“ Pedagogy of differentiated instruction in the chemistry classroom: Impact of customized pedagogical kits (CPKs) on misconceptions, achievements, self-efficacy, and attitudes of high school students and teachers

Abstract

Chemistry is known to be difficult to learn and teach because it comprises abstract theoretical concepts that require the learner to understand and make associations on both the macroscopic and microscopic levels, while using symbols. Numerous studies have shown that quite a few students hold misconceptions about learned chemistry concepts and content, which hindering their understanding of the conceptual meaning and significance of processes learned in the classroom and affect their chemistry performances. In the past few years, chemistry classrooms have become increasingly heterogeneous, comprising various types of students with different needs and psycho-learning characteristics. These circumstances require a tailored approach and personal responses to realize the teaching and learning goals in the classrooms. The number of university chemistry students has been declining recently, leading to a shortage of chemists in the industry, and a pressing need for chemistry teachers. To encourage entering this important scientific profession, it is necessary to improve the chemistry teaching in the upper high school grades and make chemistry more accessible to all the students. Various sources have recommended applying multi-tiered teaching approaches to achieve this goal. These approaches suggest implementing individual teaching programs in layers of content, time, and continuous evaluation, in varying paces and intensities tailored to individual students and addressing the broad diversity in the classroom.

In the present study, I focused on two teaching approaches: the Response to Intervention approach (RTI), and the customized teaching approach (DI – Differentiated Instruction) and constructed a pedagogical model that combines these two approaches' principles and application characteristics. Based on the model, we have developed pedagogical kits for customized teaching (CPKs) to detect and treat students' misconceptions in chemistry. The present study examined the impact of the personalized teaching kits on the students and teachers who implemented them in their classrooms. It checked changes in the students' attitude toward chemistry, personalized teaching, and student achievements, and in the teachers' attitudes toward personalized teaching and teachers' sense of self-efficacy.

Additionally, I used the sample data to check the extent to which the research model corresponds to the connections between the students' studied variables. The studied population included chemistry teachers, who were leaders in teacher learning communities near their homes and participated in guidance and mentoring courses at

the Weizmann Institute, which acquainted them with the customized teaching kits. The sample included 96 teachers and 665 high school chemistry students from all over the country.

The study's intervention model leaned on the RTI and DI literature. It evolved along the following key axes: diagnosis and detection of misconceptions in chemistry through diagnostic tasks; building and developing validated customized teaching kits; addressing students' misconceptions; and finally, gathering evidence on the effect of the CPKs on teachers and students through an assessment task and interviews with teachers and students.

The overarching purpose of the study was to understand the effects of CPKs based on the RTI approach on chemistry learning in upper high school grades. The RTI approach has been applied to date only in special education and lower elementary school grades, and mainly in teaching humanities and language.

This is a mixed-method study that uses quantitative and qualitative methodology. I have therefore used several research tools that are mainly based on quantitative data analysis. They include student attitude and pre-and-post self-efficacy questionnaires, teacher attitude and pre- and-post self-efficacy questionnaires, student diagnostic and assessment tasks, in addition to the qualitative tools of student pre-and-post interviews, and teacher pre-and- post interviews.

The main research findings indicate a significant positive effect of the CPKs on student assignment achievements, a sense of self-efficacy in chemistry learning and in their attitudes toward chemistry, and towards innovative personalized teaching against conventional traditional teaching. Furthermore, the CPKs have had a significant positive effect on teachers' attitudes toward personalized teaching and a sense of self-efficacy in using the DI pedagogy in chemistry teaching. In contrast to research literature reports, involving students in DI pedagogy in the classroom did not produce a statistically significant difference in their sense of self-efficacy in chemistry learning. The reason for this was that the students attributed their success in completing the CPK tasks and activities to the CPKs themselves and the DI approach that provided them with appropriate responses. These findings, along with other findings that emerged in the interviews, led to the conclusions and recommendations to implement additional CPKs in other classes, and implement a professional development program that aspires to further expose and integrate CPKs and DI pedagogy and increase students' involvement in pedagogical decision-making in class, to let their voice be heard.

The present study has a significant contribution since the DI approach is one of the most advanced modern teaching strategies, and researchers the world over have begun implementing it to meet the individual needs of students while considering their different levels of understanding. The present study significantly contributes to the knowledge in the field, being one of the few studies investigating the implementation of the RTI approach, developed originally for special education, in high school chemistry classes. It

is one of the few studies that have examined empirically the impact of a teaching intervention that combines the DI and RTI approaches in science teaching. Finally, it is one of the few studies to offer a complete pedagogical solution in the form of a customized pedagogical kit, to address and resolve high school chemistry students' misconceptions, measure, and evaluate those solutions.