Teacher Educators' Questioning's Influence on Prospective Teachers' Cognitive Productivity while Discussing How to Teach Concepts

In Cooperation of Higher Education Studies Application and Research Centre and Faculty of Education

By Yılmaz SOYSAL (PhD) and Somayyeh RADMARD (PhD)

İSTANBUL AYDIN ÜNİVERSİTESİ
YAYINLARI

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Istanbul Aydın University - Florya Campus

December - 2020

İstanbul Aydin University Press

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Book Design: Istanbul Aydın University Visual Design Coordinator

Publication Year: 2020, 1st Edition

E-ISBN: 978-975-2438-65-1

*This study had undergone rigorous peer review, based on the initial editor screening and anonymized refereeing by two anonymous referees.

From the President

The major duty of universities is not only the production of technical and terminological knowledge, but also the perfection, internationalisation and scientificisation of university-based teaching endeavours. A nation's most indispensable intellectual strength is its universities. The standardisation of inter-faculty teaching and the adoption of generic pedagogical principles in all cells of the university can only be attained through focusing on the innovative pedagogical approaches and strategies that are functionalised at the university level. One of the instrumental ways of transferring and sharing the pedagogic-scientific knowledge produced in the university to the interlocutors is through the examination of how these processes take place. Therefore, every effort to improve the higher education of a nation should be regarded as a serious intellectual contribution and value. As adopted in the present study, our basic idea in the context of accelerating various efforts on behalf of the university can be expressed as follows: To understand and move forward the higher education of a nation strictly requires to problematize it. One of the featured ways of taking concrete steps in knowing and solving the problems of teaching in higher education is to make the existing problems visible and examine them in-depth. In this context, this valuable work of our faculty members offers us a new vision to understand and make sense of broader and analytical principals of the effective instruction. I would like to thank our teacher educators and prospective teachers who contributed to the preparation of this work.

Associated Professor Doctor Mustafa AYDIN

Istanbul Aydın University

Chairman of the Board of Trustees

From the Rector

Today, the main purpose of higher education systems is to close the difference between theory and practice in order to enrich cultural, ethical, and aesthetic aspects of social life by producing a whole of theories fed by practice. In the globalizing world, the responsibilities of universities are also expanding. In this context, one of the main goals of the universities is to provide a pedagogical stance to both their educators and student participants who must strive for creating, communicating and sharing knowledge. When the outcomes of this research are evaluated carefully, especially on behalf of education faculties, the necessity of the necessary steps to be taken is once again concretised. In this context, the duty of investigators should be to re-consider the outcomes of the research presented here as an intellectual lens to glorify the place of higher education in Turkey. I would like to thank our teacher educators and prospective teachers who contributed to the preparation of this work.

Professor Doctor Yadigâr İZMİRLİ

Rector of Istanbul Aydın University

CONTENTS

Teacher Educators' Questioning's Influence on Prospective Teachers' Cognitive Productivity while Discussing How to Teach Concepts

Abstract: In this study, the influence of diversifying typologies and proportional occurrences of teacher educators'-questioning on the prospective teachers' cognitive contributions was explored deeply. Four teacher educators participated in the study and their in-class implementations were recorded and discursively analysed through systematic observation approach as a branch of sociocultural discourse analysis. The teacher educators enacted eight types of questioning: observe-compare-predict, communicating, monitoring, evaluating-judging-critiquing, challenging, evidencing, concluding, labelling. Four questioning typologies; communicating, monitoring, evaluating-judging-critiquing, challenging, were pervasively staged among others. The communicating questions and monitoring questions were found as specific types of utterances of the teacher educators in opening up and enriching further and more sophisticated cognitive productivity of the prospective teachers. The communicating and monitoring questions seemed to be functionalised by the teacher educators as discursive pre-organiser or pre-conditioner talk moves in fostering more complex cognitive contributions of the prospective teachers. The evaluating-judging-critiquing and challenging questions appeared having explicit and tangible influences on the cognitive productivity of the prospective teachers and these types of questions' joint effects on the rather sophisticated cognitive generations were also confirmed. Recommendations were offered for teacher educators' in-class discursive practices.

Keywords: higher education, questioning, question, cognitive productivity, teacher educator, teaching how to teach concepts

Introduction and Thesis Statement of the Present Study

In the context of higher education, effective teaching of how to teach concepts is one of the most essential dimension of teacher education programmes. To our knowledge, within a teacher education programme, there are two prominent actors: prospective teachers and teacher educators. In-class social interactions and idea exchanges between these two actors signify the "process quality" or "instructional quality" that is considerably related with the *cognitive contributions* of each parties to classroom discourse (Soysal & Radmard, 2019). The term process quality refers that a teacher educator may be a ***"qualified"*** or ***"unsatisfactory"*** implementer of in-class instructional activities (Rowen & Miller, 2007; Soysal & Radmard, 2020). It has been ensured that the process quality is substantially related with the students' academic achievements. For instance, Rowan, Correnti, and Miller (2002) indicated that due to divergences in their in-class teaching environment, two students from similar social and academic backgrounds who are in different classrooms with similar student composition could reach different achievement growth. The term process quality happening in the classroom has been inquired into in the elementary, middle, and secondary school levels and received growing attention from both researchers and practitioners (Tekkumru-Kisa et al., 2020). It is explicitly reported that schools, districts, and states have been invested large amounts of efforts for excelling in-class teaching through enhancing professional development designs, curricular activities/materials, and assessment approaches (Matsumura et al., 2002; 2006; 2008). However, to our knowledge, these efforts are not visible in the context of teaching in higher education.

Process quality is mostly regulated by teacher talk, for instance, as in the form of "questioning or questions" (Mameli & Molinari, 2014; Molinari & Mameli, 2013; Soysal & Radmard, 2020;

Soysal, 2019) as one of the fundamental elements for estimating instructional quality (Tekkumru-Kisa et al., 2020; van der Veen et al., 2015). Even though it has been acknowledged that the process quality is the core element of in-class teaching, "*instructional quality in the context of teaching in higher education"* has not received as much attention as other levels of teaching such as K-12. Thus, the present study aimed at clarifying process quality indicators at the level of higher education by making direct reference to *teacher educators' talk typologies and strategies as in the form of in-class questioning*.

It is not a simple issue to clarify the elements or indicators of process quality in the context of higher education while teaching how to teach concepts. To explicate, it is a sophisticated and multi-faceted phenomenon. Several research were conducted to extract the components of the process quality through using lesson observations, classroom artifacts, surveys, and instructional logs (e.g., Danielson, 2014; Martinez et al., 2012a, 2012b; 2016). Large-scale data collection and analysis provided mostly quantified aspects of the process quality (Kisa & Correnti, 2015). However, it has been well accepted that only quantified clarifications of process quality may not be adequate to grasp the fine-grained and emergent features of classrooms' discursive happenings that determine whether a teacher teaches well or engage students in productive classroom talks (Martinez et al., 2012a, 2012b; van der Veen et al., 2015). Tekkumru-Kisa et al. (2020) indicated that classroom observations can supply enriched information regarding rather sophisticated happenings of science teaching process. The UTeach (Walkington & Marder, 2014) and the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002) are well known examples of measuring process quality in the context of science teaching. In the current study, in-depth and fine-grained classroom-based observational data was collected, analysed, and interpreted in order to determine how teacher

educators' talk or questioning strategies and typologies fluctuated the PTs cognitive and conceptual contributions to classroom talks. The need and justification for the present study is elaborated below.

It has been well acknowledged that reform-based teaching requires *change agent*s as *teacher*s and reform-based university-levelled teaching necessitates other change agents as *teacher educator*s (Goodwin & Kosnik, 2013; Vanassche & Kelchtermans, 2016). It is also well acknowledged that theories of teacher educators regarding what-aspects and how-aspects of teaching and learning and their in-class interventions and discursive practices have not been systematically examined (Murray, 2005; Darling-Hammond, 2006; Murray & Kosnik, 2011). In the recent studies (e.g., Soysal & Radmard, 2020), it is also found that in-class practices of teacher educators (e.g., talk moves, questioning, questions) has remained an uncharted territory. Teaching is a complex process, however, teaching how to teach is a more sophisticated phenomenon compared to teaching subject matter knowledge for instance elementary science or mathematics. It is *taken for granted* for most of the prospective teacher educators that if one is good at teaching elementary/secondary-level students, then this expertise can be directly transferred to being good at training prospective teachers (Goodwin & Kosnik, 2013; Vanassche & Kelchtermans, 2016). However, holding the competency and capacity of a teacher educator is not a simple process since this strictly requires a solid and though transition from instructing, for instance, the subject matter knowledge pertaining to elementary science or mathematics to pupils, to instructing the subject matter knowledge regarding how to teach concepts, principles, strategies, methods, approaches and so forth to prospective teachers. There is no or little scholarly attempts for inquiring into teacher educators' in-class practices in a systematic manner. Beyond, there is no studies systematically examining

which in-class strategies as in the form of educator-led in-class questioning are more fostering and boosting for the prospective teachers' cognitive productivity while they are engaged in socially-oriented rigorous negotiations of meanings pertaining to the how to teach concepts.

Designing and planning *instructional sequences* or *environments/settings* for teaching how to teach concepts is *just* one aspect of teacher educators' in-class practices that are inevitably surrounded and materialised through the teacher-led questioning that is a crucial instructional device of a tutor (Chin & Osborne, 2008) in initiating, maintaining and finalising the teaching episodes. Teaching how to teach concepts may be planned and designed in a productive intention; however, teacher educators' questioning typologies may dramatically modify the effectiveness of a well-planned teaching episode. *Fruitfulness of teacher educators' questioning* refers that whether the enacted question types or questioning strategies maintain a productive discursive atmosphere where prospective teachers will have chances to make intellectual contributions to classroom talks while discussing how to teach concepts.

In this study, it is accepted that instructional strategies that are enhanced by teacher educators in maintaining argumentative learning environments that are thought to facilitate prospective teachers' conceptual change and concept formation attach importance. However, in this study, it is advocated that researchers tend to attribute improvements in students' learning to the effectiveness of the sequence of teaching activities, giving little explicit attention to the teacher's role (particularly questioning) in staging those teaching activities (Leach & Scott, 2002, p. 115). In the higher education context, it has been a research tenet to design and test teaching activities for prospective teachers' pedagogical gains with no reference to the talk (e.g., in-class questioning)

which surrounds them (e.g., Soysal & Radmard, 2020). On the other hand, teachers' talk/questioning strategies and typologies have been accepted as central to any instructional sequence where teachers work with students' propositions to talk into existence the scientific story (Mercer & Littleton, 2007; Micheals et al., 2008). It has to be noted that the researchers of the present study *do not* underestimate the typologies of the activities used in university classrooms in promoting prospective teachers to take on intellectual problems regarding in-class instruction and resolve them. Through the present study, it tried to be showed that the instrumentality and fidelity of in-class teaching activities may mostly be illuminated when there is an explicit reference to teacher-led utterances as their questions used for initiating, maintaining and wrapping up the classroom talks. A deficient point as the *mediational function of the in-class questioning* with regards to crystallising teaching activities for scaffolding prospective teachers in making sense of how to teach concepts was therefore deeply examined in the present study. This kind of analysis requires an *utterance-based exploration of the analytical perspectives of questions* as suggested by the recent studies (Kim et al., 2011) to comprehend in what ways teacher educators maintain intellectually productive or counter-productive in-class questioning.

Theoretical Framework

Discourse and cognition relation in the context of teaching in higher education

Discourse-cognition relation in the context of university-based teaching in relation with the teacher educators' questioning practices was deeply explored in the present study. It is acknowledged that discourse and cognition are *adjacent* or *joint* (Gee & Green, 1998). Classroom discourse is mainly governed and regulated by teachers' talks (or discourse) that are operated through different versions of questions or questioning (Alexander, 2005; 2006). Lee and Kinzie (2012) indicated that student-

led cognitive productivity could be estimated by taking a teacher's questioning actions into account. Teachers' questioning typologies may unfold or interrupt presumable student-led cognitive contributions to classroom discourse (Chin, 2006; 2007). This shows that enacted questioning strategies or question typologies may influence prospective teachers' intellectual contributions to classroom talks. Socialised interactions and idea exchanges between teacher educators and prospective teachers signify *discourse (enacted questioning)* and *cognition (emerged cognitive contributions) relation* (Gee & Green, 1998). The discourse may be actualised by teacher-led questioning that may create productive instructional sequences on the social plane of classroom to engage prospective teachers in negotiation of meaning sessions regarding how to teach phenomenon for individualised or private meaning making on the intrapsychological plane.

In the context of this study, teacher educators' questions are conceived as their verbal actions in managing classroom discussions. Cognitive contribution signifies how and to what extent teacher educators open discursive rooms for prospective teachers in attaining cognitive contributions to classroom discourse. Intellectual productivity of prospective teachers' utterances are expected to be substantially dependable on conversational harmony that is mostly controlled by teacher educators' questioning techniques and strategies (Mercer, 2008). As a rational, in this study, it is hypothesized that changing typologies and frequencies of teacher educators' questioning would have relative impacts on the prospective teachers' cognitive productivity by augmenting or cutting off them.

Important observations regarding in-class questioning and questions

In this study, typology or type of teacher questioning refers to discursive function of teacher educators' questions. While discussing how to teach concepts with learners, teacher educators may

elicit prospective teachers' verbal externalisations to capture their underlying meanings that may be latent to the peer community (Lemke, 1990; van Booven, 2015). This type of questioning incorporates a *request for clarification* for a provided response that may be less comprehensible or understandable to the teacher educator or class members. Prospective teachers may be required to deepen upon their responses through specific form of questions such as *probing* (known as eliciting or elaborating) (Chin, 2007). During arguing about teaching concepts, teacher educators may focus all members' attention on an important conceptual aspect that may be invaluable for the progression and unfolding of intellectual exchanges among the peer community (van Zee & Minstrell, 1997a; 1997b). Mortimer and Scott (2003) reported that questions can be staged by varying discursive purposes such as

- Shaping and framing student-proposed ideas,
- selecting or eliminating ideas from classroom discourses,
- marking key ideas,
- sharing ideas,
- checking students' understanding,
- reviewing and summarising key points.

During handling discussions regarding how to teach concepts, a teacher educator may gather several utterances from respondents through, for instance, a brainstorming activity, then, the teacher educator may select (by making prominent) or ignore (by neglecting) some specific meaning positions by taking his/her teaching agenda's conceptual flow or content into account. Moreover, teacher educators may pass the responsibility of thinking back to students through

reflective toss or *toss-back* questioning by, for instance, uttering that "*I do not know, and I am wondering what you think about it…*" (Pimentel & McNeill 2013; van Zee & Minstrell, 1997a).

Teacher educators may promote prospective teachers to link their ideas on a shared cumulative conceptual basis by inviting them for *interthinking* within joint dialogues (e.g., Brown & Kennedy, 2011). In proliferating interthinking or inter-knowing among the peer community, teacher educators may invite students to evaluate, judge, criticise and legitimate their classmates' alternative or contradictory thinking and talking (van Zee & Minstrell, 1997a). In addition, to compose an evaluative, challenging, discrepant and argumentative instructional environment, teacher educators may act as rigorous debaters, discussants or negotiators by playing the devil's advocate role (Simon et al., 2006). When this is the instructional case, prospective teachers may notice their conceptual, ontological and epistemological cognitive contradictions regarding, for instance, how to teach concepts and will adapt a more explanatory thinking and talking system favouring canonical science knowledge of generic pedagogy by modifying, revising, or completely altering their existing mental models or conceptual schemes. In this study, several variations of discursive functions of the enacted teacher questions were qualitatively and deeply explored to ascertain their potential influences on the prospective teachers' potential conceptual, ontological and epistemological cognitive contributions to classroom talks.

Teacher educator questioning and prospective teachers' cognitive productivity

In this section, it has to be noted that studies delving into discourse and cognition relation were mostly conducted in science and mathematics education fields. Related literature was therefore barrowed from these research fields. This study therefore contributed to the research cumulative

pertaining to discourse and cognition relation in the context of teaching at the level of higher education.

For university-based teaching, prospective teachers and teacher educators may negotiate diversified ideas regarding how to teach phenomenon and this may require low-level and high-level cognitive demands on the side of learners (Chin & Osborne, 2008). A teacher educator may require a prospective teacher to elucidate his/her externalisation's background or underlying meaning (Edwards & Mercer, 1987; Kawalkar & Vijapurkar, 2013; Lemke, 1990; van Booven, 2015). This creates low-level cognitive demand on the side of prospective teachers since they will be providing only a surface level clarification of their meaning position. On the other hand, when teacher educators promote prospective teachers to judge, criticise, evaluate and legitimate a given claim, this will generate high-level cognitive demand on the part of them. In this case, prospective teachers have to make a critique of the provided opinion by detecting logical inconsistencies or testing its rationality against a conceptually-determined reference system (Anderson et al., 2001; Krathwohl, 2002).

Earlier research (e.g., Dillon, 1982, 1988; Gall, 1970, 1984; Gall & Rhody, 1987) showed that specific types of teacher questions (e.g., open-ended and eliciting) may have substantial effects on the students' achievement or cognitive sophistication of the student-led verbalisations. However, Gall (1970), Dillon (1982; 1988) and Konya (1972) indicated that there may not be an ensured correlation between increasing cognitive demand of teacher-led questions and sophistication level of the cognitive contributions. In this sense, Goodwin, Sharp, Cloutier and Diamond (1983) revealed that in-class questioning should be staged by pragmatic, systematic and purposeful

instructional intentions. This intends that teacher educators should pose cognitively higher-demanding and lower-demanding questions within a harmony and rhythm to arrange presumably ascending temporal cognitive loads of learners.

In recent studies, for instance, Chin (2006) reported clear effect of *scaffolding/supporting questioning* on the higher-order thinking of students (e.g., hypothesising, evaluating, explaining, deducing) compared to *evaluating questioning* that were mostly accompanied with the lower-level student-led cognitive activity and productivity (e.g., recalling, paraphrasing, comparing etc.). Scaffolding questioning incorporates a specific type of instructional-discursive mechanism through which a teacher poses a series of questions by deliberately taking the provided responses' semantic or conceptual content and context (Roth, 2001) into account and by not strictly judging or turning down the student-led utterances solely based on the canonical science knowledge. Chin (2007) also contended the fact that the cognitive demand phenomenon can be used to elaborate what-aspects and how-aspects of the discourse and cognition relation. Chin (2007) reported that a teacher question requiring lower cognitive demand (e.g., prompting students for recalling a factual statement) accompanies with low-level cognitive effort on the part of students. This may also cause low-level student-led cognitive contributions to classroom discourse or surface level conceptual understanding, for instance, regarding how to teach concepts. Once students are not cognitively demanded at a certain level through teacher-led questioning, they will not analyse others' arguments, commenting on peers' propositions and generating original hypothesis (Anderson et al., 2001; Krathwohl, 2002) in response to others' counter arguments since these rather sophisticated cognitive and metacognitive operations are more observable by virtue of specific questioning typologies requiring more cognitive work and processing (Chin, 2007; Soysal, 2019).

Another significant aspect of teacher-led questioning is about the question's structural quality. For instance, some studies (Martin & Hand, 2009; McNeill & Pimentel, 2009) reported that when a teacher displays his/her questioning structure in an open-ended and eliciting manner, students' voices dominate the classroom conversations as an indicator intellectual productivity. Open-ended questions are mostly responded by alternative student-led responses as diversifying points of views. In addition, open-ended questions do not address a few narrowed explications and is open to various student-led interpretations. Some researchers (e.g., Martin & Hand, 2009; McNeill & Pimentel, 2009) found out that when teachers use more open-ended questions more sophisticated argumentations (e.g., justified claims, supported assertions) are accomplished by students. These researchers (e.g., Martin & Hand, 2009; McNeill & Pimentel, 2009; Pimentel & McNeill, 2013) also confirmed that, at the outset, speaking time allocated to students should be increased, then, cognitive contributions' quality (e.g., sophisticated argument quality) comes in. Similarly, van Booven (2015) indicated that monologically-oriented teacher questions (e.g., closed-ended, evaluating) were matched with restricted cognitive (e.g., recalling), structural (e.g., pre-structural level), and epistemological (e.g., declarative knowledge) student-led cognitive contributions. On the other hand, dialogically-oriented questions (e.g., open-ended, eliciting) were matched with increasing cognitive (e.g., explain, evaluate), structural (e.g., abstract thinking), and epistemological (e.g., strategic and procedural thinking) student-led cognitive contributions. Boyd and Rubin (2006) made a seminal contribution pertaining to relation between teacher questioning and intellectual productivity. Boyd and Rubin (2006) evidently showed that open-endedness or close-endedness of the teacher questioning is not completely determining in predicting the student-led cognitive productivity. Boyd and Rubin (2006) referred to "*contingency questioning"* phenomenon by indicating that when a teacher uses *student-led information (students' responses'*

temporal, emergent or contextually-oriented content) to continuously arrange his/her questioning series, students achieve more sophisticated cognitive contributions, because, in-class dialoguing and philosophising are maintained based on student-led responses. To put it differently, through contingent questioning, teachers deliberately invited students to elaborate on their articulations' underlying meanings that ensures *exploratory talk*s. Instructional effectiveness of the contingency questioning on the students' cognitive productivity was also supported by the recent studies (Lefstein et al., 2015; Molinari et al., 2013) as these adapted more discourse-analytical methodological approaches (e.g., lag sequential analysis) to delve into contingent or *authentic questioning*. For instance, Lefstein et al. (2015) revealed that when teachers increased the frequency of the close-ended questions, length of the pupils' responses (e.g., long, moderate, brief) were narrowed. On the other hand, when teachers displayed more open-ended questions, pupils were able to deliver more sophisticated or lengthy externalisations; in turn, the teachers directed increasingly complex questions based on the enlarged (longer; maintained more than five seconds) student-led utterances. More importantly, when students provided simple answers when reacting to teachers' close-ended or simplified questions, consequent teacher-led questioning was also staged by a simplified manner. To put it differently, *simplified (lower cognitive demanding)*, or close-ended questions matched with surface level student-led responses that may cause less sophisticated or lower cognitively demanding teacher-led questions as a discursive chain reaction. Molinari et al. (2013) also reported similar results compared to the outcomes of Lefstein et al. (2015). In the study of Molinari et al. (2013), it was demonstrated that student-led responses' *accuracy* or *fallacy* (e.g., logical/relevant or invalid/irrational student-led predicates) could be reacted in a twofold manner by the teachers: *(i)* direct and *immediate refusal* of the incorrect response; *(ii) constructive scaffolding* by enacting contextually appropriate *follow-up questioning*.

When the teachers decided to enact the second version of the questioning, the students were engaged in higher-order thinking; in turn, this augmented the sophistication of the teachers' follow-up questions that were accompanied with enriched student-led cognitive contributions. In the present study, all above-interpreted studies' outcomes regarding the discourse and cognition relation were considered to analyse and interpret discursive data corpus that was captured from the university classrooms in which the peer community was engaged in rigorous discussions regarding how to teach concepts through the teachers educators' questioning.

Methods

Research approach

This study was designed and conducted as a collective case study (Stake, 1995). The researchers selected multiple cases of university-levelled teaching implementations that are elaborated below sections that were conducted by different teacher educators. Diversification of instructional-discursive cases (Stake, 1995) was essential for the purposes of the current study since the researchers' methodological goal was to extract the varying perspectives of the discourse and cognition relation in the context of in-class questioning observed while teaching in higher education classrooms. The instructional cases differentiated regarding many aspects (e.g., grade level, topics under consideration, the teacher educators' capabilities to implement student-focused or skills-centred in-class activity approaches, the students' socio-demographic features, the students' capabilities and internal motivation to engage in the classroom conversations, the teacher educators' pedagogical/epistemological belief systems, etc.) that permitted the researchers to capture several dimensions of the relations between discourse and cognition.

Participants

Four teacher educators (two males, two females) were the participants. The participants designed and implemented "Teaching Methods" course in 2018-2019 academic year by involving the prospective teachers in social negotiations of meanings regarding how to teach their subjects to pupils at the elementary and middle school level. Two of the participants were affiliated at a state university, others were from a foundation-supported university, and all universities geographically located in the Marmara Region, in northwest Turkey. The participants' ages ranged from 32 to 39. The participants had a Ph.D. degree in their own fields of inquiry (e.g., elementary/middle school science teacher education (n = 1) and classroom teacher education (n = 3)). The participants' university-levelled teaching experience was 3-7 years. All the participants were internally motivated and eager to evaluate and monitor their own in-class teaching practices through the collective efforts of the present study's researchers. By virtue of the current study, the participants had chances to problematise and examine their in-class questions and their diversifying dimensions closely by checking the results that were presented to them as questioning typologies, relative occurrences of the typologies and their presumable influences on their students' cognitive productivity. Thus, the participants were truly volunteer to contribute to the present research's methodological goals and processes.

In-class implementations

The teacher educators designed and implemented four in-class activities devoted to instructional approaches and strategies for excellent teaching. The in-class implementations were maintained for four weeks. During the implementations, the peer community (the prospective teachers) and

teacher educators rigorously negotiated what-aspects and how-aspects of some specific pedagogical concepts: "teaching", "learning", "teacher", "learner", "schooling" and "nature of knowledge". Implementations' brief descriptions are displayed in Table 1. During the implementations, all the prospective teachers were invited to consider and negotiate conceptual, epistemological, and ontological dimensions of how to teach concepts in terms of different aspects that are detailed in Table 1. Through the specially-designed pedagogical cases (Table 1), how to teach phenomenon was problematised and the prospective teachers' pre-concepts and existing mental models were challenged. The prospective teachers were stimulated to apply their personal theories, perceptions, and conceptions to resolve the challenging propositions or pedagogic cases that were injected by the teacher educators' questioning into classroom talks. The in-class implementations were maintained for 2149 minutes including 16 lessons.

Table 1. In-class teaching implementations' conceptual descriptions

Week	Activity label	Brief Description
1st	*Knowledge, learning, teaching*	The group interrogated the locus of knowledge as whether it is internal or external to the learners. The groups discussed whether the knowledge is taught by teachers or acquired by students and the relation(s) between nature of knowledge, teaching and learning.
2nd	*Lily and dark room*	An instructionally problematic case was presented to the student groups. In the case, Lily, a superiorly successful secondary school

		student, responded to a teacher-led question: "*Can we see in a fully dark room?*" Even though this is impossible in scientific terms, Lily insists on the meaning position that it is possible through the accommodation as a biological function of pupil. Thus, the main pedagogical dilemma is that whether Lily acquired the vision phenomenon well or whether there was a fallacious reasoning as uttered by a very successful learner.
3rd	*Experience and learning*	Do barbers know physics? A barber, working in front of the mirror for more than 20 years, is asked the following question: "*As we get closer to the mirror, will our images grow?*" and barber responded "*Yes!*" However, to our knowledge it is impossible as there will be no change in image size when anyone or an object gets closer to or farther from the mirrors. Thus, the main instructional dilemma is that why frequent rehearsals or experiences do not ensure learning and acquisition.
4th	*Teaching profession*	Who teaches a subject better? A teacher who is equipped by substantial subject matter knowledge, or another teacher who is considerably equipped by knowledge of teaching methods, strategies, representations, etc. In this case, the prospective teachers were asked to interrogate teaching phenomenon as a profession by deducing that they should create an amalgamation of subject matter knowledge and pedagogical knowledge in constructing the

pedagogical content knowledge or their own instructional repertoire.

All in-class implementations incorporated two intertwined negotiation cycles:

- *posing-recognising cognitive contradictions* that may have a conceptual, ontological, or epistemological orientation (the role of the teacher educators),
- *negotiating-resolving cognitive contradictions* (the role of the prospective teachers).

The TEs tried to act pedagogically guiding principles for fostering the *productive disciplinary engagement* (Engle & Conant, 2002) among the peer community. All the teacher educators planned and conducted the in-class implementations by taking the four principles of productive disciplinary engagement proposed by Engle and Conant (2002) into account:

Principle-1: Problematizing: The prospective teachers were promoted to take on intellectual problems regarding teaching, learning and knowledge.

Principle-2: Authority: The prospective teachers were given epistemic and social authority while addressing such pedagogical problems (see also Table 1 for sample problematised cases)

Principle-3: Accountability: The teacher educators tried to encourage the prospective teachers to be accountable to the peer community and disciplinary norms as canonical science knowledge regarding the pedagogy and instruction.

Principle-4: Resources: The prospective teachers were provided sufficient time and instructional materials to achieve all of the above-located pedagogical-discursive pathways.

Data gathering process

The video records of the implementations were the main data source. The prospective teachers and teacher educators completed the consent form informing them about the research purposes. Two cameras were located in the classrooms to capture the teacher educators' questioning and prospective teachers' cognitive activity. The researchers visited their colleagues (the participants) to aid them during the video recording processes. The researchers used one of the cameras by walking around the classroom to capture idea exchanges and interactions patterned as teacher-student and/or student-student. The researchers continuously checked the quality of video records to ensure, for instance, whether the researchers and other coders would distinguish the simultaneous verbal initiations during the data analysis process. The visual quality of the records allowed the coders to monitor each teacher-led questioning and student-led cognitive activity. Prior to the visual data gathering, three trial warm-up recordings were conducted to eliminate any presumable Hawthorne effect on the participants by reinforcing the rapport between us (the implementers and the researchers) and the prospective teachers who were filmed for the first time.

Data analysis procedures

During the verbatim transcriptions of the visual data corpus, gestures, mimics, intonations, and gaze of the teachers as affective dimensions of interactions (Pianta & La Paro, 2003) were noted. This was functional to grasp the linguistic and bodily clues to determine whether an enacted

question supported the respondents' cognitive contributions. Contextualisation clues (Gee & Green, 1998) were also considered to extract the typologies of the teacher educators' questions.

Systematic observation approach, as a branch of sociocultural discourse analysis (e.g., Mercer 2004; 2010), was used to analyse the verbatim-transcribed data. Systematic observation was handled in two steps: *coding (qualitative aspect of the analysis)* and *counting (quantification)*. By the coding procedure, the teacher educators' questioning typologies and the prospective teachers' cognitive contributions were clarified, extracted and discerned qualitatively or analytically. Then, higher-order categories were collapsed to locate the quantitative proportions for the different typologies of the questioning and for the sophistication levels of the prospective teachers' cognitive contributions to the classroom discourses. This allowed the researchers to compare, contrast and interpret the relative influences of the qualitatively different teacher educator questions on the prospective teachers' cognitive productivity.

Higher-order categories	*Sub-categories*	*Descriptions*
Observe-Compare-Predict (OCP)	Prompting for simple comparison	Educator asks students for making comparison between two pedagogical cases, ideas, events, claims, etc.
	Prompting for simple prediction	Educator requests students for making online predictions.
	Leading for making observation	Educator prompts students to make observations regarding classroom occurrences such as instructional demonstrations.
Communicating (COM)	Demanding for elaborating on utterances	Educator asks students for expanding and enlarging on their opinions.
	Asking for clarification	Educator asks students for making their ideas more intelligible for the peer community.
	Reformulating	Educator revoice (or reformulate) a student-led response in order to make it more detailed and/or comprehensible.
	Demanding for embodying	Educator prompts students for establishing valid analogies, or relevant examples or instances in making their abstract ideas more concrete.

Monitoring (MON)	Enacting procedural and/or conceptual metadiscourse	Educator requests students for thinking, talking and commenting on the being held conceptual and/or procedural discourse.
	Focusing	Educator asks students for paying attention to a particular response, point of view, meaning position or proposition that is unfolding for the classroom discourse.
	Monitoring (*type-1: on-moment*)	Educator asks students for holding a noticing regarding online occurrences of classroom discourse.
	Monitoring (*type-2: prospective*)	Educator clarifies next discussion points as sub-topics.
	Monitoring (*type-3: retrospective*)	Educator asks students for re-considering and making comments on the previously proposed ideas.
	Summarising (consolidating)	Educator makes summary of the consolidated or pooled responses through, for instance, confirmatory talks.
	Selecting and eliminating	Educator selects contextually appropriate ideas among others and eliminates illogical or contextually irrelevant ideas.
	Asking about mind-change	Educator asks students whether they modify, revise or completely change their initial meaning positions, concepts or beliefs about, for instance, effective instruction.

Evaluating-Judging-Critiquing (EJC)	Inviting for critiquing others' ideas	Educator asks students for evaluating, judging or critiquing others' propositions, claims and assertions.
	Inviting for assessing and critiquing a given case	Educator requests students for evaluating a given case that is about, for instance, a critical aspect of the how to teach concepts.
	Inviting for critiquing the educator's assertions	Educator invites students for evaluating and judging his/her ideas, examples, propositions or meaning positions.
Challenging (CHAL)	Inviting for recognising cognitive conflictions	Educator asks students for being aware of the contradictory alternative ideas or their own cognitive contradictions that may have an ontological, epistemological or conceptual orientation.
	Challenging by monitoring	Educator invites students for seeing and noticing the contradictory or discordant points in their reasoning by comparing their past and present articulations.
Evidencing (EVID)	Prompting for evidence-based reasoning	Educator promotes students for supporting and justifying their ideas by evidence as in the form of relevant examples, instances, arguments of authorities, etc.

	Referring in-text information	Educator encourages students for considering and using available sources (e.g., printed books) to support their assertions.
Concluding (CONC)	Asking for drawing conclusions	Educator invites students for establishing overarching or generalised conceptual outcomes.
Labelling (LABEL)	Asking for assigning labels	Educator requires students for finding relevant labels or titles for the contents of their previously held thinking and talking.
	Asking for using an everyday terminology	Educator asks students for utilising a less formalised or technical thinking and talking style.

Two coding catalogues were used for the systematic observations. Teacher Educator Questioning Catalogue (TEQC; Table 2) was developed to differentiate the teacher educators' questions' types. The Structure of Observed Learning Outcomes (Biggs & Collis, 1982; the SOLO taxonomy, Table 3) taxonomy was used to analyse the prospective teachers' cognitive contributions' sophistication that are thought to be fluctuated in the presence of different typologies of the educator-led in-class questioning.

The TEQC incorporates several higher-order and subcategories to capture each analytical aspect of the teacher educators' questions' typologies. Based on the methodological suggestion of Mercer (2010), the researchers improved the TEQC by taking the video-based data corpus and related studies explored a version of discourse and cognition relation into account. Thus, the TEQC can be considered both *data-driven* (original codes derived from the data corpus) and *theory-laden* (existing/emergent coding schemes). The TEQC allowed the coders to train themselves in allocating any type of a teacher-led utterance as in the form of question to a category (Table 2) that were continuously re-generated during the analysis processes.

Table 3. The SOLO* taxonomy for assessing the STs' cognitive productivity

Levels of learning stages	***Levels of understanding***	***Descriptions***
Stage of	Prestructural	Prospective teachers do not have any kind of understanding and tend to use irrelevant information

Ignorance (out of zone)		and/or miss the point altogether. Scattered pieces of information may have been acquired, but prospective teachers' mental schemes are unorganized, unstructured, and essentially void of actual content or relation to a topic or problem.
Stages of surface learning (quantitative zone)	Unistructural	Prospective teachers do present one single aspect of a subject under consideration. Prospective teachers may use a specific terminology, retrieve factual knowledge, perform simple instructions/algorithms, paraphrase others' idea, identify a case, assign labels for their thoughts, etc.
	Multistructural	Prospective teachers may introduce several aspects of a topic under consideration and these are conceptually connected. Metaphorically speaking, prospective teachers see a lot of trees in the forest, but not seeing the complete forest as a whole. Prospective teachers can enumerate, describe, classify, and combine the pieces of knowledge claims.
Stages of deeper learning (qualitative zone)	Relational	Prospective teachers may understand the relations between several aspects of a topic under consideration and how these may fit together to form a whole. Metaphorically speaking, these piecemeal or analytically-oriented understanding forms an internally consistent structure and now prospective teachers do see how trees form a forest as

	a whole. Prospective teachers may therefore have the competence to compare, relate, analyse, and apply theory, or explain ideas in terms of cause and effect relation.
Extended abstract	Prospective teachers may generalize structure (whole) beyond what is given, and may perceive and interpret the structure from several different theoretical and practical perspectives, and transfer the ideas embedded in the structure to new areas. Prospective teachers may have the competence to generalize, hypothesize, criticize, theorise the knowledge claims regarding how to teach concepts.

*Adapted from Brabrand, C., & Dahl, B. (2009). Using the SOLO taxonomy to analyse competence progression of university science curricula. *Higher Education, 58*(4), 531-549. (pp. 535-536).

The SOLO taxonomy (Biggs & Collis, 1982) was used to represent progressively sophisticated cognitive productivity levels of the prospective teachers. The SOLO taxonomy was also used by some previous studies conducted in the context of higher education (Chan et al., 2001). In this study, the SOLO taxonomy was treated as a hierarchical assessment tool that allowed for evaluating the cognitive productivity of the prospective teachers observed for the different pedagogically-oriented thematic contents. As seen in Table 3, the SOLO taxonomy incorporates three levels of learning stages as in the forms of *varying degrees of cognitive productivity* in the context of the current study. The stages of the SOLO taxonomy are *level of ignorance*, *levels of surface learning*, and *levels of deeper learning*. Three learning stages are characterized by five levels of cognitive productivity: *pre-structural* (out of zone; unproductivity), *unistructural* (quantitative zone), *multistructural* (quantitative zone), *relational* (qualitative zone) and *extended abstract* (qualitative

zone) (Biggs & Collis, 1982). The SOLO taxonomy incorporates a threshold from quantitative (i.e., unistructural, multistructural) to qualitative zone (i.e., relational, extended abstract) regarding the cognitive productivity. In the context of the university-based teaching, Brabrand and Dahl (2009) confirmed usability and instrumentality conditions of the SOLO taxonomy that were also take into account in the present study.

Reliability of the coding processes

Three coders (two expert researchers of classroom discourse and a research assistant) worked in collaboration to assign the codes from the catalogues for *question typology* and *cognitive contribution* analysis. For the coding procedures that was maintained through the TEQC, the intercoder reliability was lower (73%) during the preliminary analysis. Then, through the continuous negotiation-persuasion sessions held between the coders, an increased intercoder reliability was achieved (91%). The reason of the initial lower level intercoder consensus was due to the coding catalogue's scope as it incorporates intensive subcategories that were compelling to capture their meanings and apply them on the data corpus. For the SOLO taxonomy, interrater reliability was initially higher (93%) and the coders had a few disagreements in differentiating the relational contributions from the extended abstract contributions of the prospective teachers.

Validity of the study

To enhance the validity standards of the coding processes, at the outset, our colleagues, studying on discourse analysis in general or classroom discourse in particular, provided us a rigorous peer review support or debriefing as an external check of the analysis. Especially, during constructing

(the TEQC) or determining for (the SOLO taxonomy) the coding catalogues, peer debriefing was efficient and improving. Secondly, through member checking, the researchers backed the results obtained from the initial analysis to the teacher educators so that they could judge the accuracy and credibility of our interpretations derived from the analysed data corpus.

Findings and Results

Qualitative Findings

This study investigated the relations between the discourse and cognition regarding the effects of the varying typologies and frequencies of teacher educators' questions on the cognitive productivity (cognitive contributions) of prospective teachers. Four teacher educators; Oliver, Jake, Linda and Lauren (as their pseudonyms) completed four in-class teaching implementations devoted to negotiating how to teach concepts. During the implementations, the TEs displayed 8 types of questions with 25 accompanying subcategories (Table 2). An example analysis of the dialogues between Linda and her students is represented in Table 4.

Questions for observe-compare-predict: The teacher educators guided the prospective teachers for observing, predicting and comparing cases, ideas, events, etc. by questioning for observe-compare-predict ("OCP"; e.g., "*Which instructional approach or tendency would be more effective compared to other: conventional teaching or conventional plus inquiry-based teaching?*").

"Experience and Learning" Implementation: *Do barbers know physics? A barber, working in front of the mirror for more than 20 years, is asked the following question: "As we get closer to the mirror, will our images grow?" and barber responded "Yes!" However, to our knowledge it is impossible as there will be no change in image size when anyone or an object gets closer to or farther from the mirrors. Thus, the main instructional dilemma is that why frequent rehearsals or experiences do not ensure learning and acquisition.*

Turn	***Speaker***	***Utterance***	***Discursive function of the question***	***Cognitive contribution***
1	**TE***	In short, why the barber made such a mistake after so many repeats and practice in front of the mirror? **(1)** // Actually, Christine had said something important about it. **(2)** // She said that "the pervasive repetitions of the barber have made his ideas more rigid (stereotyped)", do you remember? **(3)**	***1.*** *Inviting for assessing and critiquing a given case* ***2.*** *Monitoring (type-3: retrospective)* ***3.*** *Focusing*	

		of his way. Only because he sees the hair and the appearance of the face growing in front of the mirror, he always considers the situation as such.		*Multistructural*
3	**TE**	Is that idea possible? What do you say to your friend?	*Inviting for critiquing others' ideas*	
4	**S2**	I don't think he (the barber) ever thought on that problem		*Unistructural*
5	**TE**	Why he did not think on that? How so? **(1)** // Can you explain a little more clearly? **(2)**	***1.*** *Demanding for elaborating on utterances* ***2.*** *Asking for clarification*	
6	**S2**	No need. I do not think the barber needs to know that. Barbers have other knowledge and skills.		*Multistructural*
7	**S3**	He was not interested. It doesn't matter that the image gets smaller or bigger. His focus is on customers' hair. So, he needs		*Multistructural*

		to deal with more important problems than thinking on the images in the mirror.		
8	**TE**	Let's see what your friends think of what you say. Yeah, let's get your comments. What do you think about that?	*Inviting for critiquing others' ideas*	
9	**S4**	The barber internalized this situation only within himself. In addition, it is all about his experience.		*Multistructural*
10	**TE**	Can you explain a little bit, please?	*Demanding for elaborating on utterances*	
11	**S4**	Barber did not deal with this situation in a certain context... or … how I can say … by an intentional manner within a learning and teaching environment. It did not need to be treated as a learning situation. This is just a simple, ordinary experience of a barber.		*Relational*
12	**S2**	I think it is all about attention and focus. I do not think the barber ever thought about it before. He only thinks the image		*Multistructural*

		has grown when he saw that the details in the mirror had decreased.		
13	**TE**	The barber has therefore a misconception… Does anyone accept my idea? **(1)** // So, what do you think regarding when the barber's error might have come about? **(2)**	***1.*** *Inviting for critiquing the educator's assertions* ***2.*** *Demanding for elaborating on utterances*	
14	**S5**	It appears when you start questioning. When he started thinking. I mean, when you start to ponder about it. When he finds the answer to the question of the research, actually a learning begins.		*Relational*
15	**TE**	We talked about misconceptions and alternative concepts. **(1)** // Do these misconceptions and alternative conceptions exist before coming to school or occur at school? **(2)**	***1.*** *Monitoring (type-3: retrospective)*	

			2. *Inviting for critiquing the educator's assertions*	
16	**S5**	When we realize we are wrong, we feel our misunderstandings. Because we never think about it before.		*Multistructural*
17	**TE**	So, if we do not think about it, don't we have misconceptions?	*Inviting for recognising cognitive confliction*	
18	**S5**	I do not know. I never thought that.		*None*
19	**S3**	There is always a misconception, but when we do not think about it, we do not actually realize it. We do not know that it is a conceptual error. The barber never questioned the distance to the mirror and the size of the image. For example, we do not		*Relational*

		question the difference between the concepts of weight and mass.		
20	**TE**	At this point, I want to combine what you said with Wendy's sayings. First, the barber did not need that. It did not matter to him whether he knew how big or small the appearance was in front of the mirror. Second, he needs it and starts to use it once he realizes that his experience is wrong. Three, misconception arises. **(1)** // However, I wonder a specific point as your classmate mentioned: "Don't we have misconceptions until we get to school? On the other hand, do we live comfortably with our existing concepts? **(2)**	***1.*** *Summarising (consolidating)* ***2.*** *Inviting for critiquing others' ideas*	
21	**S4**	No! We have misconceptions before coming to school, but we are not aware of them. Before we start school, we think everything is true by ourselves. When we come to school, we learn that what we know as right would be wrong. Since		*Relational*

		questioning begins at school, we become aware of our misconceptions.		
22	**TE**	Then you say that when students are exposed to school science, misconceptions emerge. Is school a place to gain misconceptions? **(1)** // Wouldn't you normally expect it to be earlier? Can we please consider this point? **(2)**	***1.*** *Inviting for recognising cognitive conflictions* ***2.*** *Inviting for critiquing the educator's assertions*	
23	**S1**	Can we explain this with paradigm shift? For example, let's think of a father in the subway sitting with his pupils. And suppose that he has three naughty kids. You look at the children several times carefully with your eyes. Your goal is to warn them and make sure they do not make noise anymore. Nevertheless, there is no change in the kids as they keep		*Extended abstract*

		making noise. However, you may be free from your misconception when the father of the children say that they are so restless because they lost their mother a few days ago. Therefore, we have a new perception of reality regarding children's condition. However, what they did is the noise. Therefore, my initial perception is not completely wrong.		
24	**TE**	Does anyone agree or disagree with your friend's assertion? Does this look like the situation we just talked about?	*Inviting for critiquing others' ideas*	
25	**S5**	Then the misconception is not entirely an illusion. Therefore, there are points in the misconception that are correct. So, it is a mistake to claim that plants are fed from the soil, but this is necessary for photosynthesis. So, our senses are not totally wrong.		*Relational*

Analysis of the utterances in terms of the enacted question typologies (Linda's implementation) and cognitive productivity (the rospective teachers' cognitive contributions to classroom discourses); **TE:** Teacher educator (Linda) and **S1** refers to the first speaker ı the conversation.

*Questions for communicating***:** To capture the prospective teachers' underlying understanding, meaning positions or reasoning structure that might *not* be intelligible to the class members, the teacher educators enacted their questions for ensuring a *healthy communication* among the peer community by

- *requesting for clarification*,
- *probing,*
- *reformulating* a given response or
- *revoicing* a given response or
- *requiring analogies* from the prospective teachers to *embody* their utterances pertaining to teaching, learning and knowledge (*questioning for communicating*; "COM"; see examples in Table 4 within the following talks at turns: 5, 10).

*Questions for monitoring***:** It was also purposed by the teacher educators to maintain the prospective teachers' *online cognitive engagement* in the classroom's discursive occurrences through the questions observed under the monitoring category (MON). For instance, the teacher educators required the prospective teachers to re-ponder and re-consider their initially introduced meaning positions by promoting them to perform procedural or conceptual metadiscourse (e.g., "*Why did we focus on prior mental schemes of a student when we were talking about designing instructional scene staging*?"). The teacher educators also invited the prospective teachers for holding a *conscious awareness* pertaining to the sub-topical episodes' content flows by an "*online*", "*prospective*" or "*retrospective*" manner (see also Turn 1 in Table 4). Moreover, under the category of the MON, the teacher educators summarised the student-led responses by pooling and

demonstrating the conceptual variations in the proposed opinions. Furthermore, under the category of the MON, some of the students' responses were neglected while some other particular responses that were more appropriate for sustaining unfolding and progressive classroom talks were made *prominent* through the selecting and eliminating questions of the teacher educators (see also Turn 20 in Table 4). Under the category of the MON, the teacher educators promoted the prospective teachers to check their mental status to detect whether there is a mind (concept) change on the side of them, for instance, by uttering:

Did you change your initial ideas about the disadvantageous sides of the knowledge transmission modes of teaching strategies in terms of students' intellectual gains regarding mathematics concepts after all these discussions?

Questions for evaluating-judging-legitimating: The teacher educators pressed the prospective teachers to critique their classmates' assertions by operating a specific groups of questioning techniques such as evaluating-judging-critiquing (questioning for evaluating-judging-critiquing; EJC questions). When the teacher educators enacted the EJC questions in the classroom talks, the prospective teachers were forced to evaluate, judge, critique and legitimate a proposed idea's credibility, validity and accuracy (see examples in Table 4 within the following talks at turns: 3, 8, 13, 15, 20, 22, and 24).

Questions for challenging: The prospective teachers' alternative opinions or misconceptions regarding how to teach concepts were also challenged (CHAL questions; see also Table 4) by the teacher educators who were in search of conceptual, ontological and epistemological cognitive

deviations that might be latently and explicitly embedded in the prospective teachers' existing mental models. Indeed, the teacher educators acted as rigorous "discussants", "negotiators" or "legitimators" of the proposed responses by virtue of the CHAL questions (see examples in Table 4 within the following talks at turns: 17, 22).

*Questions for evidencing**:** During the in-class implementations, it was observed that the teacher educators promoted the prospective teachers to propose their ideas by emphasizing internally persuasive exemplifications as in the form of evidential reasoning. An example of an EVID question can be seen in below:*

Do you have an example to support your opinion that ascertains that teaching and learning is associated and cannot be thought by an isolated manner?

*Questions for concluding**:*** The teacher educators' encouraged the prospective teachers to draw overarching rough inductions after considering and discussing several aspects of the how to teach concepts CONC questions. An example of a CONC question is presented below.

So… What could be our inferences regarding the term learner-centred teaching after considering all these pedagogical instances?

*Questions for labelling**:*** Finally, the prospective teachers were prompted to come up with *overarching titles* that are expected to conceptually cover and characterise the content of the

discussions held during the in-class implementations by virtue of the LABEL questions and one of them is exemplified below.

OK, how we could denominate this process in which students are cognitively supported by their teachers? Scaffolding? Pedagogic support? Instructional facilitation? I want to hear your suggestions…

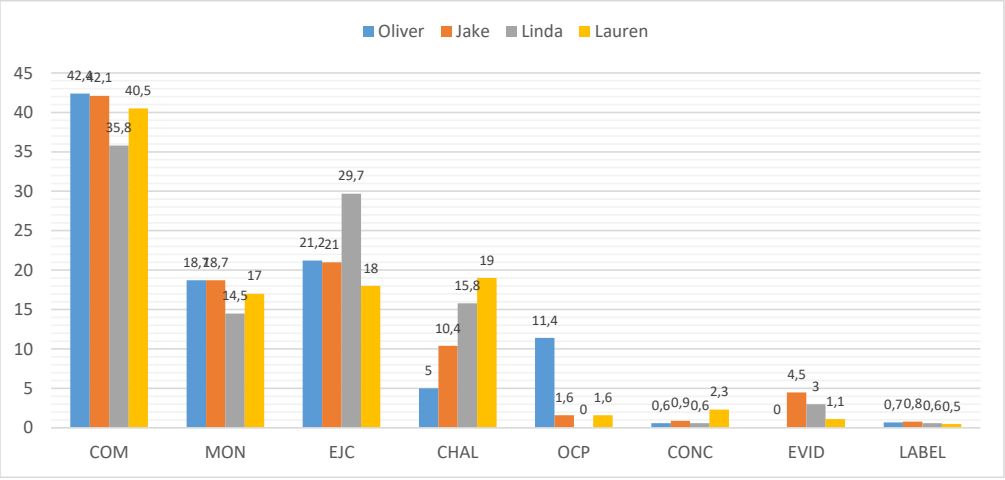
In summary, the teacher educators operated their questions for several classroom discourse or instructional purposes. The questions were displayed for

- promoting the prospective teachers to make wise projections, comparisons, and observations (OCP questions),
- ensuring effective verbal interactions and exchanges among the peer community (COM questions),
- sustaining metacognitive conscious awareness or student-led online conscious noticing (MON questions),
- maintaining student-student or peer-led evaluations (EJC questions),
- locating alternating points of views mostly proposed by the prospective teachers (CHAL questions),
- permitting the prospective teachers for attaining rough inductive reasoning (CONC questions),
- inviting the prospective teachers to name the content of the thinking and talking (LABEL questions).

In this study, it was also purposed to find out and extract the patterns occurred between the teacher educators' *discourse* and the prospective teachers' cognitive contributions (as cognition) that are represented below in a detailed manner.

Quantitative Results

Even though there was a qualitative variation in the teacher educators' questions' typologies, some types of them were more frequent compared to others. To put it differently, it seemed that Oliver, Jake, Linda and Lauren managed the in-class discursive interactions and idea exchanges largely through four types of the observed questions as their percentages across the educators and implementations are displayed in Figure 1:



COM: Communicating questions; ***MON:*** Monitoring questions; ***EJC:*** Evaluating-Judging-Critiquing questions; ***CHAL:*** Challenging questions; ***OCP:*** Observe-Compare-Predict questions; ***CONC:*** Concluding questions; ***EVID:*** Evidencing questions; ***LABEL:*** Labelling questions.

Figure 1. The teacher educators' questions' typologies and their averages occurrences during the in-class implementations*

1. "COM" questions (*mean* = 40.2%; relatively),
2. "MON" questions (*mean* = 17.2%; relatively),
3. "EJC" questions (*mean* = 22.4%; relatively),
4. "CHAL" questions (*mean* = 12.5%; relatively).

This confirms that more than nine out of 10 (relatively 92.5%) analytical statements of the teacher educators enacted in the implementations were allocated to these four types of the questions. Only 7.5% of all the enacted questions of the teacher educators were devoted to remaining four typologies [e.g., OCP (*mean* = 3.65%; relatively); CONC (*mean* = 1.1%; relatively); EVID (*mean* = 2.1%; relatively) and LABEL (mean = 0.65%; relatively)]. It can be therefore concluded that the prospective teachers' cognitive contributions were mostly regulated and fluctuated by these four prominent typologies of the questions. Other four question types' (OCP, CONC, EVID, LABEL) influences on the cognitive contributions of the prospective teachers to the classroom talks were found at minor level. To make evidential and concrete linkages between discourse and cognition, the four teacher educators' students' cognitive productivity should be continuously compared to delve into which salient question types are more influential compared to other(s) in terms of fluctuating the cognitive contributions.

As presented in Figure 2, cognitive productivity of the prospective teachers was considerably varying in different teacher educators' classroom. As above-mentioned, the qualities of the

cognitive contributions of the prospective teachers were assessed by the SOLO taxonomy incorporating quantitative (unistructural, multistructural: low level cognitive productivity) and qualitative stages (relational, extended abstract: higher-level cognitive productivity). As seen in Figure 2, in Linda's classroom, the prospective teachers cognitive contributions' qualities were found at the highest levels ($Mean_{\text{relational}} + Mean_{\text{extended abstract}} = 30.1\%$) as followed by Lauren ($Mean_{\text{relational}} + Mean_{\text{extended abstract}} = 21.1\%$), Jack ($Mean_{\text{relational}} + Mean_{\text{extended abstract}} = 18.8\%$) and Oliver ($Mean_{\text{relational}} + Mean_{\text{extended abstract}} = 5.1\%$).

Additionally, in the classroom of Oliver, the prospective teachers' cognitive productivity pitched at lower levels that were mostly observed within the quantitative stages of the SOLO taxonomy ($Mean_{\text{unistructural}} + Mean_{\text{multistructural}} = 93.4\%$). In the other teacher educators' implementations, there were descending levels of the lower level cognitive productivity occurred at the unistructural and multistructural stages of the taxonomy (Jake: $Mean_{\text{unistructural}} + Mean_{\text{multistructural}} = 78.8\%$; Lauren: $Mean_{\text{unistructural}} + Mean_{\text{multistructural}} = 78.9\%$; Linda: $Mean_{\text{unistructural}} + Mean_{\text{multistructural}} = 69.9\%$) compared to the in-class implementations managed by Oliver.

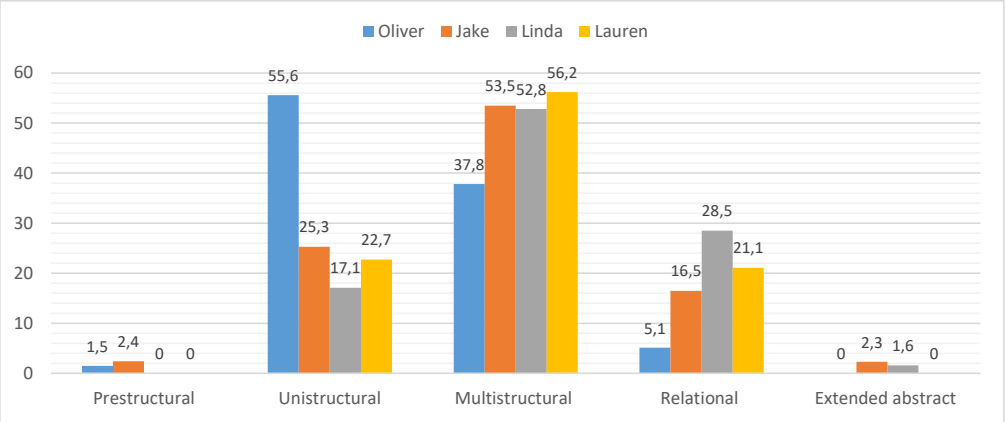


Figure 2. Averages of the STs' cognitive contributions to classroom discourse during implementations

As seen in Figure 1, COM questions were mostly staged by Oliver (42.4%) and Jake (42.1%) and they were followed by Lauren (40.5%). ***Even though the COM questions were less performed by Linda (35.8%) compared to Oliver, Jake and Lauren, in Linda's classroom, the prospective teachers were able to attain negotiating the relationships between several aspects of teaching, learning and knowledge concepts (see Table 4 for examples within following talks at turns: 11, 14, 19, 21 and 25) and determining how these terms may fit together to form a whole in explicating, for instance, effective in-class teaching*** (see also Turn 23 in Table 4). Thus, it can be inferred that the COM questions appeared to be effective in regulating the prospective teachers cognitive productivity *within bounds*.

There may be two explanations of the above-stated result:

1. The COM questions may be a pre-organiser or pre-conditioner of the higher-order cognitive productivity, or,
2. Effects of the COM questions on the cognitive contributions may be more tangible and visible in the presence of other complementary and compensatory questioning styles such as the MON, EJC or CHAL that were frequently enacted questions by the teacher educators on average like the COM questions. To put if differently, ***joint effects*** of the featured question types might be in action in explicating the differentiating cognitive productivity of the prospective teachers.

In a similar vein, the MON questions seemed to fluctuate the cognitive productivity, however, this category of questions held limits in accounting for the discourse and cognition relation observed in the present study. In the most intellectually productive implementations that were handled in the Linda's classroom, on average, Linda staged the MON questions at the lowest level (14.5%) compared to Oliver (18.7%), Jack (18.7%) and Lauren (17%) (see also Figure 1). Thus, it can be concluded that although the MON questions were featured among others, their influence on the cognitive productivity was restricted, or their boosting effects on the cognitive contributions were observed to a certain extent. To put it differently, even though the MON questions were in action in keeping the prospective teachers' minds alive at different times frames of the classroom happenings, their influences on the cognitive productivity might be more visible and concrete in the presence of other questioning strategies such as EJC and/or CHAL.

One of the most concrete effects of the questioning types and their frequencies on the cognitive productivity was evident and visible for the EJC questions. It appeared that when Linda promoted

her students to comment on the others' propositions or when she encouraged the students to determine the legitimisation, credibility and accuracy criterion of the provided claims by considerably higher frequency (29.7%), the prospective teachers were able to generate enriched arguments regarding how to teach concepts. When Linda deliberately pressed her students to critique their classmates' conceptually alternating or contradictory assertions, they seemed to be enabled relating, analysing and applying their theories of teaching, learning and knowledge in judging and evaluating the provided propositions as these operations had required highest cognitive demands on the side of the prospective. In addition, when Linda increasingly used the CHAL questions (15.8%) by clarifying her students' thinking fallacies and misinterpretations regarding how to teach concepts that were embedded in the provided responses, the prospective teachers seemed to expand their cognitive productivity's scope. When the prospective teachers were frequently contradicted by a rigorous debater (Linda), at the outset, they tried to protect their arguments from the counter and/or alternating meaning positions (see also Table 4). Then, if needed, in the Linda's classroom, the prospective teachers tried to revise and modify their arguments to enrich their conceptualisations' scopes to convince the negotiator teacher educator by defencing their points of views (see also Table 4).

It is also worthwhile to interpret the joint effects of the question types (e.g., the presumable joint effects of the EJC questions and the CHAL questions) on the cognitive productivity. It was observed that Lauren tended to enact the CHAL questions (19.0%) more than Linda (15.8%). As seen, there was a small mean difference (3.2%) between Lauren's and Linda's implementations in terms of staging the CHAL questions. However, there was a greater mean difference (11.7%) between Linda (29.7%) and Lauren (18%) with regards to enacting the EJC questions. It can be

therefore deduced that there might be joint effects of the different types of the questions ("EJC + CHAL") on the cognitive productivity of the prospective teachers. This joint influence of the EJC and CHAL questions was also confirmed once the Lauren's and Jake's implementations were juxtaposed in terms of the cognitive productivity levels of the prospective teachers. As seen in Figure 1, Jake (21%) tended to perform the EJC questions more than Lauren (18%) and mean difference was acceptably small (3%). However, Lauren (19.0%) performed the CHAL questions more pervasive than Jake (10.4%) as the mean difference (8.6%) was substantial and this might differ Lauren's and Jake's implementations' cognitive productivity the as Lauren's students were more successful than Jake's students in making higher-order cognitive contributions to classroom discourses while negotiating how to teach concepts. Moreover, as seen in Figure 1, Jake (21%) and Oliver (21.2%) performed the EJC questions by very close percentages, however, Jake (10.4%) tended to stage the CHAL questions pervasively more than Oliver (5%) and the mean difference (5.4%) might augment the Jake's students' higher-order cognitive generations. All these inter-implementation and intra-implementation comparisons evidently proved that when the frequency of the EJC and CHAL questions are dominantly practiced in classroom talks *together*, a teacher educator's students may reach the highest cognitive generations.

Finally, in the Oliver's classroom, the prospective teachers stayed at the lowest levels of the cognitive productivity. There was a specific discursive case for Oliver as he enacted the OCP questions pervasively (11.4%) compared to Linda (0%), Lauren (1.6%) and Jack (1.6%). Through the OCP questions, Oliver required the prospective teachers to make simple observations and predictions or simply compare ideas, cases, opinions about how to teach concepts. This type of questioning seemed to convey ***lower cognitive demands*** on the side of the prospective teachers

who did not tend to make higher order cognitive contributions at the level of relational thinking or by establishing extended abstractions regarding how to teach concepts.

Discussion

This study clarified the clues of discourse and cognition relation in the context of university-based teaching. The sophistication of the prospective teachers' cognitive activity and productivity seemed to be fluctuated by the classroom dialogues governed by the teacher educators' questions' typologies and differentiating frequencies of the observed types of the questions as reported by some previous studies (e.g., Littleton & Mercer, 2013; van der Veen, van Kruistum & Michaels, 2015). The teacher educators staged their questions by a twofold manner: as a *pedagogical tool* and a *cognitive tool*. In this study, it was detected that when the teacher educators performed their questions by intersecting the twofold instrumentality, the quality of cognitive productivity on the side of the prospective teachers was dramatically augmented. This conclusion is also supported by the previous studies (Nystrand, 1997; Nystrand et al., 2003).

In this study, it was observed that the prospective teachers' responses' conceptual quality depended on the classroom conversations where they were promoted to probe their thinking through the COM questions as observed in other studies (e.g., Edwards-Groves et al., 2014; Kyriacou & Issitt, 2008; Wolf, Crosson & Resnick, 2006). Some studies (e.g., Herrenkohl, Tasker & White, 2011) detected a direct and positive relation between the COM questions and students' scientific discourse and the learning that occurred. In the mathematics classroom, Webb et al. (2014) found out that when the teachers used the COM questions by an intentional and pressing manner, the cognitive productivity

was increased since the students tried to deeply illustrate their underlying reasoning by being semantically comprehensible to the peer community.

This study showed a different aspect of the effects of the COM questions on the cognition. The COM questions seemed to be performed as a springboard for more enriched presumable intellectual contributions of the prospective teachers. To be clear, in the classroom of Oliver (lowest cognitive productivity) and Jake (lower cognitive productivity), the prospective teachers' articulations were considerably and continuously clarified, probed, embodied, and reformulated. Expectedly, the COM questions opened up dialogic spaces or discourse opportunities for the prospective teachers in the implementations that were conducted by Oliver and Jake. This boosted the prospective teachers' *speaking time* quantitatively as this point was also confirmed by the previous studies (e.g., Chin, 2006; 2007; Martin & Hand, 2009; McNeill & Pimentel, 2010). Martin and Hand (2009) and McNeill and Pimentel (2010) reported a direct and positive relation between the increasing frequencies of the COM questions and the students' argumentations' sophistication. However, in this study, it was detected that the COM questions were mostly associated with the quantitative aspects of the prospective teachers' responses that were largely pitched at *unistructural* or *multistructural* stages of learning, in the implementations of, for instance, Oliver.

For characterising the COM questions, Sfard (2007; 2008) offered the term *"commognition"* as an amalgamation of communication and (plus) cognition. Sfard (2007; 2008) advocated the idea that the precondition of the commognition must include a specific pedagogical process where classroom members should comprehend and internalise what others try to say. Sfard (2008) also focused on that higher cognitive productivity occurs if the peer community is involved in the classroom

discourse where all members capture others' meaning positions' conceptual orientations. In this study, based on the interpretations of Sfard (2007; 2008), it should be acknowledged that frequent questioning for COM might ensure more voices of the prospective teachers. Nevertheless, as shown in this study, probing, clarifying, reformulating, or embodying the prospective teachers' utterances might not guarantee to scaffold them for generating relational thinking or abstractions pertaining to how to teach concepts. A discursive atmosphere that should be more intellectually rigorous and challenging had to be launched and maintained by the teacher educators (e.g., Oliver) through increasingly performing other types of the questions (e.g., the EJC questions and/or the CHAL questions). The COM questions may be conceived as a prerequisite for higher-order cognitive productivity. To advocate, it was observed that the prospective teachers' speaking time or allocated discursive spaces were quantitatively boosted in the presence of pervasively staged questioning for COM.

In this study, it was demonstrated that the MON questions also limited effects in boosting the cognitive productivity of the prospective teachers. In the presence of the MON questions, the prospective teachers tried to keep their cognitive engagement continuous or be mentally alive or online for the classroom occurrences. The prospective teachers were guided to differentiate the important and unimportant pieces of the proposed ideas through the MON questions. Berland and Hammer (2012) and Hutchison and Hammer (2010) conceptualised abovementioned process as *framing* that is used for describing a specific mental activity of a learner in observing and analysing or noticing the classroom happenings through responding a specific question: *what is really it that's going on there?* For example, when the teacher educators featured a specific student-led articulation among others, the prospective teachers were cognitively stimulated to ponder about

why the teacher neglected other alternative responses. For another instance, the teacher educators used the MON questions to invite the prospective teachers to juxtapose and contrast their initially-located and transforming meaning positions pertaining to the mechanics of how to teach strategies. Thus, the prospective teachers monitored their *mind-changing* or *mind-adjusting* processes. Thus, the MON questions were performed as a pre-organiser tool to guide the prospective teachers to have a meta-discursive awareness regarding the classroom happenings but not for increasing the cognitive productivity in-depth. The MON questions might be the pedagogical-discursive initiator of the higher cognitive productivity in this study. To explicate, the teacher educators reminded the prospective teachers that they had held a divergent line of reasoning on the how to teach concepts compared to their metamorphosing or emerging understanding. The prospective teachers undertook the cognitive effort to rearrange their initial mental models. This was vital for the prospective teachers to establish more coherent lines of reasoning (e.g., rule-based reasoning; inductive/deductive reasoning characterising the higher stages of the SOLO taxonomy; e.g., relational thinking, extended abstract).

In the present study, the CHAL questions seemed to be clearly in action for enriching the cognitive productivity of the prospective teachers. When, for instance, Linda and Lauren behaved as a rigorous debater by treading on the prospective teachers' corns through the CHAL questions frequently, this seemed to promote them to reason about how to teach concepts profoundly by necessarily operating higher-order reasoning (Lee & Kinzie, 2012; Walshaw & Anthony, 2008). Resnick, Michaels, and O'Connor (2010) reported that when a teacher uses the CHAL questions in all discourse cycles of an in-class implementation, the students' *productive disciplinary engagement* is increased, and they are able to contribute to classroom discourses by a sophisticated

manner. This was also validated by a broader study of Gillies and Khan (2008) where they proposed that teachers' increasing acceptance for performing the CHAL questions had dramatic influences on the follow-up reasoning and problem-solving activities.

In the context of the current study, frequent questioning for contradicting the illogical propositions might demand deeper cognitive requirements on the side of the prospective teachers. For instance, Soysal (2019) indicated that the CHAL questions create cognitive demands at specific levels such as "analysis", "evaluation", "create" described in the revised Bloomian taxonomy. In the present study, for instance, when Linda and Lauren performed the CHAL questions pervasively, the prospective teachers had to take the responsibility of defencing, validating or legitimating their ideas that required increasing cognitive efforts or processing on the side of them. As observed, when Linda (the highest cognitive productivity) and Lauren (higher cognitive productivity) enacted the CHAL questions frequently, they actually did not intent to falsify the student-led responses. Instead, Linda and Lauren tried to demonstrate the fact that the prospective teachers' thinking and talking systems could be less illustrative for shedding light on the given pedagogical problematics. Indeed, while executing the CHAL questions, particularly Linda and Lauren tried to present alternative thinking and talking systems to the prospective teachers and the presented alternates could be substantially different from the prospective teachers' assertions pertaining to how to teach concepts. The prospective teachers were therefore in charge of establishing internally persuasive discourses for responding to, for instance, Linda's or Lauren's challenging questioning and that cognitive processing seemed to demand more mental work on the side of the prospective teachers. To put it differently, there was a cognitive obligation for the prospective teachers, especially in the classroom of Linda and Lauren once they injected the materialised conceptual conflictions into the

classroom conversations and this seemed to foster the capacity of the intellectual productivity occurred in the classroom that is also confirmed by the previous studies (Alexander, 2006; Chen et al., 2017).

It was well observed that when the teacher educators staged the EJC questions, the prospective teachers were able to reach to the highest points of the abstractions pertaining to the how to teach phenomena. Especially when Linda enacted her questioning for the EJC in a very frequent manner (29.7%), she allowed the prospective teachers to engage in ***interthinking*** or ***knowing-together processes*** with the other members of the community. When the prospective teachers were pressed to criticise others by commenting on the proposed assertions by the aid of the EJC questions, they tried to present, elaborate, justify or *challenge* others' propositions as an interthinking activity where their logical and abstract reasoning capacities were fostered as observed in the previous studies (e.g., Gallardo-Virgen & DeVillar, 2011; Sinha et al., 2015; Wells & Arauz, 2006). In the classroom of Linda, there were more intellectually productive dialogues where the prospective teachers had to take the community's ideas seriously, in turn, exceeded the limits of their own perceptions about how to teach concepts when the "***contingent thinking and talking"*** (van der Veen, van Kruistum & Michaels, 2015) were created by the Linda's questioning for the EJC. ***To advocate, when Linda focused the prospective teachers on the alternating meaning positions, they had to consider, revise, modify or completely alter their previous cognitive schemes through correcting, fixing and improving others' assertions by crossing the boundaries of the accepted conceptual norms of the others (social) and the self (individual).*** In other words, Linda created a classroom setting where "an inclusive space of dialogue within which self and others mutually construct and reconstruct each other'' (Wegerif 2008, p. 353). This type of questioning (EJC) was

used as a very effective pedagogical tool by Linda in ***harnessing the power of student-student talks*** to lead out the prospective teachers cognitive potentiality that resulted in greater cognitive contributions to the classroom discourses and that claim was also supported by Alexander (2006).

In this study, when Linda frequently staged her questioning by promoting the prospective teachers to commenting on the others' meaning positions, they were assigned as ***co-judgers*** or ***co-legitimators.*** There was an instructional invitation from Linda to her students to decide on what constitutes a well-argued answer (Mercer & Littleton 2007; Resnistkaya & Gregory, 2013). In the Linda's in-class implementations, the quality criteria of the proposed ideas were mostly determined by the prospective teachers when Linda insistently used the EJC questions. Indeed, Linda pushed the prospective teachers for tackling with two compelling or demanding and epistemogically-oriented questions:

1. How do we know a response incorporates credibility and validity?
2. Why do we believe a given response? (Cazden 1986; Lemke 1990).

In the Linda's classroom, ***the primary knower*** of the community was not only determined as Linda. The prospective teachers in the Linda's classroom had authentic ***accountabilities*** for establishing the ground rules of what should be admitted as rational and why in the classroom discussions. Thus, there were ***accountable talk***s (Michaels & O'Connor, 2002; Michaels, O'Connor & Resnick, 2008) in the Linda's classroom where the EJC questions were performed frequently. For instance, in the classroom of Linda, the prospective teachers had to be accountable to the learning community. In the presence of the frequent questioning for the EJC, the prospective teachers had to listen to,

respond to and elaborate on the community members' understanding of, for instance, effective teaching. Moreover, the prospective teachers were accountable to the accepted standards of reasoning by performing logical thinking and drawing well-reasoned conclusions to persuade others in the presence of frequently occurred questions for the EJC in the classroom of Linda. Furthermore, the prospective teachers were accountable to theoretical perspective as knowledge cumulative or theories regarding, for instance, teaching, learning, instruction, and pedagogy. Particularly during the implementations of Linda, the accountability of the prospective teachers was often higher, in turn, there was a more cognitively demanding classroom environment by the aid of frequently staged questions for the EJC.

As observed systematically, both Jake (21%) and Oliver (21.2%) performed the EJC questions by relatively higher levels (see also Figure 1). However, in Jake and Oliver's in-class implementations, the prospective teachers' cognitive productivity stayed at lower levels compared to Lauren and particularly Linda. This seemed to confirm a **joint effect** of the different question types on the cognitive productivity. In the current study, the joint effect of the EJC questions and CHAL questions might regulate the cognitive productivity of the prospective teachers. As clearly observed in the present study, during the Jake's (10.4%) and particularly in the Oliver's (5%) in-class implementations, the CHAL questions were staged within lower limits compared to Lauren. When the teacher educators (e.g., Linda or Lauren) used a pragmatic combination of the [EJC + CHAL] questions, the prospective teachers reached to the highest points in terms of the cognitive productivity. This shows that there were sessions of the ***exploratory talk***s (Barnes, 1976) particularly in the classroom of Linda and relatively during the implementations of Lauren. When the EJC questions attached with the CHAL questions, there was an ***exploration*** of the alternative

ideas among the community members, when the prospective teachers were encouraged to make interpretations on others' assertions ***critically but constructively*** (Barnes & Todd, 1977). For example, in the classroom of Linda, the prospective teachers had to challenge each other and present alternative assertions when their meaning positions were challenged, criticised, evaluated and judged ***by Linda and/or by the peer community***. Particularly in Linda's classroom, the prospective teachers' cognitive engagement was critical but constructive by virtue of the joint questioning formulated as "EJC+CHAL". There were no signs of the ***disputational talk***s in the Linda's classroom among the peer community where none of the prospective teachers had a tendency to make their own assertions featured without taking others' arguments into consideration or refuse them in the intersection of the EJC and CHAL questions. Furthermore, in the classroom of Linda, there were no times dedicated for the ***simplified cumulative talk***s in which learners consider the proposed assertions in an uncritical manner (e.g., Mercer 1995, 1996) since Linda behaved as a negotiator by associating the CHAL questions with the EJC questions. This is also supported by Mercer (1995) as he defined fundamental ground rules of the productive exploratory talk as inviting group members to intellectually contribute to ideas that was more possible by the aid of the EJC questions and making challenging or alternating thinking explicit and rigorously negotiating them that were more attainable by means of the CHAL questions. These discursive practices were more concrete in the classroom of Linda when she displayed an associated or contingent form of the questioning (e.g., EJC+CHAL). The Linda's implementations incorporated a distinctive social mode of thinking which was based on the ***accountability*** (the EJC questions), the ***clarity*** (the COM questions), the ***constructive criticism*** (the CHAL questions and questioning for "EJC+CHAL") and these question- or talk-based discursive amalgamations' effects on the cognitive productivity of the knowledge producers were reported by previous studies (Mercer &

Littleton, 2007; Rabel & Wooldridge 2013; Rojas-Drummond et al., 2013; Wegerif & Mercer 2000) and evidently confirmed in the current study within the context of teaching how to teach concepts.

Concluding Remarks

Four conclusions are drawn in the current study. First, the teacher educators used diversifying questioning techniques to initiate and expand classroom discussions. Second, four questioning typologies; the COM, MON, EJC, CHAL, were dominantly staged in addition to others (OCP, LABEL, EVID, CONC) across different concepts of how to teach. Third, the COM and MON questions were found as specific types of discourse practices of the teacher educators in opening up and enriching further higher-order cognitive productivity. the COM and MON questions can be acknowledged as pre-organiser or pre-conditioner for augmenting deeper cognitive productivity. Forth, the EJC and CHAL questions were found to have obvious influences on the cognitive contributions and these types of questions' joint effects on the higher-order cognitive generations were also confirmed.

Educational Recommendations

This study shows the sophisticated nature of the discourse and cognition relation in the context of teaching how to teach concepts in higher education level. One of the vital suggestions of this study is that there should be an interrogation regarding whether educators hold a conscious awareness of their own in-class questioning's types, frequencies, and their effects on the cognitive productivity. To enhance a concrete metacognitive awareness for the relation between the enacted questions and occurred cognitive productivity, educators have to be involved in higher quality professional

development processes. As Schon (1983; 1987) offered, teacher educators should achieve self-reflections on the multi-layered typologies of their questioning strategies by the systematic observations that are exemplified in the current study. This study is limited in terms of discursive observations and analyses that were carried out for only faculty of education members. Across the different faculties, disciplines and contents, faculty members' in-class practices should be closely examined through discursive analytical processes that are modelled in this study in-depth.

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In Cooperation of Higher Education Studies Application and Research Centre and Faculty of Education

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YAYINLARI

ISBN 978-9752438651