EXPLORING THE IMPACT OF EDUCATIVE MATERIALS ON
TEACHERS’ PEDAGOGICAL CONTENT KNOWLEDGE

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Science teachers’ professional development needs to consider the changing focus of science education. This
qualitative study included an international team of ENGAGE researchers working in Cyprus, Israel,
Norway, and Spain. Together, they examined the impact of educative materials on 31 teachers’ PCK.
Primary data sources were the teachers’ lesson preparation forms and lesson reflection forms. To support
the PCK data collection, the teachers’ lessons were observed with an observation table. The data were
coded by using Atlas.ti qualitative data analysis software. Frequent online and face-to-face team meetings
were needed to reach consensus on the procedures and to ensure consistency. Results of this study showed
that some teachers changed their PCK, especially the aspect of the PCK related to their instructional
strategies, after using the ENGAGE materials in their teaching. Years of general teaching experience
seemed to have no correlation with the quality of the teachers’ PCK. In all countries, the less developed part
of PCK was about assessment. Implications include designing shorter teacher professional development that
can potentially influence teachers’ PCK.

Keywords: PCK, Educative Teaching Materials, Teacher Professional Development

INTRODUCTION

Problem statement and theoretical framework

As a result of the recent developments in science and technology major changes happened in society which
proceeded a shift in the focus of science education. Currently, science education does not only aim to
educate future scientists but also to educate whole student population to be responsive citizens who are
scientifically literate, meaning that they can understand concepts, principles and processes of science
(DeBoer, 2000). Today’s society needs citizens who are familiar with the scientific way of thinking, and can
use it in everyday lives. Therefore, science teachers’ professional development needs to consider the
changed focus of science education.

ENGAGE project is granted by European Commission under the ‘science in society’ call. The project claims
that, to engage the young generation in scientific issues, the way traditional science is taught at schools
should be changed. For this purpose, the project team designed educative materials to foster the engagement
of teachers and students in socio-scientific issues and to emphasize the social dimension of science and
techno-scientific practices in daily life. These educative materials are ready to use, open educational
resources which include a teacher guide, student worksheets and presentation materials. All materials start
with a socio-scientific dilemma (e.g. diesel: drive cheaper versus environment-friendly) where students have
to search for evidences to make their arguments.

Since it is known that educative materials are "both effective and efficient” in the way they can help teachers
to deal with implementation problems (Davis and Krajcik (2005), ENGAGE materials are designed to
facilitate the first step of 'classroom experimentation'. This is also based on the argument that using educative materials has an impact on specific teaching practices (Schneider & Krajcik, 2002).

The aims of the ENGAGE project fit with the renewed interest in context-based science teaching in many
developed countries. Embedding real-world contexts in the teaching of science is a much-needed pedagogy
in addressing the increasing disengagement towards science among adolescents (Tang, 2013). Instead of teaching a list of isolated concepts, science concepts are used in the context of understanding common real-world situations, thus challenging students to make sense of science and technology that affects their lives. This is exactly what ENGAGE activities practice: students apply science to new contexts and use higher order thinking to form evidence-based opinions on societal needs and social values.

In order to help students to integrate science knowledge with ethical values for evidence-based thinking, teachers must develop pedagogical know-how and practice (i.e. Pedagogical Content Knowledge). PCK is the knowledge of teachers which is principally known and produced by teachers themselves. It is highly determined by individual experiences, personality variables, personal history, subject matter knowledge, and so on. Teachers’ PCK is accepted as a crucial determinant of their teaching practice and their students’ learning and success (cf. Park & Suh, 2012). It is also widely accepted that PCK develops over time based on the teachers’ experiences of teaching a topic repeatedly. Long-term professional development programs can contribute to enhancing teachers’ PCK. This can be challenging: (a) especially for projects that apply innovative ideas (e.g. ENGAGE) and are looking for changes in teaching practices in short periods of time, and (b) for real situations in which teachers cannot have access to long-term professional development.

Research goals

The aim of this research was to explore whether the use of the ENGAGE educative materials can have an impact on teachers’ PCK. More specifically, we are interested in exploring the kinds of changes that take place in teachers’ PCK when they use these educative materials, and where these changes might be attributed. The ultimate goal was to formulate grounded recommendations on how to inform teacher professional development in the area of PCK when teaching the social dimension of science and techno-scientific practices in daily life.

METHOD

Research Design

This qualitative study included an international team of ENGAGE researchers, junior and senior scientists in chemistry education working at different locations (Cyprus, Israel, Norway, and Spain). The team was led by 2 senior researchers from the Netherlands. Teachers in each country had to choose one of the ENGAGE single-lesson materials to use in class without any previous training. To support the researchers, the leading team prepared guides for the data collection instruments, observation and coding exercises, and some videos. Several online and face-to-face meetings were planned to achieve consensus on the research procedures. The study was running from February 2015 to February 2017 including a pilot study to test the instruments and the initial code list.

Data Collection and Analysis

Data were collected through 3 instruments, developed by one of the leading researchers. 1) Lesson Preparation (LP) form - PCK before; 2) Lesson Reflection (LR) form - PCK after, and 3) Lesson Observation (LO) table - support PCK data collection. The data instruments are based on the CoRe instrument by Loughran, Mulhall and Berry (2004) and the PCK model by Magnusson, Krajcik and Borko (1999). The instruments were translated by each researcher into their own language and validated through back translation.

The first step of analysis was aimed at obtaining a coding scheme to be used by each researcher. To this end, one of the international researchers (from Cyprus) translated the completed LP and LR forms of one teacher into English. These forms were coded by the leading team by using Atlas.ti qualitative data analysis software. Units of analysis were text segments initially grouped into categories stemming from the four
components of PCK (Magnusson et al., 1999), and the questions on the forms. Then, the text segments were coded using an open coding procedure attaching descriptive codes to each segment, to find possible dimensions within each of the categories. As to the completed LO table, categories and sub-codes were developed related to the observation groups and the different items within these groups. The final code list was sent to the international research partners to be used in analytical coding. Individual teacher profiles were created based on the analysis.

RESULTS AND PRIMARY CONCLUSIONS

Table 1 presents a summary of the results of our analyses.

<table>
<thead>
<tr>
<th>Country, (Number of teachers)</th>
<th>Goals in line with ENGAGE objectives</th>
<th>Focused mainly on skills</th>
<th>Focused mainly on science</th>
<th>Aware of specific student difficulties</th>
<th>Adapted the material to fit their students</th>
<th>Prepared assessment activity / tool</th>
<th>Changed PCK (main aspects*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain (7)</td>
<td>5 teachers</td>
<td>1</td>
<td>1</td>
<td>3 (misc., beliefs)</td>
<td>3</td>
<td>1</td>
<td>2 (IS, US)</td>
</tr>
<tr>
<td>Norway (7)</td>
<td>3 teachers</td>
<td>2</td>
<td>2</td>
<td>6 (skills, beliefs)</td>
<td>1</td>
<td>0</td>
<td>3 (IS)</td>
</tr>
<tr>
<td>Israel (10)</td>
<td>4 teachers</td>
<td>6</td>
<td>0</td>
<td>5 (skills, beliefs)</td>
<td>2</td>
<td>0</td>
<td>3 (IS)</td>
</tr>
<tr>
<td>Cyprus (7)</td>
<td>6 teachers</td>
<td>1</td>
<td>0</td>
<td>6 (misc., beliefs)</td>
<td>6</td>
<td>0</td>
<td>5 (IS, US)</td>
</tr>
</tbody>
</table>

*IS =Instructional strategies, US= students’ understanding

As evident in Table 1, eighteen teachers articulated goals that were in line with the ENGAGE objectives (i.e. students apply science to new contexts, use higher order thinking to form evidence-based opinions on societal needs and values). Remarkably, our analyses showed that years of general teaching experience had no direct correlation with the quality of the teachers’ PCK. The main conclusion is that by using these ENGAGE materials some of the teachers changed aspects of their PCK related to Instructional Strategies. Analysis of individual teachers’ profiles suggests that these changes are linked to teachers’ reflecting on specific difficulties they faced during teaching - especially difficulties linked to coordinating argumentation activities, group work and discussing uncertainty. Moreover, in all countries, the less developed PCK component was about Assessment. This might be linked to the fact that most of the teachers implemented the ENGAGE lesson as a separate lesson, not linked to their curriculum. One of the contributions of the study is that our findings suggest that PCK can change by using educative materials, without necessarily engaging in long-term professional development. Detailed findings, trends in PCK development across individual teachers and countries, as well as possible explanations will be discussed in the full paper. Suggestions for further PCK development will be included.

REFERENCES


