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Abstract

Understanding the causal mechanisms that underlie natural phenomena is the focus of biological inquiry. Mechanistic reasoning is a thought process as to how a cause brings about an effect. Without this skill, students find it hard to explain various biological processes, for example such as those related to cells. However, research has shown that many teachers believe that it is inappropriate in trying to infuse mechanistic reasoning among the low achieving students as compared to the high achieving ones. Thus, the overall aim of this study was to explore in depth, selected Form Four high and low achieving students' mechanistic reasoning for the Theory of Cell. In addition, the study investigated students' progression of mechanistic reasoning as well as the emergent representations or the learning outcomes of their mechanistic reasoning.

This study is an exploratory study which employed qualitative data collection methods. The study began with the preparation of three instruments which were the Science Test, the Incoherency Tests and the Living Cell Tool. The Science test was used to categorise students into high and low achievers. Based on the Science Test, four high-achieving and six low achieving students were identified as the sample of this study. The four incoherency tests were used to explore students' incoherencies for the four chapters related to the Theory of Cell in order to prepare the Living Cell Tool. The Living Cell Tool was prepared both as a teaching-learning material to infuse mechanistic reasoning as well as a tool to collect data. Since the Living Cell Tool was utilised in a normal classroom lesson, it was prepared aligned with the Form Four Biology curriculum specified by the Ministry of Education. Infusion of mechanistic reasoning was carried out over five months for the four topics related to the Theory of Cell which were cell structure and organisation, movement of substances across the plasma membrane, chemical composition of cell and

cell division. Data was obtained from students' written answers, researcher's observations, audio and video data reflecting students' mechanistic reasoning, and students' interviews. Due to the complexity of the data, using existing analytical frameworks was insufficient to uncover in depth the students' mechanistic reasoning. Thus, the researcher through much discussion planned a seven (7) step procedure to analyse students' mechanistic reasoning. This procedure revealed four types of cognitive processing within the mechanistic reasoning among the student sample. There were named as Type I and Type II Simple Cognitive Processing and Type I and Type II Complex Cognitive Processing in ascending order.

The findings showed that in the beginning of this study all of the high and low achieving students only managed to achieve either Type I or Type II simple cognitive processing. Furthermore, as the study proceeded, both the high and low achieving students' mechanistic reasoning began to achieve Type I or Type II complex cognitive processing. Upon further analysis, the study also revealed several learning outcomes which were named as representations as a result of the students' mechanistic reasoning. These representations reflected the students' understanding of the Theory of cell and were categorised as intuitive representations, assimilated representations, transformational representations and misinterpreted representations. Implications and suggestions for further research were also put forward.

Penaakulan Mekanistik dalam Kalangan Murid Sains Tingkatan Empat Terpilih bagi Teori Sel

Abstrak

Pemahaman mekanisme bersebab yang menjadi dasar kepada fenomena semula jadi merupakan fokus bagi inkuiri biologi. Penaakulan mekanistik merupakan satu proses pemikiran yang menjelaskan bagaimana suatu punca membawa kepada suatu kesan. Tanpa kemahiran ini, murid menghadapi kesulitan untuk menjelaskan pelbagai proses biologi, contohnya proses yang berkaitan dengan sel. Akan tetapi, kajian telah menunjukkan bahawa ramai guru percaya penyemaian kemahiran penaakulan mekanistik adalah kurang sesuai dalam kalangan murid pencapaian rendah berbanding dengan murid pencapaian tinggi. Oleh yang demikian, tujuan keselurahan kajian ini adalah untuk mengkaji secara mendalam, penaakulan mekanistik dalam kalangan murid pencapaian tinggi and rendah bagi Teori Sel. Tambahan pula, kajian ini menyelidik perkembangan penaakulan mekanistik murid serta perwakilan atau hasil pembelajaran yang muncul daripada penaakulan mekanistik murid.

Kajian ini adalah satu kajian penerokaan yang menggunakan kaedah pengumpulan data kualitatif. Kajian ini bermula dengan penyediaan tiga jenis instrumen iaitu ujian Sains, ujian ketakkoherenan dan Alat Sel Hidup. Ujian Sains digunakan untuk mengkategorikan murid pencapaian tinggi dan rendah. Daripada Ujian Sains ini, enam murid pencapaian rendah and empat murid pencapaian tinggi telah dikenal pasti untuk persampelan kajian ini. Empat ujian takkoherenan digunakan untuk meninjau kekoherenan murid bagi empat bab Teori Sel demi menyediakan Alat Sel Hidup. Alat Sel Hidup ini disediakan sebagai satu bahan pengajaran dan pembelajaran untuk menyemai penaakulan mekanistik dalam kalangan murid serta merupakan salah satu instrumen untuk memungut data.

Memandangkan Alat Sel Hidup ini digunakan dalam pengajaran dan pembelajaran biasa dalam kelas, ia disediakan selaras dengan kurikulum Biologi Tingkatan Empat yang ditetapkan oleh Kementerian. Penyemaian penaakulan mekanistic dijalankan selama lima bulan untuk empat topik yang berkaitan dengan Teori Sel iaitu sel struktur dan organisasi, pergerakan bahan merentasi membran plasma, komposisi kimia dalam sel dan pembahagian sel. Data dikumpul daripada jawapan bertulis murid, permerhatian pengkaji, data audio and video yang mencerminkan proses penaakulan mekanistik, dan temu bual murid. Disebabkan kekompleksan data yang dikumpul, kerangka analisis yang sedia ada didapati tidak mencukupi untuk mendedahkan penaakulan mekanistik murid secara mendalam. Oleh itu, pengkaji melalui beberapa perbincangan telah merancang satu prosedur yang merangkumi tujuh (7) langkah untuk menganalisis penaakulan mekanistik murid. Prosedur ini mendedahkan empat jenis proses kognitif dalam kalangan sampel murid. Ia dikenali jenis I dan II proses kognitif ringkas serta jenis I dan II proses kognitif kompleks.

Dapatan kajian menunjukkan semua murid pencapaian tinggi dan rendah hanya berkemampuan untuk mencapai jenis I dan II proses kognitif ringkas pada permulaan kajian. Tambahan pula, apabila kajian ini berterusan, murid pencapaian tinggi dan rendah mulai berkemampuan untuk mencapai jenis I dan II proses kognitif kompleks.

Analisis lanjutan mendedahkan beberapa hasil pembelajaran yang dinamakan sebagai perwakilan. Perwakilan-perwakilan ini mencerminkan pemahaman murid tentang Teori Sel dan dikategorikan sebagai perwakilan intuitif, perwakilan assimilasi, perwakilan transformasi dan perwakilan salahtafsiran. Implikasi dan cadangan untuk kajian selanjutnya juga dikemukakan.