Cultivating students' thinking and communication skills in Physics

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Abstract. In science education students learn to utilize discipline-specific mathematical concepts, but, it is equally important to develop students' deeper understanding of physics. Traditional courses with textbooks and basic exercises have their limitations in developing students' understanding and critical thinking. This study presents pedagogical strategies that can foster students' creative thinking and problem-solving skills through concept maps and question strategies. The study examines the tactics developed at NDU to promote deeper learning among students. Useful for learning are interrogative questions and combined models that give students the freedom to ask even less complete questions.

Introduction

Questioning strategy is essential part in learning and teaching. Hintikka's (2007) interrogative model of inquiry is proposed to characterize construction processes of knowledge within scientific analysis [1]. Big questions explain the subject of the entire research process, and operational questions show how certain information is found. It is important that students understand the foundations behind phenomena, but they must also be able to form new questions and insights. It is crucial that teachers give space for completely new ways of thinking [2].

Educational designers, teachers, and students recognize the role of textbooks as a pivotal source of knowledge and a central guiding force for the curriculum. Textbooks are aimed to support the intellectual growth of students by presenting the subject matter in a manner that honors established traditions of each discipline. Textbooks in the sciences are typically designed with the specific level and content of instruction in mind. Notably, in the context of physics education, the textbook may assume a predominant role in the course's execution [3].

Snow [4] noticed that students exhibit a deficiency in strategies for the effective processing of scientific texts. According to Bryce and MacMillan [5] even materials of substantial quality fail to align with the pragmatic realities of learners, rendering the provided examples and associated computational exercises alien. The voluminous content and lack of engagement found in these books underline the necessity for augmenting traditional textbook-based instruction with educational platforms tailored to the learners' knowledge level. Within the pedagogical strategies employed in physics education, the primary objective is to cultivate students' problem-solving capabilities. But this is not yet enough. The explication of the symbiotic relationship between reading and substance under studying enables students to more effectively synthesize new knowledge with that which they have previously acquired [6]. These capabilities can be empowered if students are encouraged to present questions more freely. Mind maps are seen as valuable tools for the visualization of linked or dissimilar concepts within a specific field of study [7]. They are also useful in aiding students in self-questioning.

The aim of the study

This research clarifies models and teaching strategies how students' reading and communication skills are tried to mature in NDU's physics education. The major challenge is technology courses, where basic physics is just refreshed. Beside that this study elucidates those difficulties which students face in science courses at NDU. In addition to this, it is also

considered how teachers should evaluate and promote their pedagogical interventions during the courses. Overall, the study emphasizes the importance of a multifaceted approach to science education that equips students with the tools to not only learn scientific concepts but also understand and critically analyze scientific concepts and their presence in texts. We noticed that activating students with inquire based learning and proper questioning policy seems fruitful in enhancing students' critical thinking skills as well communication abilities.

The research argues that:

- Textbooks are a central resource but can be difficult for students to comprehend due to factors like language and structure. Think support material e.g. in MOODLE.
- Traditional methods that focus solely on memorizing textbook content are not effective for deep learning or for life long utilization of knowledge.
- Students need to develop critical reading skills and abilities to present new questions.

We propose solutions such as:

- Teaching students for processing scientific texts with efficient questioning strategies.
- Tools for concept clarification (e.g. concept maps).
- Integrating reading, writing, and critical thinking skills into science education.
- Utilization of theme days for promoting new types of exercises [8].

Conclusions

The use of dynamic teaching strategies and compelling pedagogical techniques is crucial to strengthen students' understanding of scientific texts and their critical thinking skills. Instead of pure knowledge capturing we need to inspire students also to knowledge formation [2]. Ability to allow for students space also for less formal or complete questions gives also more space for creative and critical thinking.

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