Two-stage Heuristic for Primary School Timetabling Problem with Combined Classes Consideration

San Nah Sze[a,1], See Yan Tan[a,2], Kang Leng Chiew[a,3], Wei King Tiong[a,4]

[a] Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, Kota Samarahan, 94300, Sarawak, Malaysia
E-mail: [1]snsze@unimas.my; [2]jessietan516@hotmail.com; [3]klchiew@unimas.my; [4]wktiong@unimas.my

Abstract—This research focuses on a primary school timetabling problem, a small-scale primary school that is located at Pengerang, Johor. In this small-scale primary school, six classes have been allotted, from standard one until standard six. Most of the primary school timetables are manually developed, which is extremely time-consuming. According to the new policy announced on 12th Dec 2017by the Ministry of Education (MoE) Malaysia, due to the shortage of teachers, combined-classes should be implemented in low-enrolment schools with fewer than 30 students. MoE has introduced another policy on 30th June 2018 that recommends schools to reduce the number of subjects that are being taught in a day to solve the overloaded school bag issue. There is a set of hard constraints in this primary school timetabling problem due to the stipulation that a teacher can only teach one subject at a time; each subject must satisfy the total weekly period(s), and the combined classes can only combine one subject at a time. The main objective of this study is to propose a heuristic solution to this solves primary school timetabling problem with the consideration of combined-classes. A two-stage timetabling heuristic approaches been offered due to its simplicity in dealing with numerous constraints. The two-stage heuristic method was clustered into subject groups in the first stage to ease the timeslots allocation in the second stage. A clash-free timetable can be obtained from this proposed algorithm. The result generated by this proposed solution outperforms the current manual practice in solution quality and computing efficiency.

Keywords— combined classes; government policy; primary school timetabling; small scale primary school; two-stage heuristic.

I. INTRODUCTION

Timetabling issues can be categorized into three main categories, which are university course timetabling, university examination timetabling, and school timetabling [1], [2]. School timetabling is the arranging of subjects for a week for all classes in a school [2]. Scheduling a list of subjects at a fixed time that must fulfill all the constraints is always a challenge. School timetabling is a vital activity for each school, and it is a time-consuming task. The quality of the school timetables has a huge impact on its educational system [3]–[5]. The complexity of timetabling has gained the attention of researchers in the Operational Research and Artificial Intelligence field [6]. School timetabling problem is a complex combinatorial optimization problem. A school timetabling problem is an NP-hard problem. Many constraints need to be considered in a school timetabling problem [7].

Some previous studies exposed general timetabling models [7]–[11]. Other previous findings revealed the real cases of the timetabling problem [12]–[16]. While many methods and approaches that can be used to solve a school timetabling problem. There is no fixed algorithm or method to solve the scheduling problem [17]. Different approaches may have different results. The distinct uniqueness of the problem may require different algorithms [17]. Therefore, a new approach to satisfy a set of constraints will be studied in this paper.

II. MATERIALS AND METHOD

The primary timetabling problem in this research is an actual case study of a small-scale primary school that is located at Pengerang, Johor. This small-scale primary school has a small number of teachers and students. Table I shows the number of students, teachers, and classes in this primary school from the year 2017 until 2019.

TABLE I
NUMBER OF TEACHERS, STUDENTS, AND CLASSES IN SMALL-SCALE PRIMARY SCHOOL

Year	2017	2018	2019
Number of Teachers	10	8	8
Number of Students	23	18	16
Number of Classes	6	5	5

As stated in Table I above, the total amount of students in this primary school for the last few years has been less than 30 people. Due to the shortage of teachers, the Ministry of