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Pedagogical Content Knowledge As Mediating Construct Between Teacher Expertise And Students' Conceptual Understanding: A Theoretical Framework

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Abstract: The problem of cultivating conceptual knowledge in the students is still a major challenge in the secondary level education regardless of the fact that the teachers are highly disciplined and trained in pedagogical knowledge. According to the existing research, it has been proposed that content knowledge or general pedagogical knowledge does not explain the differences in meaningful learning of students. This is an abstracted concept paper, and it advances theoretically based framework to denominate Pedagogical Content Knowledge (PCK) as mediating factor between teacher knowledge and the conceptual knowledge of the students in the learners. As the paper is built on the existing theories about teacher knowledge and learning, it synthesises the scholarly literature and describes how teachers convert the subject matter into pedagogically empowering representations that respond to existing knowledge, misunderstandings, and need of the learners in their minds. The suggested framework explains the processes in which teacher quality impacts conceptual knowledge, such as the nature of instructional representation, order of content, and responsive pedagogic thinking. The implication of PCK as the key predictive variable of the paper is provided in terms of teacher education, the professional development, and curriculum design, and represents the basis of the future empirical and theoretical research on teaching in understanding.

Index Terms- Pedagogical Content Knowledge, teacher expertise, conceptual understanding, secondary education, instructional mediation

1. Introduction

Although secondary education has undergone continuous reforms, one of the issues that have continued to be raised across the disclosed disciplines has been the apparent disunity between the professional expertise of the teachers and the conceptual knowledge of the students on the subject matter. Studies have consistently indicated that, despite a teacher having high disciplinary background, the student may still fail to be able to acquire deep and transferable understanding of the concept especially in the secondary level where content is more abstract and hierarchical (Hattie, 2009; National Research Council [NRC], 2000). This contradiction has put scholars to the task of challenging linear assumptions that content knowledge in teachers builds straight into meaningful student learning.

In recent years, the conceptualisation of teacher expertise has traditionally occurred in small areas of content knowledge (CK) and pedagogical knowledge (PK). Although the accuracy and depth of matter in the CK are ensured and classroom management and instructional organisation facilitated by PK, the separation of the domains as independent factors in the classroom has failed to offer a complete understanding of differences

in the conceptual interpretation of students (Ball et al.; 2008). Subject specific misconceptions cannot be effectively addressed through generic pedagogical strategies, whereas pedagogical transformation without content expertise can result into transmission motivated instruction whereby emphasis is put on covering rather than comprehending.

To address these shortcomings, Pedagogical Content Knowledge (PCK), first defined by Shulman, (1986) has cropped up as an all-inclusive construct, which defines how teachers translate subject matter into pedagogically potent and learner friendly forms. PCK anticipates teacher knowledge about representations, explanation, and student challenges, and thus, it is a more valuable tool in terms of conceptual understanding as far as teaching is concerned.

The conceptual seniority of this area makes a theoretical framework approach justified in order to integrate prior knowledge and demystify the explanatory processes, as opposed to the formation of any new empirical evidence. Based on this, this paper is aimed at theoretically analyzing PCK as an intervening factor between teacher expertise and student conceptual understanding at the secondary level. The main thesis presented is the idea that teacher knowledge does not have a direct effect on the student comprehension but on it via the quality and performance of the pedagogical content knowledge.

2. Conceptualising Teacher Expertise in Secondary Education

2.1 Teacher Content Knowledge (CK)

Teacher Content Knowledge (CK) is the profound knowledge that a teacher holds on the teaching subject along with its basic concepts, organization, and the general principles of the subject. At secondary school level, CK goes beyond the factuality to include an interpretation of how knowledge in a field is tracked, linked and warranted (Shulman, 1986). Strong CK can help teachers to identify the conceptual consistency of a course and to differentiate the key ideas and the peripheral information, which is especially important in those subjects that can be defined as abstract like math and science.

Notably, CK does not solely entail disciplinary mastery as a result of the higher education; another aspect of CK is curricular knowledge- an awareness with regard to how subject matter is ordered and conveyed in the school curriculum (Grossman, 1990). The strong CK of teachers puts them at the advantage of predicting well the student misconceptions, identifying the conceptually rigorous issues, and being able to flexibly address the unexpected student inquiries (Hill et al.; 2008). Nonetheless, it has been found that, though CK is a requirement to an effective teaching process, alone it is not enough to promote conceptual learning by students (Baumert et al., 2010).

2.2 Pedagogical Knowledge (PK)

Pedagogical Knowledge (PK) refers to broad generic principles and techniques of teaching which cut across subject areas. This involves classroom management, lesson planning, assessment plans and general knowledge of student learning (Konig et al., 2011). PK aids the structure of learning space and the proper administration of instructional time, both contributing to the efficient work of the classroom.

Although of critical significance, generic pedagogical competence is often insensitive to the issues of learning in subjects. Research has indicated that a method of teaching which works well in one subject area does not necessarily facilitate learning in a different area especially when the concepts are conceptually complex (Cochran et al.; 1993). Due to this fact, any dependence on PK can result in the creation of what amount to well-managed classrooms, but where procedural completion or rote learning become the order of the day rather than a profound engagement with concepts.

2.3 Limitations of CK–PK Separation

One of the severe drawbacks of classic theories of teacher expertise is the unnatural distinction between CK and PK. There is a possibility that the teachers are well informed in subjects but would find it hard to render the subject concepts accessible to them or they would be good pedagogically equipped without enough disciplinary depth to effectively challenge misconceptions on any significant level (Ball et al., 2008). Both empirical and theoretical research are increasingly indicating that neither of the two domains, alone, can give an adequate explanation of teaching in conceptual understanding.

This shortcoming highlights the importance of the integrative construct that describes the pedagogical transformation of the content knowledge to the learners. It is only upon such integration that accounting of

teaching effectiveness is fragmented and theoretically incomplete, especially in the secondary level where one of the major educational objectives is conceptual understanding.

3. Pedagogical Content Knowledge: Theoretical Foundations

3.1 Origin and Evolution of Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) was initially conceptualised systematically by Shulman (1986, 1987) in reaction to the disjointed approach that had taken to teacher knowledge, and that had divided subject matter knowledge and pedagogy. Shulman contended that proper teaching must demand a special kind of professional knowledge, which is a combination of content knowledge, and pedagogical rationale, thus making teachers be able to turn disciplinary knowledge into forms understandable by students. PCK was therefore described as knowledge on how specific topics, issues or concepts are structured, represented, and modified to meet the various capacities and background knowledge of students.

Further research increased and developed what Shulman had conceptualized. Grossman (1990) expounded PCK by placing it in the broader sets of knowledge of teachers and its reliance on the curriculum and the purposes of instruction is important. Subsequently, more operationalisation of PCK occurred in the work discipline-specific: in mathematics and science education, specific topic-related aspects like knowledge of student misconceptions or representations of instruction were identified (Magnusson et al.; 1999; Hill et al., 2008). These developments made it a framework of conceptual understanding of teaching and not just an abstract construct as it used to be.

3.2 Core Components of Pedagogical Content Knowledge

In both theoretical and empirical literatures, some of the essential elements of PCK have almost been identified. Central to them is how the teacher is familiar with the previous knowledge of the students, their misconceptions, and their learning problems regarding some content. Conceptual barriers are better addressed by anticipating how students might interpret or misunderstand things therefore enabling teachers to construct instructions that address the concept in ways the students are likely to understand (Hill et al., 2008).

Knowledge of representations, analogies, examples, and explanations making abstract ideas understandable is another vital element. Good educators will use various representations and modify them through the reaction to the thinking of students thus will reinforce conceptual associations as opposed to memorization (Shulman, 1987). Another area of PCK is knowledge of the specific instructional steps required by the content such as sequencing of ideas and choice of tasks that cannot be interchanged across disciplines (Magnusson et al., 1999). Lastly, conceptual understanding assessment, especially formative assessment knowledge, ensures instructors can track the process of learning and modify teaching on the spot (Black & Wiliam, 2009).

3.3 PCK as Situated and Dynamic Knowledge

The modern views state the fact that both PCK is not universal, instead, it is placed and dynamic. The development of teachers PCK takes place in classrooms, reflection, and interaction with particular learners and the curriculum situations (Park & Oliver, 2008). The issue of PCK has been varying according to its context due to the influences enacted by curriculum demands, classroom realities, and sociocultural factors. As a result, PCK would be better described as professional knowledge-in-action; it is in the renewal of which teachers would always react to the intricacies of teaching to gain conceptual knowledge at the secondary level.

4. Conceptual Understanding in Secondary School Students

4.1 Defining Conceptual Understanding

Conceptual understanding involves the integrated functional knowledge base of students in a given field of study so that they can understand knowledge as opposed to rehearsing procedures or rules. It is usually contrasted with procedural fluency, which entails the effective and precise implementation of algorithms or routines (Hiebert & Lefevre, 1986). Whereas procedural knowledge explains how a task can be done, conceptual knowledge explains why procedural works and why they will apply. Studies have always shown

the possibility of the student to demonstrate procedural competence without a sound conceptual understanding and this results in a vulnerable learning process that can be easily neglected in new situations (Rittle-Johnson & Schneider, 2015).

There are a number of attributes that are the hallmarks of deep conceptual understanding. Others are being able to move knowledge between contexts, presenting ideas based upon coherent reasoning and the provision of reasons as to why solutions are plausibly justified based on logical reasoning (National Research Council [NRC], 2000). By understanding this, learners are able to perceive the underlying structures, derive associations between ideas as well as flexibly adjust knowledge. As a result, conceptual learning is generally considered one of the foundations of significant learning and an objective of secondary education.

4.2 Importance at the Secondary Level

The secondary school stage is when the academic content changes significantly in both its nature and character, as the students are exposed to more abstract, symbolic and hierarchical ideas. Topics like mathematics and science require reasoning in the form of generalisation, representations and formal systems and this subjects students to increased cognitive loads (Bruner, 1960). The students are likely to use memorisation strategies to prevent long term learning and conceptual cohesion without a sound conceptual background.

Conceptual knowledge is also directly associated with skills of higher-order thinking, such as problem solving, critical thinking, and metacognition at this level. Learners with strong conceptual knowledge are in a better position to decompose new problems, appraise alternative solutions, and also, they think reflectively (OECD, 2018). Therefore, to promote conceptual learning is not only necessary in relation to academic success but also prepares the student to handle intricate intellectual chores that go beyond the schooling period.

4.3 Instructional Preconditions for Conceptual Understanding

Acquisition of conceptual understanding needs instructional environments that place emphasis on meaning-making rather than content coverage. Significant explanations, well-selected representations, and discussion opportunities are critical to assisting students in building up of knowledge (Hiebert et al., 1997). Teachers should also apply formative assessment activities that can unveil the thought of students and their illusiveness so that an adjustment can take place in the instruction process (Black & Wiliam, 2009). These circumstances highlight the relevance of teaching based on social pedagogy that strategically aims at conceptual development.

5. Pedagogical Content Knowledge as a Mediating Construct: Theoretical Rationale

In educational theory, mediation describes the manner in which an antecedent variable has an outcome who interacts indirectly through an intervening mechanism instead of being directly related to the outcome. When applied to teaching and learning, mediation can be used to understand why the experience of teachers does not necessarily translate into conceptual learning of students without first being inscribed on them through effective instruction processes (Vygotsky, 1978; Schoenfeld, 2011). In this sense, Pedagogical Content Knowledge (PCK) can be theoretically placed in the middle between CK and PK of teachers and the learning experience of students.

The conceptual understanding of teacher expertise, which can be understood as the holding of CK and PK, is a required premise of successful teaching. Nevertheless, CK offers knowledge of subject matter and PK knows that there is teaching in general, but neither will tell how specific content is to be delivered to specific students to gain conceptual knowledge (Ball et al., 2008). This transformative role of PCK is carried out through the incorporation of disciplinary knowledge with the knowledge of learning constraints of the students when it comes to acquiring a particular concept. With the help of PCK, teachers understand the meaning of learning objectives, predict obstacles to learning and construct instructions that render the abstract concepts available to students so as to mediate how their knowledge affects learning outcomes in students.

There are a number of processes that describe the effects of PCK on the conceptual knowledge of students. Firstly, PCK directs what is selected and sequenced in learning, which allows teachers to emphasis central concepts and course learning pathways which develop conceptual unity but not piece meal learning (Bruner, 1960; Magnusson et al., 1999). Second, student misconceptions enable teachers to predict and verbalize false

thinking; this is essential to such concept change (Vosniadou, 2013). Third, PCK enlightens the use of various representations that include diagrams, analogies, symbols and examples to enable students to create links between tangible experience and abstract ideas (Ainsworth, 2006). Lastly, PCK provides a basis on adaptive instructional decision-making enabling teachers to make instructions, tasks and questions flexible when students are just developing sense in the instruction (Park & Oliver, 2008).

Constructivist and cognitive learning theories mostly support the mediating role played by PCK. Constructivist views underline that learners are the ones to build up knowledge based on previous knowledge, and, thus, to achieve conceptual advancement, teacher sensitivity to student thinking is of crucial importance (Vygotsky, 1978). The cognitive theories also emphasize the role of organizing information, dealing with cognitive load, and maintaining schema development and that all of them require the pedagogically informed representation of content by teachers (Sweller et al., 2019). Combined, these two positions support a perception that learning does not occur as a result of content exposure, but rather occurs as a result of pedagogical transformation of this content.

Conceptually, thus, PCK needs to be placed in the core of the explanatory variables in teaching in the level of conceptual understanding in the secondary level. It is via PCK that teacher expertise comes to play as instructionally significant and educationally consequential, and therefore cannot be ignored in explaining variations in conceptual knowledge of students that cannot be considered based on either CK or PK in an independent manner.

6. Proposed Theoretical Framework

6.1 Description of the Framework

In the proposed theoretical framework, teacher expertise is the input, Pedagogical Content Knowledge (PCK) is the mediating process and conceptual understanding of students are the outcome in instruction. The conceptualisation of teacher expertise is based on two types of content knowledge (CK) and pedagogical knowledge (PK). Whilst, CK serves to give teachers a profound insight on the organization of discipline and the foundational concepts, PK offers them with the general concepts of teaching, management within the classroom, and evaluation. Nonetheless, neither field in itself describes the influence on the process of teaching that causes meaningful student knowledge (Shulman, 1987; Ball et al., 2008).

In this model, teacher knowledge is a mediating variable that converts teacher expertise into a pedagogically effective teaching. It reflects the ability by teachers to select, represent and customize subject material in a responsive fashion to the previous knowledge, misunderstandings as well as the cognitive requirements of learners (Magnusson et al., 1999). PCK allows teachers to make conscious decision of instruction on the sequence of content, representations, explanation and assessment techniques, thus determining the chances that students will develop conceptual understanding. The conceptual understanding of students is considered as the result of such mediated process and it indicates the capability of the student to explain, transfer and apply their knowledge in meaningful ways instead of just repeating procedures (National Research Council [NRC], 2000).

6.2 Key Assumptions of the Framework

The model is based on a number of assumptions based on preconceived learning theories. Firstly, it presupposes that teacher knowledge should be pedagogically reconfigured in order to be transformed into an instructionally effective one. Having subject expertise is not sufficient to be understood unless contents must be reorganised into forms that will be understood by learners (Shulman, 1986). Second, the framework presumes that the representation and explanation of instructional content inform the development of conceptual knowledge among the students and this is achieved by using analogies, examples and multiple representations to facilitate sense-making (Ainsworth, 2006; Hiebert et al., 1997). Third, it acknowledges the fact that PCK is practised in context and that curricular requirements, the classroom diversity and sociocultural influences do affect the teacher's mobilization of their knowledge into teaching practice (Park & Oliver, 2008). What these assumptions underline is that teaching is a provisional and interactive act as opposed to the application of knowledge in a rigid manner.

6.3 Significance of the Framework

The framework proposed is conceptually clear as it explicitly theorizes the connection between teacher expertise and students conceptual understanding using PCK, which is a longstanding gap in teacher education research. In defining PCK as a mediating construct, the framework offers a logical framework upon which future empirical research and theoretical developments can be based. It also has a practical implication in teacher education and professional development, of the necessity to move beyond single-subject improvement of content or pedagogy, to subject-specific pedagogical justification. Based on this, the framework helps in providing a more detailed conceptualization of teaching to conceptual understanding at the secondary level.

7. Educational Implications

7.1 Implications for Teacher Education

A theoretical preliminary of Pedagogical Content Knowledge (PCK) as an intervening construct has significant conceptual implication on pre-service teacher education. The traditional teacher preparation programs tend to focus on the learning of disciplinary content knowledge (CK) and general pedagogical skills (PK) as two distinct areas. Research has however indicated that conceptual understanding in students cannot be well prepared by such compartmentalised methods of teaching (Grossman, 1990; Shulman, 1987). The teacher education programs should therefore focus on the facilitation of PCK so that aspiring teachers can gain knowledge on how subject matter can be pedagogically modified to benefit a wide range of learners. It entails incorporating content, pedagogy and content analytical analysis of thinking of learners in coursework and practicum experiences. The possibility to study student misconceptions, create content-driven explanation, and cogitate over decisions that happen in the instruction can assist pre-service teachers in the development of pedagogical reasoning as opposed to just knowledge accretion (Darling-Hammond et al., 2017). This kind of integration enables the growth of teaching activities that are conceptual based as opposed to those based on transmitting its procedures.

7.2 Implications for Professional Development

To the in-service teachers, the framework highlights the necessity of professional development, which is based on instructional reasoning and subject specific pedagogy rather than the generic teaching strategies. The studies have shown that the professional learning is better when based on the subject area of teachers and related to classroom practice (Desimone & Garet, 2015). Professional development activities, thus, ought to make teachers analyze the way students comprehend certain ideas, how they get the misconceptions, and how teaching representations can be improved to enhance their understanding.

7.3 Implications for Curriculum and Policy

At the policy and curriculum level, the framework emphasizes the need to ensure that the goals of the curriculum are aligned to conceptual knowledge and not recognition of contents. Reasoning, explanation and transfer of knowledge must clearly be appreciated in curriculum documentation and assessment policies (National Research Council [NRC], 2000). In addition, the teacher evaluation frameworks ought to go beyond the limited measures of content knowledge and include data on pedagogical reasoning and instructional competence in the subject, acknowledging that PCK is one of the key features of the teacher quality (Blomeke et al., 2015).

8. Directions for Future Research

Although the current paper contributes to the development of a theoretically based framework that places Pedagogical Content Knowledge (PCK) as an intermediate construct, more studies should be done to enhance and increase its explanatory capacity. First, empirical support of the suggested framework using the situation of secondary school would facilitate investigating the quality and efficacy of intermediate position of PCK among the characteristics of teacher knowledge and conceptual learning of students (Baumert et al., 2010). Second, special studies are required, in that the organization of PCK and teaching enactment differs among subjects including mathematics, science and languages (Magnusson et al., 1999; Hill et al., 2008). Lastly,

longitudinal research on teacher PCK development and its long-term effects on student learning would also provide an important information on how teacher pedagogical reasoning changes as a result of experience and professional learning (Park & Oliver, 2008). Such studies would help to better understand teaching as conceptual understanding, and understand it in a more nuanced, developmentally sensitive way.

9. Conclusion

In this paper, we have substantiated an intellectual based argument that Pedagogical Content Knowledge (PCK) is a mediating critical construct between the professional knowledge of the teachers and the conceptual knowledge of the students on the secondary school level. Based on existing literature, the examination has revealed that content knowledge and pedagogical knowledge are important but cannot be used alone to tell meaningful results of learning (Shulman, 1987; Ball et al., 2008). It is PCK through which teachers can turn disciplinary knowledge into pedagogically strong forms that could react to the prior knowledge and misperceptions of learners. By making PCK the leading explanatory tool, the paper provides some conceptual clarity of current debates about teacher quality and effectiveness teaching. The suggested model is a consistent theoretical perspective on research in the future, as well as a platform to reconsider teacher education and professional growth with more emphasis on teaching towards conceptualization.

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