TRANSFER OF A TEACHING-LEARNING SEQUENCE FROM GREEK TO ITALIAN SCHOOL: DO SIMILARITIES IN EDUCATIONAL SYSTEMS REALLY HELP?

Testa[1]*, A. Molohidis*[2,3] *S.Lombardi*[1]*, D.Psillos*[2]*, G.Monroy*[1]*, E. Hatzikraniotis*[4]
[1]Department of Physical Sciences, University "Federico II" Naples, Italy
[2]Department of Primary Education, Aristotle University of Thessaloniki, Greece
[3]Pedagogical Academy for Muslim Minority Teachers, Thessaloniki, Greece
[4]Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract: The specific purpose of this paper is to investigate the changes that occurred in the process of the transfer of a Teaching-Learning Sequence (TLS) from the designer's to a host's context. Besides we discuss if the similarities between educational systems may actually favour such a transfer. The specific case concerns the transfer of a TLS on thermal properties of materials from the Greek educational context into Italian one. The research has been framed in the "*Adaptation* and *Re-Invention"* (ARI) theoretical model. According to this model, some "core" elements of the original TLS, namely, scientific concepts addressed, pedagogical approach adopted, ICT-enhanced aspects and the activities' sequence, have been first identified and then adapted for the new context. The resulting new core elements of the transferred TLS have been compared with those of the original TLS to investigate about the feasibility of the transfer. Results show that the similarities between the two educational contexts acted mainly as facilitators of the transfer process. Moreover, direct communication and interactions between the involved groups and an external expert helped significantly the process. Data from implementations in the two educational contexts show also similar positive effects on students' learning outcomes.

Keywords: Teaching-Learning Sequences; Knowledge transfer; Heat conduction

BACKGROUND, FRAMEWORK AND PURPOSE

Exchanges of successful educational practices and artefacts have become one important issue for debate within European Union. Despite the interest and profound educational and political implications, research studies devoted to document and reflect upon efforts to disseminate successful practices amongst different countries are rather scarce at least in Science Education. In this paper we address this issue in terms of a case study involving the transfer of a Teaching-Learning Sequence (TLS) (Meheut & Psillos, 2004) about heat conduction, originally designed by a group of researchers and experienced teachers located in the Department of Primary Education Aristotle University of Thessaloniki for compulsory lower Secondary Schools, Gymnasium (13-15 yrs students), into the corresponding Italian school level (14-15 yrs students).

The Italian and Greek educational systems are both centralized; the curriculum is compulsory and established at national level. In both countries, science teaching shares some other important characteristics as, for instance, the low diffusion of hands-on laboratory and ICT based activities and the lack of habits of inquiry teaching on behalf of teachers. Moreover, concerning the scientific contents addressed in the curriculum at lower secondary school level, basic aspects about heat and temperature phenomenology, heat conduction and some ideas about the matter structure, e.g., atoms and molecules, are addressed in both countries.

The specific purpose of this study is therefore to investigate to what extent such similarities between the educational systems of the two Countries have favoured the transfer of an educational practice which has been proved to be successful in the original context. In particular, the specific research questions that guided this study are:

RQ1) was the original TLS changed in the process of transfer in the new context?

RQ2) what were the similarities between the educational systems that favoured (or influenced) the embedment of the original TLS in the new context?

RATIONALE

A simple way to transfer knowledge organized in the form of a TLS would consist in a unidirectional adaptation from the original educational context to the host one: this linear process would occur mainly when TLSs are edit in such a format that makes difficult any flexibility. However, previous studies in Science Education (Pintò, 2005) have shown that TLSs, in particular those aimed at innovating usual teaching habits, cannot simply transferred from the original designers to the users (scholars, teachers, …) but re-made, re-constituted, and re-structured. To put it simpler, the actions that will take place in order to adapt the original teaching proposal to the context in which it will be actually implemented are unavoidably transformative. Hence, from a general perspective, knowledge transfer of a research-based TLS is not an unilateral process from a developer to a passive receiver since a TLS necessarily involves both explicit artefacts containing formal knowledge and tacit knowledge related to designing and implementing it.

To take into account the complexity embedded in the TLS transfer process, we opted to frame this study into the "*Adaptation* and *Re-Invention"* (ARI) model (Rogers, 1983). Within this model, a basic transfer process consists in a bi-directional communication between two main "actors", namely the original knowledge producer and the host one. During the communication process, the two actors reach a consensus about the adaptations and refinements that the original product must undergo in order to fit the host context (Figure 1).

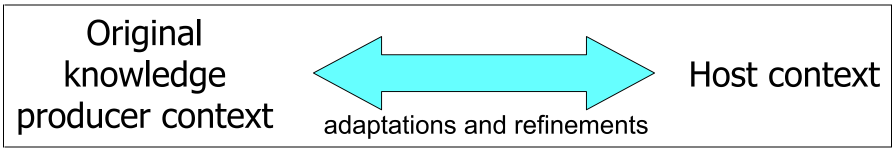

Figure 1: graphical representation of the basic ARI model (Rogers, 1983)

In the case of the transfer of a TLS, we conceive the process as an interactive cycle consisting in a de-contextualization of the original implementation procedures, the identification and adaptation of general "core" ideas embedded in a TLS, and a re-contextualization in the new setting (Figure 2).

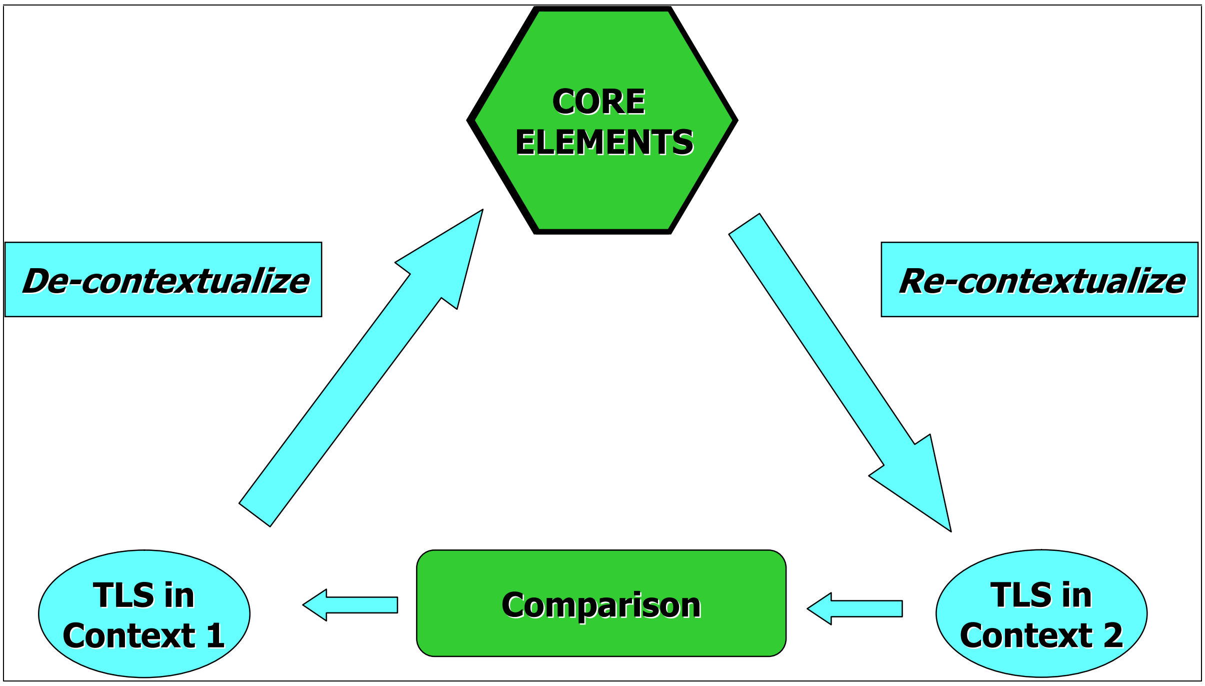

Figure 2: graphical representation of the modified ARI model to frame TLS transfer process

Briefly speaking, we suggest that the core ideas of a TLS materialize in specific elements concerning the scientific concepts and models addressed, the pedagogical approach used in the activities, and some ICT-enhanced aspects. Not all elements in original TLS are core ideas, of course: for instance, some specific activities or particular experiments cannot be included in the core, unless they are considered essential for the conceptual sequence of the overall TLS. The envisioned process is essentially research driven: data (original and host designers' views, involved teachers' actions and ideas, students' achievements) are collected in both contexts during the overall transfer process. In particular, content analysis "in retrospective" of the data collected in the host context allows to compare if the core elements of original context in the re-contextualization phase have been modified, kept or removed. Possible factors that have favoured or hindered the transfer can in this way be reliably identified. Within the proposed modified ARI model, the original TLS is therefore transferable if the whole process does not affect radically its core elements.

For the specific case reported here, the TLS to be transferred was aimed at the understanding of scientific concepts and models related to heat conduction and thermal properties of materials (Hatzikraniotis et al., 2010). Proposed teaching units are based on the Predict-Observe-Explain (POE) strategy (White & Gunstone, 1992) and are aimed at familiarizing students with scientific inquiry, specially improving their capability to design experimental investigations, to verify or reject a hypothesis and to become familiar with the use of experimental evidence. An ICT enriched learning environment is adopted to exploit didactically reconstructed microscopic representations which depict thermal interactions in iconic, graphic and symbolic forms. During the TLS activities, students work in groups, solve problems, and are engaged in classroom discussions with the aim of constructing links between evidence and explanations. The main "core elements" of the original TLS are resumed in Table 1.

Table 1. Core elements of the original TLS on heat conduction

Core Element	Description
Pedagogical approach	Guided inquiry Experimentation from teacher led towards more open investigations, Application of POE strategy based on autonomous group work Design of experiments by students Meta-cognitive reflections within units and overall at the end of the TLS
Modelling	Deductive use by students of simulated microscopic teaching models for visualizing and interpreting temperature and thermal conductivity. Engagement of students to guided explorative modelling activities and reflections on the nature and scope of scientific models.
Scientific concepts	Heat and temperature, heat conduction in materials, behaviour of thermal insulators and conductors (ceramics and metals), microscopic model of matter, factors affecting conduction
ICT	Use of simulated microscopic models of temperature change and thermal conduction in ceramics and metals Use of a virtual laboratory and simulated Flash-based experiments
Other aspects	Combination of virtual and hands on experiments Use of exemplar experiments on thermal conduction in metals Interplay of macro- with micro-processes, conductivity in containers and bars Thermal insulation of a house

METHODS

The transfer process was designed as following. The original developer of the TLS, the Greek group, prepared and provided the host partner, the Italian group, with a “background” document including, in concise form, the formal knowledge of the artefact, contextual information, the specific school settings, relevance of TLS with the local curriculum, and information about the design and implementation of TLS, namely, design principles, the pedagogical approach, the methodological framework, the student assessment tools and the procedures used to apply the TLS. Then, internet based communication (e-mails exchanges, file sharing, etc…) followed, with the aim of enhancing interactions and mutual understanding between the two groups. As a third step, the Italian group prepared a new background document in which information about the educational context where the TLS would have been implemented and the adaptations carried out were provided. Comments and reflections were also given as a sort of feedback to the original designers. As a forth step, two “study visits” followed, involving both developer and host groups experts. One external expert also participated in both visits. Each visit lasted one week and was aimed at analysing the process of implementation and validation of the TLS in both educational contexts. During the visits, at least one implementation in a real school context occurred and data were collected, including for this specific case: experts’ observation notes; interviews with local teachers and students; notes on discussions between researchers and the external expert, students’ pre- and post-questionnaires. As a fifth step, after each visit, the visiting experts prepared a report on the basis of the data collected during the visit, so to give feedback about the feasibility of the TLS to the original designers and about the effectiveness of introduced changes to the partner that adapted the TLS.

The primary source of data for this study were the background documents and the study visit observations, discussions and reports as well as some students' learning outcomes. In particular, evidence to investigate the feasibility of the TLS transfer was drawn from the comparison between the core elements of the original and adapted TLS, resulting in the identification of those elements that have been more easily adapted or transferred from one educational context to another, as well as of favoring and hindering factors.

FINDINGS

The main adaptations introduced by the Italian group and their justification/interpretation are reported in Table 2, according to the adopted core elements analysis.

Table 2. Core elements of the transferred TLS on heat conduction

Core Element	Description (D) and justification (J) of the change(s)
Modelling	*D.* Additional use of mechanical analogies for justifying particle interactions in ceramics and metals *J.* To facilitate students' interpretation of the heat transfer mechanism
Scientific concepts	*D.* Quantitative relationship amongst the factors influencing thermal conduction *J.* The formalization seemed necessary because Italian textbooks at lower secondary school level usually formalize physics laws in a mathematical way. Moreover, it is usual to collect experimental data to prove studied laws
Other aspects	*D.* Changes in the conceptual sequence, e.g., *a)* problematic situation about house insulation addressed at the beginning of TLS; b) introduction of all factors affecting heat conduction before microscopic model *J.* a) House insulation can be motivating for students and an unifying thread for all the proposed activities; b) improve the understanding of macroscopic behaviour may allow for a better justification of the microscopic interpretation

Data about students' achievements have also been collected. Analysis of results after the implementation in a Greek context has been already reported (Hatzikraniotis et al., 2010); preliminary data from the Italian implementation with about 20 students show that, as far as the students' achievements about the addressed contents, the results of the post-test are significantly different from those of the pre-test. A complete quantitative analysis of students' learning outcomes after the implementation of the TLS in the Italian context and the comparison with the results obtained in the Greek context will be reported in a forthcoming paper.

DISCUSSION AND CONCLUSIONS

Taking into account the introduced adaptations, the original designers agreed that the transferred version of the TLS has kept certain essential features of the module in terms of the core elements, as for instance, the use of a guided inquiry approach, the POE strategy, the adoption of a combination of virtual and hands-on experiments and the ICT-enhanced visualizations of microscopic model of matter. The adaptation of the overall conceptual sequence and the introduction of more quantitative aspects, carried out to better fit the original TLS to the local curriculum, were considered to have not affected the core elements.

In the context of the above evidence, it seems plausible to infer that context similarities such as school settings and educational practice between the Greek and Italian educational systems have plausibly acted as “facilitators” in the transfer process. First of all, the centralization of both educational systems seem to have played a key role: in particular, the fact that thermal phenomena was a content present in the both national and compulsory curricula favoured the implementation of the original TLS in the Italian context in usual school time, not requiring any extra school involvement of students and of the teacher who actually implemented the activities. Moreover, the circumstance that in both systems, at lower Secondary School level, Physics is taught as single subject, has driven the choice of the teacher involved in the actual TLS implementation on the basis of the implicit requirement that this teacher should have had a strong content knowledge to correctly exploit some features of the TLS (e.g., visualizations of heat conduction at microscopic level) and to conduct effective laboratory experiments. Also the similarities between the Greek and Italian contexts at the level of pedagogical practices, namely the predominant transmissive teaching approach based on textbooks, the overall weak orientation towards authentic scientific inquiry and the scarce use of laboratory activities, seem to have plausibly helped the transfer process.

Actually, the host group did not need to strongly adapt the proposed activities to the conditions of Italian teaching practice, since the original TLS designers had already taken into account very similar boundary conditions. In a similar way, the school settings (the average number of students per class, the somewhat limited laboratory and ICT equipment), very similar between Greece and Italy, favoured actual school implementations which were highly consistent in the original and host contexts.

In concluding this paper we may note that we have qualitatively described and discussed the transfer of an effective TLS between two educational contexts, the Greek and Italian one, which share some key common characteristics as, e.g.: a centralized curriculum, a general lack of authentic inquiry laboratory practice in science teaching, a traditional teacher-centred pedagogical habit. Basically, the comparison between the original and adapted TLS, carried out in the framework of the ARI model, has shown that these common characteristics have plausible helped the transfer process. This implies that some commonalities in achievements and difficulties when implementing this TLS in these two countries may be expected.

However, similarities are not a sufficient condition for successful transfer, as it has emerged looking back at the whole process. We consider that designers’ shared science education research framework has also played an important role since common views about pedagogical strategies as guided inquiry, POE, modelling and ICT-based interventions, speeded up the process of de-contextualization and re-contextualization of the core elements of the original TLS. In the future, supplementary analysis of the overall transfer process, documented by means of different data sources, will provide additional insights to scholars interested in the more general problem of transferring effective practices across different European countries.

ACKNOLEDGMENTS

The work presented in this paper was supported by the European Union through the European Communities Research Directorate General in the project **Materials Science – University-School Partnerships for the Design and Implementation of Research-Based ICT-Enhanced Modules on Material Properties**, Science and Society Programme, FP6, SAS6-CT-2006-042942

The authors want to thank prof. M. Meheut for her contributions during the different phases of the transfer process

REFERENCES

Hatzikraniotis, E., Kallery, M., Molohidis, A & Psillos, D. (2010) Students' design of experiments: an inquiry module on the conduction of heat. *Physics Education,* 45, 4, 335-344

Meheut, M. & Psillos, D. (2004). Teaching-Learning sequences: aims and tools for science education research. *International Journal of Science Education*, 26, 5, 515-535.

Pintò, R. (2005) Introducing curriculum innovations in science: Identifying teachers' transformations and the design of related teacher education. *Science Education,* 89, 1, 1-12.

Rogers, E.M. (1983), Diffusion of Innovations. *The Free Press*, New York, NY

White, R. T., & Gunstone, R. F. (1992). *Probing Understanding*. London: Falmer Press.