach and in order to capture the variation of different virtual classroom activities, we have used a wide range of methods to collect empirical data. These include documentations such as national curricula, focus group or individual interviews with teachers, students, principals and IT support staff, recorded online meetings, workshops, classroom observation and video recordings during project activities, online discussions, blog comments shared online and online questionnaires.

Instructional Design Challenges

Experiences from the first year of the project as reported in (Lundh-Snis et. al., 2012) revealed that the online-based collaboration were more challenging than anticipated, and that organizational and technical issues have superseded and squeezed out subject-oriented discussions due to surprisingly many practical issues that needed to be handled first. There were three major barriers: 1) synchronization of diverse IT systems in the collaborating schools; 2) scheduling coordination to allow synchronous collaboration; and 3) linguistic and communication difficulties rooted in participants communicating in their respective Nordic language. Being able to communicate within Nordic languages are explicit learning goals in all three schools systems, and therefore part of the project aim.

However, during the first year we also experienced cross-nation collaborative tasks that were successfully completed and that were appropriate and meaningful from a subject learning perspective. For example in mathematics, one instructional design was that all students constructed a mathematical problem (a brainteaser) and sent it as a Christmas card to someone in the collaborating class, which was then solved and reported in a videoconference meeting between classroom and classroom. Such collaborative task to construct a tricky problem (that you need to be able to solve yourself), and to see how a Nordic classmate from a neighbouring country solve your problem, is well-designed from several learning perspectives: Learning situations where students pose the questions has long been advocated by for instance Papert, (1980) and Piaget (1952). It creates a learning situation which is motivational, and is aligned with well-known learning theories such as learning-by-doing doing (Dewey, 1933), reflection-in-action (Schön, 1983) and Experiential learning (Kolb and Fry, 1975 m.fl.). To construct a good problem, constitutes the highest knowledge level according to Bloom's knowledge hierarchy (Bloom et al, 1956). To be responsible for providing the problem puts the student in the role as a teacher or expert, which is not often used in education but is advocated by learning theorists (Hamlen (2010), Gutstein & Mack, 1999, Vygotsky, 1978). In the process of constructing a tricky problem to someone else, the students ought to reflect on their own knowledge in the domain and are most likely triggered to self-explain in order to think about what trickiness they want to pursue. Self-explanation is used by successful students (Roscoe & Chi, 2007) and is a powerful activity for mathematical understanding (Mitrovic, 2005; Wong, Lawson & Keeves, 2002). The design also gave plenty of opportunity to discuss which problems that are considered difficult and why that is which are challenging questions to discuss (Jonassen and Hung, 2008), as well as if there were any cultural differences in either problem construction or problem solutions between the involved nations.

Yet, it was considered difficult to actually pinpoint whether the tasks they designed actually gave a *subject related added value due to the cross-nations collaboration* or not, and if it did what the added value actually constituted of. Particular for the subject mathematics it was challenging to identify subject-related added value related to the instructional designs. And since the cross-nations collaborations took additional time and effort for the teachers and students compared to traditional education – partly because of the technical and organizational hurdles but mainly because collaboration normally means additional communication including negotiating ideas and needs which may be quite cumbersome before the collaborators become accustomed to each other. Thus, for motivational purposes it was important that the collaborating teams became convinced that their tasks actually could yield subject-related added value (i.e., a learning benefit) to retain a balance between cost/effort and benefit.

Hence, there was a growing demand for some kind of help or tool for the collaborative teams that would support the instructional design process in a novel situation in such a way that potential learning benefits are in focus (to as far as possible guarantee an added value of the Nordic collaboration).

The proposed Model – the GNUbic cube

To meet these demands, the Nordic researchers in mathematic didactics organized a workshop to discuss these issues. The agenda of the workshop was to 1) identify types of added value due to cross-nation collaboration, 2) compare and try to unify required mathematical competencies from the three national curricula, and 3) compare and try to unify central content for mathematics in the appropriate age levels within the three curricula.

A previous analysis comparing the Danish, Swedish and Norwegian curricula in mathematics showed that the curricula are quite similar with respect to subject content to be covered and learning goals with respect to competencies that should be reached. All three curricula advocate practical application of the subject, interpretation, problem solving, and mathematical connection to the society. The curricula are similar enough to allow for a meaningful collaboration.

The idea of the model arose when the Danish researchers presented a report from the Danish Ministry of Education (Niss & Hojgaard, 2002), where the mathematical curricula was presented as a matrix (see Figure 1) of the key learning content (subject areas) and the learning goals to be met (competencies to acquire). The matrix structure indicates a relation between subject areas and various competencies, where the mathematical subject areas comprise, for example, the rows, and the eight competencies the columns. The matrix could then be regarded as a statement of how the individual competencies are practised in relation to the individual subject areas. Each cell denotes the interplay between a particular subject area and a particular competency, where some relations may be of great relevance while some competency may be less relevant for a particular subject area. We appreciated the model as a useful mental tool for designing instructional tasks, since the designer has to consider not only which subject area a task belongs to, but also reflect over which competencies (normally there are more than one) that are actually practised in the task.

Competency/ Subject area	Math. thinking comp.	Problem tackling comp.	Model- ling comp.	...	Aids and tools comp.
subject area 1					
subject area 2					
...					
subject area n					

Figure 1. *The subject - competency matrix. From "Competencies and mathematical Learning", (Niss & Hojgaard, 2002).*

Since the matrix is a condensed description of the Danish curricula content and the presentation was considered both adequate and useful for our purposes, we adopted and extended that model. All cross-nation instructional designs - just as all traditional instruction - need of course to adhere to the national curricula. However, for our cross-nation collaborative instructional designs, we also wanted to assure an added learning value. Hence, we extended the matrix with a dimension of added value, which resulted in the following cube (Figure 2):

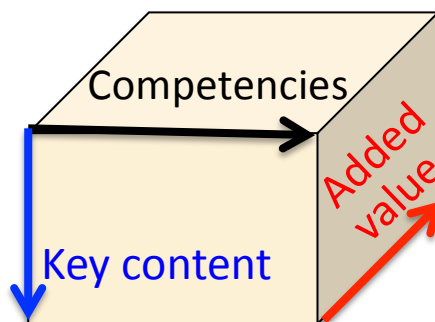


Figure 2. *The general dimensions of the Instructional Design Model – the GNUbic cube*

The components of the two original dimensions was then discussed and negotiated so that the result would reflect and unify all three national curricula. Finally, the new dimension particular to our project to generate learning benefits due to cross-nation collaboration was created and discussed.

The Model components

The process of unifying the key content subject area was fairly straight forward since the three curricula had the mathematics subject divided in similar categories. The content was listed and connected to formulation in each of the national the curriculum, respectively. In the unification activity, it was not always easy to find the perfect match how content and competences were presented in the three different national curricula. For example problem solving was treated differently: it was described as a subject area (key content) in one curriculum but as a competency in another. We adopted the Danish model and integrated problem solving as a competence in the GNUbic cube, since the other curricula repeatedly points at that problem solving ought to be applied in all subject areas.

The competency dimension of the Danish matrix was less straightforward to map directly into the national curricula, since the respective curricula used different ways of describing what learning outcome that was expected. However, the variation was rather one the level of formulations than actual variation in content, which meant that we could identify mappings as

pointers from the model category into the respective national curricula text to make the connection apparent and to better support the teachers in their work. There are eight competencies that should be acquired in mathematics: 1) Mathematical thinking competency: to be able to think mathematically (including the understanding of concepts, the ability to estimate and to assess), 2) Problem tackling competency: to be able to formulate and solve mathematical problems, 3) Modelling competency: to be able to analyse and build mathematical models, 4) Reasoning competency: to be able to reason mathematically, 5) Representing competency: to be able to handle various representations of mathematical facts, 6) Symbol and formalism competency: to be able to deal with mathematical symbols and formalism, 7) Communicating competency: to be able to communicate in, with and about mathematics, and finally 8) Aids and tools competency: to be able to use and assess tools for mathematical activity, including IT.

Components in the new dimension, the added value dimension, was inspired from already conducted instructional designs from the project, and from the researchers' own vision of potential learning value due to the type of intended collaboration. The researchers identified and generalized these learning benefits and identified two types of value creating reasons: one that takes advantage of a that different countries are involved with possibly national differences, the other that tries to turn the linguistic difference between the Nordic languages into something advantageous and not only an obstacle. The possible added value that we came up with were the following:

1. *Create curiosity and motivation* (national difference). Here we have seen that students in general are curious to work with students from neighbouring countries since the difference in nationality results in more variation in the collaboration, and this natural curiosity can be utilized as motivational power if the tasks are designed accordingly.
2. *The need to explain to each other* (linguistic difference). To articulate and explain (to oneself or to others) are activities that can foster a better conceptual understanding and a reflective approach to mathematics, and the need become much more apparent when the student communicate in similar yet different languages. We have seen that even the most basic concepts may need to be explained (because the concept names in two languages were so different). This is a very good exercise, which is hard to motivate students to do in a single-language setting.
3. *Use mathematical language for clarification and specification* (linguistic difference). By this we mean that even younger students could easier understand the advantage of using formal mathematical language instead of natural languages when communicating with other Nordic classmates, since it is common for all and has an exact meaning. That would be an enormous gain for the subject.
4. *Discuss differences, more variation* (national difference). Collaboration with others per se could introduce more variation and opportunities to discuss differences, but we expect and have seen greater variations and more differences due to the cross-nation collaboration since there are cultural differences between the countries.
5. *Collect and compare national data* (national difference). There are many tasks that become more motivational and more reality-adopted (and inter-disciplinary) when students collect and compare data from their respective countries.
6. *Encourage subject related reflection* (national difference). By this we mean that by the setup when the same exercise is planned, implemented and compared in different contexts most likely differences in attitudes, practice, methods, principles and underlying ideas ought to come to the surface. Perhaps this added value is primarily for the teachers, but the students may start reflecting over "how they do things" as well, especially if the teachers encourage such reflections and discussions.

Hence, we end up with the following model with three dimensions corresponding to key content, competencies, and added value (Figure 3):

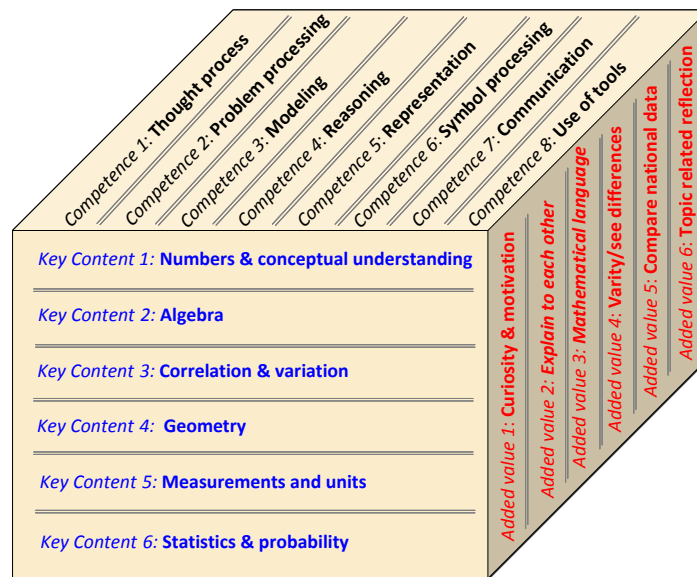


Figure 3: The proposed model: The GNUbic cube

The model has two distinct purposes:

- 1) as an analytical tool for classifying the cross-nation instructional designs, i.e., a classification system which are rooted in all three nations curricula, and
- 2) as an innovation tool for idea generation during planning phase of new instructional designs by for example randomly choosing a combination of the three dimensions and try to imagine what kind of tasks that would fit into that classification. This is in accordance with established idea generating methods.

Evaluation of the Model

The model was evaluated as an analytical tool by classifying 5 previously instructional designs conducted by the cross-nation teams in the project. Design 1, Christmas brainteaser, was described above. Design 2: Problem-solving with fractions was similar to design 1, but the topic was fractions instead of arithmetic. Design 3: choosing and solving fractions, was organized so that each student had to select 3 exercises from their respective math book, one simple, one medium and one difficult. Solutions including explanations of the exercises were video recorded. Exercises including solution video clips were exchanged between the students. Identified learning value of the design included that the video recording required explanation, the exchange allowed for everybody to see someone else's solution in action, and the process of selecting exercises in three levels encourage reflection of task difficulty. Design 4: glossaries, were performed in smaller groups where each group had to select 10 mathematical words (i.e. concepts), explain what they meant and then ask matching groups from the other two countries to fill in the corresponding word in their language. The added value of the task included having to explain often rather basic concepts (such as addition) that the students found rather challenging. Many groups used mathematical examples to illustrate the concept. Design 5: price comparison task consisted of finding out and comparing prices of different common products in their own country with the prices of the same product in the

other countries. Since there are three different currencies, Euro was used as a unifying currency. Below the GNUbic cube with classification items highlighted are shown from three of the designs ().

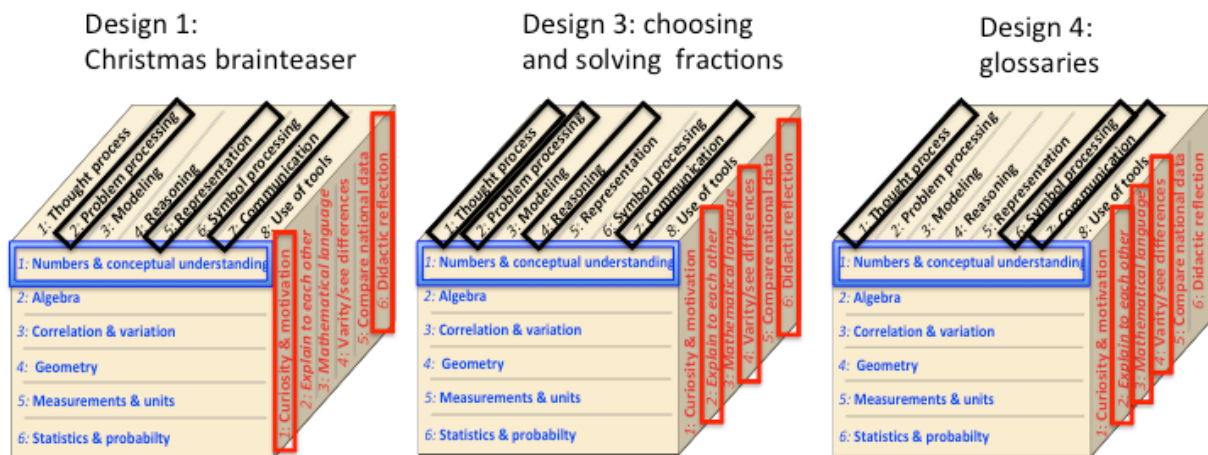


Figure 4. Classification in the GNUbic cube of three different cross-nation instructional designs

The model was also evaluated as an innovation tool, since it was used in the planning process of three new instructional designs. These were all a bit more elaborated and ambitious, partly because it was the next iteration of constructing new designs, but we believe that the awareness of the variation and possibilities that the GNUbic cube pursues also influenced the designs. Design 6, packaging factory consisted of an more open-ended construction problem where the students in groups were to model, draw and construct packages according to a specification given from their partner group in the other country. The effectiveness with respect to for example material cost and material loss were also calculated. The added value came from comparing different solutions and having to explain and motivate their choices to the specifying group. Design 7, school investigation was about making an inquiry on their own school, make diagrams and compare the results to their neighbour countries results. The last evaluated design 8, diary packaging, compared physical dairy containers online (half of the containers from each group) and ordered them according to different aspects such as size, % fat, and so on. The task required plenty of communication and formulation of the problems.

Table 1. Summary of the classification in GNUbic cube of all evaluated instructional designs.

Designs	Key content						Competencies								Added value						
	1	2	3	4	5	6	1	2	3	4	5	6	7	8	1	2	3	4	5	6	
Previous																					
1	•							•			•		•		•						•
2	•							•			•		•		•			•			•
3	•						•	•		•			•			•		•			•
4	•						•					•	•	•		•	•	•			
5					•	•		•		•		•		•	•					•	
New																					
6				•	•			•	•	•		•		•		•		•			
7					•		•		•	•			•	•	•			•	•		
8	•		•		•		•	•		•	•		•		•	•				•	

The classification summary in the table above show that all categories except one, the subject are algebra, were used in the evaluated designs, indicating that the classification system mirror actual activities quite well. Also, the classification process was considered straightforward by the researchers (who perhaps are more accustomed to such activity than the teachers), so the usability of the model need to be further evaluated by the primary users, the teachers, alone. However, many of the teachers have so far appreciated the model.

Finally, even though the model was first developed for the subject mathematics, the same idea is being transferred to the other subjects in the project.

Conclusions and Future Work

In general the model has shown to be appropriate for classification purposes, even though specific categorization in the three dimensions may need to be modified to assure natural, non-overlapping categories that are covering the desired content. The model also seems to be useful as an innovation tool, but this needs further exploration and evaluation to establish.

Future work include continue to explore and evaluate the usefulness of the model in the other subjects, and to transfer the model to some other change initiatives aiming at learning improvements in schools such as for example various ICT initiatives. Any proposed change initiative ought to come with the idea that the change should generate something better, i.e., an added value compare to prior the change.

Acknowledgements

We would like to thank all involved teachers and students for their engagement, our research assistant for her help and the European Regional Development Fund for funding the project.

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