מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Thesis for the degree

Doctor of Philosophy

Submitted to the Scientific Council of
the Weizmann Institute of Science

Rehovot, Israel

By:

Enas Easa

עבודת גמר (לתזה) לתואר

דוקטור לפילוסופיה

מוגשת למועצה המדעית של מכון ויצמן

רחובות, ישראל

מאת:

אינאס עיסא

הפדגוגיה של הוראה מותאמת אישית בכיתת הכימיה: השפעה של ערכות הוראה מותאמות אישית על תפיסות שגויות, הישגים, מסוגלות עצמית, ועמדות של תלמידים ושל מורי כימיה

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

Advisor:

Prof. Ron Blonder

מנחה:

פרופ' רון בלונדר

2022

תפש"ב

Abstract

Chemistry is known to be difficult to teach and learn because it comprises abstract theoretical concepts that require the learner to understand and make connections 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. These misconceptions hinder their understanding of the 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, with 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. Furthermore, 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 chemistry teaching in the upper high school classes 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 personalized content- and time-layered teaching programs with continuous evaluation, at varying paces and intensities tailored to individual students and addressing the broad diversity in the classroom.

In the present study, we focused on two teaching approaches: the Response to Intervention approach (RTI) and the Differentiated Instruction approach (DI). Based on the characteristics of these approaches, we have developed customized pedagogical kits (CPKs) to detect and address students' misconceptions in chemistry. The CPKs contain the following components: diagnosis and detection of misconceptions in chemistry through diagnostic tasks; building and developing validated customized teaching kits to address 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 goal of the study was to understand the influence of CPKs on chemistry learning in upper high school classes and on teachers who operated the CPKs. To date, the RTI approach has been applied only in special education and lower elementary school classes and mostly in humanities and language teaching. Extending its application to include chemistry is one of the present study's main contributions.

The present study examined the impact of the personalized teaching kits on the students and teachers who implemented them in their classrooms. The two interventions of the present study implemented the developed customized teaching kits (CPKs) in two stages. In the central intervention, we examined the impact of the CPKs' implementation on student achievements and on the attitudes and self-efficacy of teachers who applied the CPKs against those who did not. In a second “mini” intervention, we examined the impact of CPKs on the self-efficacy, attitudes, and achievements of students who received explanations about the pedagogy of DI against those who were not aware of the pedagogy beyond the CPKs. Based on the relevant literature, I designed a structural model that correlated the students' variables and examined was the correspondence between the present study's sample data and the proposed model.

This is a mixed-method study that combines quantitative and qualitative methodology but leans heavily on quantitative data. Thus, I used several research tools that are mainly based on quantitative data analysis, including students' attitudes and pre-and-post self-efficacy questionnaires, teachers' attitudes and pre-and-post self-efficacy questionnaires, and student diagnostic and assessment tasks. The additional qualitative tools used included students' and teachers' pre-and-post interviews. The studied sample includes 96 chemistry teachers and 665 high school chemistry students across Israel.