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Developing pedagogical content knowledge through formative assessment and competency-based teaching:

Towards ensuring high quality e-learning

تطوير المعرفة البيداغوجية للمحتوى من خلال التقييم التكويني والتدريس بالكفاءات: نحو ضمان جودة التعليم الرقمي

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Abstract: This paper aims to investigate how formative assessment and competency-based teaching may help in effectively developing teachers' pedagogical content knowledge. The significance of the study lies in presenting some perspectives on formative assessment methods and highlighting the challenges and shortcomings of PCK in e-learning given the shift towards this system worldwide. Thus, we have adopted an analytical method to discuss Jones and Moreland's (2015) PCK model. The results show that Jones and Moreland's PCK model is coherent and comprehensive. Formative assessment and competency-based teaching may be crucial to developing teachers' PCK through tracking the students' progress using CAT and CBM.

Keywords: competency-based teaching; e-learning, formative assessment; pedagogical content; modern technologies

ملخص:

تهدف هذه الورقة البحثية إلى استكشاف الكيفية التي يمكن أن يُسهم من خلالها كل من التقييم التكويني والتدريس بالكفاءات في تطوير المعرفة البيداغوجية للمحتوى الخاصة بالمدرسين اسهاما فعالا. وتكمن أهمية الدراسة في تقديم بعض وجهات النظر حول طرق التقييم التكويني وإبراز التحديات والنقائص المتعلقة بالمعرفة البيداغوجية للمحتوى في سياق التعليم الإلكتروني بالنظر إلى التحول نحو هذا النظام في جميع أنحاء العالم. وبالتالي، اعتمدنا منهجا تحليليًا لمناقشة النموذج الذي

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اقترحه كل من جونز ومورلاند (2015). وقد أظهرت النتائج أنّ النموذج المذكور منسجم وشامل. كما قد يكون التقييم التكويني والتدريس بالكفاءات أساسيان لتطوير المعرفة البيداغوجية للمحتوى من خلال تتبع تقدم الطلاب باستخدام الاختبار التكيفي المحوسب والقياس المبني على المنهج الدراسي.
الكلمات المفتاحية: تدريس بالكفاءات؛ تعليم رقمي؛ تقييم تكويني؛ محتوى بيداغوجي؛ تكنولوجيات حديثة

1. **Introduction:**

Teaching is a complex process that involves several aspects, skills, and competences. Knowledge is at the heart of the teaching activity. Further, teaching behaviour, pedagogical content, performances, and competences represent significant aspects that should be taken into account. Several models of pedagogical content knowledge were suggested and discussed by scholars and researchers in the education science field. The assessment of PCK is not easy due to many variables, formative assessments are elements which can allow the enhancement and evaluation of teachers' pedagogical content through identifying strengths and weaknesses of learners and adjusting knowledge contents accordingly. Competency-based teaching may determine the nature of pedagogical content and the way it is delivered to learners in an e-learning context where advanced technologies are used to optimise the outcomes of both teaching and learning.

The problem we address in our paper is as follows: How can formative assessment and competency-based teaching help in assessing pedagogical content knowledge? We suppose that reliable and regular formative assessment as well as solid implementation of competency-based teaching may help determine the strengths and shortcomings of pedagogical content through providing feedback and addressing the real needs of learners. Moreover, we will try to answer the following questions: Is there any comprehensive PCK model that can be used in e-learning process? How can competency-based teaching enhance e-learning outcomes? In this regard, we suggest the following hypotheses: Jones and Moreland's (2015) PCK model may be of paramount importance in e-learning. Competency-based teaching can enhance e-learning outcomes through providing personalised satisfactory instruction using modern technology with all the advantages it offers.

2. **Pedagogical content knowledge:**

There is no agreed-upon definition of pedagogical content knowledge (PCK), many definitions were given to this concept in the fields of Teacher Education and Science Education which mainly focus on its characteristics and contexts.

The concept of pedagogical content knowledge was introduced by Lee Shulman in 1987 who defined it as: "special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (Shulman, L, 1987, 8). In other words, pedagogical content knowledge is the blending of pedagogy, which is of key importance in the teaching process and content to form an understanding and a representation of a particular subject matter to enable learners to grasp the various meanings. Hence, pedagogy and content go hand in hand to ensure the teaching process.

Shulman (1987) explained that successful teachers are capable of making their knowledge of scientific concepts understandable and comprehensible by learners. To this end, various kinds of knowledge are transformed into PCK to build relevant teaching content. That is to say; the degree of teachers' success is determined by their ability to transform their complex types of knowledge into simple ones, and enable students to easily grasp them.

Teachers may design their courses according to their own pedagogical content knowledge, this is what explains the differences that exist between two teachers providing the same courses through selecting the main points to be explained and learned as well as the ways they are represented and assessed.

Therefore, we can define pedagogical content knowledge as a generic knowledge of pedagogy, which is the way, methods and approaches of teaching, as well as the teaching content, taking into account the learners' environment and characteristics.

Pedagogical content knowledge of teachers may define what and how they teach. Feiman-Nemser (2001) noted that the knowledge of teachers broadens and develops as they learn how to make concepts easily understandable and facilitate their assimilation by students. The development of this knowledge requires trying new ideas, concepts, ways of teaching, refining and updating old ones and engaging in problem-solving activities. (Poulson, L, Wallace, M, 2003, 8). Teachers' knowledge cannot be separated from their own experiences and practice because teachers develop a knowledge that regulates their own teaching through experience (Carter, K, 1990). This is the reason why the teaching experience is very unique and determines the practical knowledge of teachers.

Practical knowledge: "refers to the integrated set of knowledge, conceptions, beliefs, and values teachers develop in the context of the teaching situation" (Verloop, N, Van Driel, J, & Meijer, P, 2001, 141). In other words, practical knowledge is the teaching experience in a

particular setting that involves the teachers' knowledge of the subject matter, their values, beliefs, and social environment.

2.1 PCK components and methods:

Several models of PCK were introduced including those of Shulman (1986), Tamir (1988), Grossman (1990), Marks (1990), Magnusson, Krajcik and Borko (1999), and Hashweh (2005) to enhance teaching quality and students' learning. All these models tried to define PCK components which are distinctive and can be summed up in the various orientations to teaching the subject matter, the knowledge of subject matter, knowledge of students' understanding, knowledge of curriculum, knowledge of pedagogy and instructional strategies, knowledge of assessment and context. (Kulm, G & Wu, Z, 2004, 24)

We notice that PCK components are various and multiple; one type of knowledge is not sufficient to ensure a good teaching process, the teaching conceptions and contents are central to pedagogical content knowledge. The understanding competencies and characteristics of students should not be neglected. The curriculum and teaching programmes are of paramount importance along with pedagogical strategies, evaluation methods, and teaching environment.

It is worth noting that the concept of PCK was applied to many disciplines; many scholars and researchers were interested in examining and measuring teachers' pedagogical content knowledge despites many claims of the difficulties of this task.

The assessment of pedagogical content knowledge is very important, although it is difficult to be effectively measured due to several variables. There are three assumptions underlying the assessment of pedagogical content knowledge, namely: (1) teaching and assessment methods are influenced by science content, (2) pedagogy has huge impact on teaching content and ways as well as assessment subject, (3) assessment knowledge has an impact on the subject and methods of assessment as well as teaching content and ways. (Shepardson, D, 2011, 10) As we can see, all these assumptions are interrelated and form the core components of pedagogical content knowledge. Thus, they should be taken into account in any assessment process.

To measure and assess pedagogical content knowledge, questionnaires, interviews, video observation of real instruction, student performance, and paper-and-pencil tests are among the mostly used measurement methods. (Bindernagel, J, & Eilks, I, 2009; Phelps, G, & Schilling, S, 2004)

Questionnaires are practical to collect large data especially online since they are cost-efficient and the result can be easily analysed and quantified. Interviews are also a good assessment instrument and allow the collect of in-depth information. Video observation is a very efficient and direct method to assess pedagogical content; they clearly reveal strengths and shortcomings of teaching in general and pedagogical content in particular. As for paper-and-pencil tests, they are formal assessments, widely used in formative assessment and fall under direct observation.

Some of these methods are used separately, others in combination with other methods; the purpose of combining more than one method is to optimise results. In this regard, Shulman argued that there is no single measure of evaluation, multiple measures should be used to address/remedy the flaws of using each measure separately. (Shulman, L, 1988, 38)

2.2 PCK models:

We have found another model which appears to be very interesting especially in the e-learning context that we will discuss below, introduced by Jones L. and Moreland J. (2015) who argued that pedagogical content knowledge has seven components which are the nature and characteristics of the subject, conceptual, procedural and technical aspects of the subject, knowledge of the curriculum, including goals and objectives and specific programmes, knowledge of student learning in the subject, including existing knowledge, strengths and weaknesses and progression of student learning, specific teaching and assessment practices of the subject, such as authentic, holistic, construct reference; understanding the role and place of context, and classroom environment and management relating to the subject, for example managing resources, equipment and technical management. (70)

We notice that this model seems robust and comprehensive since it includes many parameters that should be taken into account when assessing pedagogical content knowledge. Understanding the discipline enables teachers to select the most appropriate information and activities to be focused on; knowing all the various aspects of the subject matter helps teachers set goals and achieve them. Being aware of the curriculum is crucial to focusing on the most important points to be addressed; identifying students' degrees and difficulties of assimilation helps them enhance their interaction and learning process; knowing effective teaching ways in relation to the subject matter enables teachers to transform concepts into comprehensible forms. Highlighting the importance of contexts

allows teachers and students to understand complex concepts and optimise relevancy, and paying attention to the surrounding environment and conditions increases positive attitudes. Thus, this model may have positive impacts on assessing the teachers' competencies, pedagogical content, and the students' learning progress.

Although many models were suggested, there is no single established method to measure pedagogical content knowledge. Instead, many methods and instruments can be used to ensure a comprehensive assessment of PCK, effective measures can be defined based on Jones and Moreland's model of pedagogical content knowledge through adapting measures to each components of this model taking into consideration the specific nature of e-learning.

Based on Jones and Moreland PCK model, we suggest the following elements to assess e-learning pedagogical content:

- Types and relevancy of the subjects taught through using e-lessons;

-Identification of courses types and characteristics (preparatory, developmental, discovery learning, conceptual, procedural, technical courses);

-Identification of the courses' purposes: (formulation of potential research questions, making comparisons and contrasts, establishment of relationships, and so on);

-Evaluation of the degree of correspondence between the courses' types, characteristics and purposes;

-Measurement of the curriculum application rate and correspondence between the programme and courses' content;

-Evaluation of student knowledge of the subject through formative assessments;

-Evaluation of types of assessments as well as their efficiency and reliability;

-Identification and assessment of the used electronic tools (servers, desktops, laptops, tablets, WIFI, networks) and supports (e-books, audio-books, e-courses);

-Identification of students' learning contexts and environment as well as evaluation of their strengths, weaknesses, and progress pace.

3. Formative assessment:

Assessment is primarily used to assess the students' knowledge, measure their competencies, and identify their strengths and weaknesses.

Formative assessment is "a planned process in which teachers or students use assessment-based evidence to adjust what they are currently doing" (Popham, J, 2008, 6). Formative assessment can be formal such as formal examinations or informal such as the teachers'

questioning strategies (Caffrey, E, 2009, 4) Both types of formative assessment enables the identification and measurement of the students' progress pace and the adaptation of the courses' content accordingly. Teachers may change the teaching methods or repeat the already-taught content.

In this vein, teachers should regularly use formative assessment which is different from summative assessment, this later is graded and applied at the end of the learning process. Computer-Adaptive Testing (CAT) and Curriculum-Based Measurement (CBM) are considered to be the most reliable tools of formative assessment because they provide accurate data about the students' progress. CAT provides a measure of broad achievement through using students' answers to inform subsequent questions and adjusting to students' levels. CBM is quick and is good for progress monitoring. (FastBridge Learning, 2018, 4) Further, one-minute essay or question, web or concept map, misconception check, self-assessment, and journal entry are among the techniques that are often used by teachers to conduct formative assessment.

Formative assessment enables teachers to measure the progress of their students and adjust their teaching methods and pedagogical contents accordingly. In this context, competency-based teaching may also be applied to achieve the learning goals.

4. Competency-based teaching:

Competence-based curriculum can be traced back to the early 1970s with the emergence of competence-based education in the United States of America (Richard, J, & Rogers, T, 2001), it spread over European countries such as the United Kingdom and Germany in the 1980s (Wolf, A, 2001). Nowadays, many universities and teachers seek to implement this approach in the teaching and training they offer.

According to the Dictionary of Education (1981), competency-based teaching is conceived as that movement within Teacher Education whose proponents: "trained teachers in specific skills of interacting with pupils in classroom and who advocate that courses taken by prospective and in-service teachers should spell out very clearly the knowledge, skills and attitudes they are expected to acquire". (as cited in Singh, V, 2010, 31)

It is inferred from the above definition that competency-based teaching is a type of teaching that provides learners with the knowledge and skills they really need by highly competent teachers through interaction in classrooms. Much freedom is given to students to

express their opinions, needs, and expectations since they are the centre of the teaching-learning process.

Rama (1979) defined teacher competency as "the ability of a teacher manifested through a set of overt teacher classroom behaviours which is resulted of the interaction between the presage and product variables of teaching within a social setting". (as cited in Singh, V, 2010, 32). This means that competence-based teaching is built on the interaction between the teacher and the student in a given context and is dependent on the teacher's behaviour in the classroom.

The following teacher's competencies classification was introduced by Borich and Fenton (1977) which includes: knowledge competencies that encompasses the teacher's cognitive understanding through effective teaching methods and class management or relevant subject content. (Singh, V, 2010, 33-34) In other words, knowledge competencies are related to cognitive knowledge and pedagogical content of the teacher.

It is noteworthy that competency-based teaching is different from the conventional content-based teaching in many aspects. Competency-based teaching is learner-centred and intended to provide lifelong personalised learning skills, it does not focus on passing grade to assess the real level of learners, whereas traditional teaching is time-based, depending on pre-defined academic outcomes that should be achieved in a given period of time, much attention is paid to grading instead of tracking the real progress of learners. Thus, competency-based teaching requires highly competent teachers who are able to meet the learners' needs.

Performance competencies are related to the teaching behaviours in the classroom and include appropriate assessment methods such as asking well-constructed direct or indirect questions, and accepting learners' answers and feelings. These competencies should be assessed through systematic observations of teaching behaviours. (Singh, 2010, V, 34) This type of competencies is practical and can be easily identified and evaluated through observation, it is related to the way of turning knowledge competencies into tangible forms.

Consequence competencies are the representations of teaching effectiveness through learners' behaviours. (Singh, V, 2010, 34) That is to say, consequence competencies are reflected in the achievements and performances of learners. All these competencies combined are most likely to ensure a good quality teaching to get satisfactory academic outcomes.

The best way to apply competency-based teaching is through reorganising content knowledge and changing the way it is provided to learners without denying its value. (Hong, W, 2002)

Hence, lifelong learning should be at the centre of the teaching goals through improving curriculum, teaching approaches, learning contexts, using modern technologies, providing real training opportunities and applying reliable assessment methods. We believe that pedagogical content and formative assessment go hand in hand, there is a two-way relation between them. Additionally, competency-based teaching can effectively enhance pedagogical content in e-learning contexts through providing personalised courses and activities which enhance critical analysis, reflection, assimilation, as well as decision-taking and problem-solving skills. Each learner can progress following his/her own pace and may develop their own learning pace according to their needs, expectations, strengths, and weaknesses.

5. E-learning:

E-learning is an emerging learning system which mainly relies on modern technologies such as computers, cell-phones, tablets, and software. Delivering curriculum via electronic means depends on the flexible instructional design, students' motivation, knowledge content, and teachers' ability to make representations comprehensible.

In this vein, several crucial an effective pedagogical requirements should be provided to ensure a good-quality e-learning such as well-defined and organised pedagogical knowledge, well-structured instructional method, questions and immediate feedback, problem-based and project-based learning, formative and summative assessments, technical usability such as site structure, cross-platform, accessibility, screen appearance, navigation and database, libraries and forums linking as well as multimedia design, pedagogical usability such as a multiple, well-structured, understandable, online presentation and synchronous communication (chats). (Buzzetto-More, N, 2007, 37-43)

Following the Covid-19 pandemic, many universities worldwide have moved towards e-learning which is an "important type of learning that is more and more spreading; many factors and requirements should be gathered to ensure an effective e-learning process. Pedagogical contents should be designed and adjusted according to the learners' characteristics and attitudes, formative assessments should be well-designed and

implemented and competency-based teaching should be adopted to enable every learner to achieve good academic outcomes and acquire a lifelong learning". (Benlakdar, M, 2021, 205)

6. Conclusion:

In the light of what has been discussed above, we conclude that pedagogical content knowledge is a broad concept which is crucial to the teaching-learning process; much attention should be paid to enhance its various models. Jones and Moreland's PCK model is quite interesting; based on this latter we have made our assessment suggestions (see section 1). As for formative assessment, it can be a reliable tool to assess teachers' pedagogical content through tracking the students' progress; the most reliable assessment tools are CAT and CBM which provide accurate data about students' achievements. Competency-based teaching is another efficient means to assess and adjust pedagogical content through focusing on lifelong and personalised learning, enhancing teachers' competencies, as well as applying effective learning approaches. Finally, teachers should make full use of technology and meet the e-learning requirements to ensure high quality academic instruction through adjusting and regularly assessing their pedagogical content.

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