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Enhancing students' interest in science and STEM careers

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University
 of Cyprus

Enhancing students' interest in science and STEM careers

An investigation of career-based scenarios and
 students' self-views in relation to science

PhD thesis

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 University of Groningen
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Abstract

Increasing the numbers of Science, Technology, Engineering, and Mathematics [STEM] graduates in many developed countries is more intensified than ever before to confront societal challenges that threaten the pursuit of human prosperity. The available statistics indicate that the share of tertiary STEM graduates in Europe is comparatively lower than in other fields and combined with demographic changes a critical mismatch is anticipated between supply and demand in STEM personnel. In addressing this issue, policy makers and the science education community focused on educational reform efforts with an emphasis on fostering young people's interest in science. Numerous pedagogical initiatives have been implemented in this context to encourage young people to pursue STEM studies and relevant careers. Nevertheless, an important question still arises about how pedagogical interventions can provide the students with opportunities to identify themselves with science and relevant careers.

In responding to this call, the purpose of this research project was to support students in enhancing their interest in science and developing more realistic understandings of STEM careers and also to explore the evolution in their self-views in relation to science and STEM career aspirations. Theoretically framed within Social Cognitive Career Theory (SCCT) this research project evolved into *four studies*. The first, second, and third studies focused on designing and implementing career-oriented instruction in science classes. The fourth study focused on mapping out the evolution in students' self-views in relation to science and STEM careers during compulsory and post-compulsory secondary education.

More specifically, the *first study (Chapter 2)* presents the design and the implementation of a set of career-oriented curricular innovations – referred to as *career-based scenarios* - aiming to enhance students' interest in science and their understandings of STEM careers. This study provides readers with an understanding of how we proceeded from the design to the enactment of the curriculum materials and what we have learned that might have a bearing on other efforts to design curricular innovations.

The *second study (Chapter 3)* reports on the findings from a scenario implementation in two science classrooms (students 14-15 years old) using an iterative design-based approach focusing on the design adjustments to the scenario. The study investigates what scenario features worked best and how these were supported to generate students' interest and enhance their understandings of STEM careers. The findings of this study highlight that career-related instruction can broaden students' basic understandings of STEM careers and possibly influence their career aspirations when connections between theory and practice are established fostering meaningful interaction with experts.

The *third study (Chapter 4)* focused on the impact of career-based scenarios on students' interest in science and understandings of STEM careers over a two-year classroom intervention (students aged 13-15 years). The findings confirmed and enriched the results from the second study illustrating that scenarios framed within a personally-relevant context that promotes opportunities for active engagement in scientific practices and interactions with experts were

important conditions for career-based scenarios to enhance students' situational interest and understandings of STEM careers.

Finally, the *fourth* study (*Chapter 5*), investigates students' self-views in relation to science and STEM careers (following eight students for five consecutive years from 13 to 17 years old). The study focused on developing a better understanding of the interplay between experiences with school science, factors relating to the social and family environment, and evolving self-views during adolescence and career aspirations. The findings revealed a dynamic relationship between students' self-views and career aspirations that is influenced by experiences with school science, and also extrinsic factors relating to the social context and the family environment.

Considering all the studies collectively, this research project provides insights that inform the career-oriented instruction in science class, and further suggests that an intersectional approach is warranted to comprehensively examine students' self-views and career aspirations thus facilitating their self-identification with science.

Περίληψη

Η αύξηση του αριθμού των αποφοίτων της τριτοβάθμιας εκπαίδευσης στους κλάδους STEM (Science, Technology, Engineering, Mathematics) αποτελεί ένα φλέγον ζήτημα για την αντιμετώπιση διαφόρων κοινωνικών προκλήσεων που απειλούν τις σύγχρονες κοινωνίες. Σύμφωνα με στατιστικά δεδομένα, το ποσοστό των αποφοίτων από αυτούς κλάδους στην Ευρώπη είναι συγκριτικά χαμηλότερο από ότι σε άλλους τομείς, και συνδυαστικά με τις δημογραφικές αλλαγές, προβλέπεται μία κρίσιμη αναντιστοιχία μεταξύ προσφοράς και ζήτησης προσωπικού με ειδικές γνώσεις στους κλάδους STEM. Για να αντιμετωπιστεί αυτό το ζήτημα, οι υπεύθυνοι χάραξης πολιτικής και η κοινότητα της επιστημονικής εκπαίδευσης επικεντρώθηκαν στις προσπάθειες εκπαιδευτικών μεταρρυθμίσεων με έμφαση στην ενίσχυση του ενδιαφέροντος των νέων για την επιστήμη και την τεχνολογία. Μέχρι σήμερα, έχουν εφαρμοστεί αρκετές παιδαγωγικές παρεμβάσεις με στόχο την ενθάρρυνση των μαθητών ώστε να επιλέξουν τους κλάδους STEM ως πιθανές κατευθύνσεις για ακαδημαϊκές σπουδές ή επαγγελματική ενασχόληση. Ωστόσο, ένα σημαντικό ερώτημα αφορά στον τρόπο με τον οποίο οι παιδαγωγικές παρεμβάσεις μπορούν να προσφέρουν στους μαθητές ευκαιρίες ώστε να ταυτιστούν με την επιστήμη και τις σχετικές επαγγελματικές επιλογές.

Ανταποκρινόμενοι σε αυτό το κάλεσμα, αυτό το ερευνητικό έργο είχε ως σκοπό να ενισχύσει το ενδιαφέρον των μαθητών για την επιστήμη, να διευρύνει την κατανόησή τους σχετικά με τις επαγγελματικές επιλογές στους κλάδους STEM, καθώς και να διερευνήσει τις απόψεις τους για το πώς βλέπουν τον εαυτό τους σε σχέση με την επιστήμη (self-view in relation to science) και τις επαγγελματικές τους φιλοδοξίες (career aspirations) στους κλάδους αυτούς. Το ερευνητικό έργο στηρίζεται στην Κοινωνικογνωστική θεωρία της σταδιοδρομίας (Social Cognitive Career Theory) και εξελίσσεται σε τέσσερις μελέτες. Οι πρώτες τρεις ερευνητικές μελέτες επικεντρώθηκαν στον σχεδιασμό και την εφαρμογή διδακτικών σεναρίων με επαγγελματικό προσανατολισμό σε περιβάλλοντα τάξης στην δευτεροβάθμια εκπαίδευση, στα γνωστικά αντικείμενα της Φυσικής, της Βιολογίας, και της Χημείας. Η τέταρτη μελέτη επικεντρώθηκε στη χαρτογράφηση της εξέλιξης των απόψεων των μαθητών σε σχέση με την επιστήμη και τις επαγγελματικές φιλοδοξίες στους κλάδους STEM κατά τη διάρκεια της φοίτησής τους στη δευτεροβάθμια εκπαίδευση (υποχρεωτική και μη).

Συγκεκριμένα, η πρώτη μελέτη (Κεφάλαιο 2) παρουσιάζει τον σχεδιασμό και την εφαρμογή μιας σειράς καινοτόμων διδακτικών επινοήσεων - διδακτικά σενάρια με επαγγελματικό προσανατολισμό - με στόχο την ενίσχυση του ενδιαφέροντος των μαθητών για την επιστήμη και της ενημερότητάς τους για τις επαγγελματικές επιλογές τους κλάδους STEM. Αυτή η μελέτη περιγράφει τα στάδια σχεδιασμού και εφαρμογής των διδακτικών σεναρίων καθώς και αναστοχασμούς από την εφαρμογή που ενημερώνουν τον σχεδιασμό καινοτόμων αναλυτικών προγραμμάτων σπουδών.

Η δεύτερη μελέτη (Κεφάλαιο 3) αναφέρει τα αποτελέσματα από την εφαρμογή ενός σεναρίου σε δύο τάξεις (Γ' γυμνασίου, μαθητές 14-15 ετών) με έμφαση στις προσαρμογές που έγιναν μετά την πρώτη εφαρμογή. Η μελέτη διερευνά ποια χαρακτηριστικά του σεναρίου λειτούργησαν καλύτερα και τον τρόπο με τον υποστηρίχθηκαν κατά την εφαρμογή ώστε ενισχύσουν το ενδιαφέρον των μαθητών και την ενημερότητά τους για τα

επαγγέλματα στους κλάδους STEM. Σύμφωνα με τα αποτελέσματα, η διδασκαλία με επαγγελματικό προσανατολισμό μπορεί να διευρύνει τις βασικές γνώσεις των μαθητών για τις επαγγελματικές επιλογές στους κλάδους STEM και να επηρεάσει τις φιλοδοξίες τους κυρίως όταν επιδιώκονται συνδέσεις μεταξύ θεωρίας και πρακτικής μέσα από την αλληλεπίδραση με ειδικούς στους κλάδους αυτούς.

Η τρίτη μελέτη (Κεφάλαιο 4) διερεύνησε τις επιπτώσεις της εφαρμογής των διδακτικών σεναρίων στο ενδιαφέρον των μαθητών για την επιστήμη και την κατανόηση τους για επαγγελματικές επιλογές στους κλάδους STEM μέσα από μια διετή παρέμβαση σε τάξη της δευτεροβάθμιας εκπαίδευσης (μαθητές ηλικίας 13-15 ετών). Αυτή η μελέτη επιβεβαίωσε και ενίσχυσε τα αποτελέσματα της προηγούμενης μελέτης. Συγκεκριμένα, τα αποτελέσματα έδειξαν ότι τα διδακτικά σενάρια που πλαισιώνονται σε ένα συγκείμενο το οποίο σχετίζεται με τους μαθητές και προωθούν ευκαιρίες για ενεργό συμμετοχή των μαθητών σε δραστηριότητες που βασίζονται σε επιστημονικές πρακτικές με την αλληλεπίδραση ειδικών, αποτελούν σημαντικές προϋποθέσεις για την ενίσχυση του ενδιαφέροντος τους καθώς και της ενημερότητάς τους για τις επαγγελματικές επιλογές στους κλάδους STEM.

Τέλος, η τέταρτη μελέτη (Κεφάλαιο 5), παρουσιάζει μια σειρά από μελέτες περίπτωσης οκτώ μαθητών για πέντε συνεχόμενα έτη (13-17 ετών) με στόχο την κατανόηση της αλληλεπίδρασης μεταξύ των σχολικών εμπειριών των μαθητών σε μάθημα των φυσικών επιστημών, παραγόντων που σχετίζονται με την κοινωνία και το οικογενειακό περιβάλλον, και τις απόψεις των μαθητών για το πώς προσδιορίζουν τον εαυτό τους σε σχέση με την επιστήμη κατά τη διάρκεια της εφηβείας καθώς και τις επαγγελματικές τους φιλοδοξίες. Τα αποτελέσματα παρουσίασαν μια δυναμική σχέση μεταξύ των απόψεων των μαθητών και των επαγγελματικών τους φιλοδοξιών η οποία επηρεάζεται από τις σχολικές εμπειρίες, καθώς και εξωγενείς παράγοντες που σχετίζονται με το κοινωνικό πλαίσιο και το οικογενειακό περιβάλλον.

Λαμβάνοντας υπόψη όλες τις μελέτες, τα ευρήματα αυτού του ερευνητικού έργου μπορούν να ενημερώσουν τον σχεδιασμό αναλυτικών προγραμμάτων με επαγγελματικό προσανατολισμό στα γνωστικά αντικείμενα των φυσικών επιστημών. Επίσης, προτείνουν την υιοθέτηση μιας διατομεακής προσέγγισης (intersectional approach) για περαιτέρω διερεύνηση των απόψεων των μαθητών σε σχέση με την επιστήμη και τις επαγγελματικές τους φιλοδοξίες, διευκολύνοντας έτσι τις προσπάθειες να προσδιορίσουν τον εαυτό τους σε σχέση με την επιστήμη και σχετικές επαγγελματικές επιλογές.

ENHANCING STUDENTS INTEREST IN SCIENCE AND STEM CAREERS

An investigation of career-based scenarios and students' self-views
in relation to science

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