Personalized Study Guide: A Moodle Plug-in Generating Personal Learning Path for Students

Abstract. Applying learning analytics to generate personalized learning paths is getting popular in recent research. This study designs a Moodle plug-in called Personalized Study Guide that can generate personalized learning paths according to students' learning styles. The plug-in supports two ways to determine students' learning styles: one is using Inventory of Learning Styles (ILS), the well-established learning style questionnaire developed by Felder and Silverman, and the other is through the analysis of students' past behaviour patterns on Moodle. The Personalized Study Guide analyzes the learning-style weightings for each learning resources/activities in the course. Using the calculated learning-style weightings, the Personalized Study Guide could determine which learning resources/activities are closer to students' learning styles to generate the recommended learning path. The research team is conducting the experiment to evaluate the perceived usefulness of the Personal Study Guide in 2023. The details of the evaluation plan are also described in this study.

Keywords: Recommendation System, Moodle Plug-in, Learning Style, Behaviour Pattern, Behaviour Analytics block.

1 Introduction

Learning analytics is used in analyzing learners' behaviour and the learning content to enhance learners' performance and the learning environment [5]. Learning Management System (LMS) is one of the most used platforms for the learning analytic research [7]. There are some existing learning analytics tools that are capable of extracting students' behaviour patterns on Moodle, e.g., Behaviour Analytics Moodle Plug-in [9] and Learning Object Relation Discovery (LORD) Moodle Plug-in [10].

The research team aims to use the existing behaviour analytics tool accompany with the Index of Learning Styles to generate a recommended learning path for students so instead of one-fit-all general study guide they can have their personalized study guide while learning according to the learning behaviour of the other students who share similar learning styles. Section 2 introduces the definition of the learning styles and its related studies. The system architecture of the Personal Study Guide is described in Section 3. Section 4 demonstrates the system workflow of students using

Personal Study Guide in learning. An evaluation plan examining the usability of Personal Study Guide and the effectiveness of using the existing behaviour analytics to identify student's learning style is illustrated in Section 5. Section 6 makes a brief conclusion.

2 Learning Styles

Students may have different preferences in receiving and processing information in the learning environment [11][12]. Researchers start investigating how to categorize students' preferences in learning into different learning styles [2]. For example, Jackson's Learning Styles Profiler (LSP) is based on the personality to determine whether students are initiators, reasoners, analysts, or implementers. Each personality has the strengths and weaknesses based on the different preferences so the students can us the strengths to become more effective learners [6]. Kolb proposed students with different learning styles – which are diverging, assimilating, converging, and accommodating – are more comfortable with different stages in the learning circle; in this case, the students can identify which stages of the learning circle are their lesser preferred and strengthen these stages to enhance their learning outcome [8].

Felder and Silverman's learning- and teaching-style model (FSLSM) distinguish learners' learning style into each of the following four dimensions, which are information processing (active or reflective learners), information reception (visual or verbal learners), information perception (sensing or intuitive learners), and information understanding (sequential or global learners [3]. To access students' preference, the Index of Learning Styles (ILS) was developed as a web-based instrument [4]. ILS is a 44-item questionnaire – 11 questions in each dimension – where each item has two options sit in the two side of the learning style in the dimension. For example, in the *information processing* dimension, if the student selects the active option, the *active* preference is increased with a value of 1, and the *reflective* preference is decreased with a value of -1. At the end, the preference of each learning style is ranged between -11 to +11.

Investigating the relationship between learning objects and learning styles decides how to deliver different content to students according to their learning styles [12]. In Assis and colleagues' research, 39 studies were included in the systematic literature review to discover the relationship between the learning object types and the learning styles in FSLSM. There are 46 types of learning objects identified from the past literature reviews and weighting of each learning styles corresponding to the learning objects types are calculated based on the number of occurrences that the learning objects has been connected to the learning styles [1].

3 Personalized Study Guide Generation

This research designs a Moodle plugin, Personalized Study Guide (PSG), that can adjust the study guide a student is referring for learning in Moodle based on either his/her learning style calculated from FSLSM or his/her learning behaviour patterns

found from learning logs. Fig. 1 shows the PSG's workflow. There are three sources feeding to the PSG:

1. The Learning Resources/Activities: are the structure and the content of the learning resources/activities on Moodle.
2. Students' Learning Log: contains the actions students were taking on Moodle for learning.
3. ILS Questionnaire: stores students' responses to the ILS questionnaire.

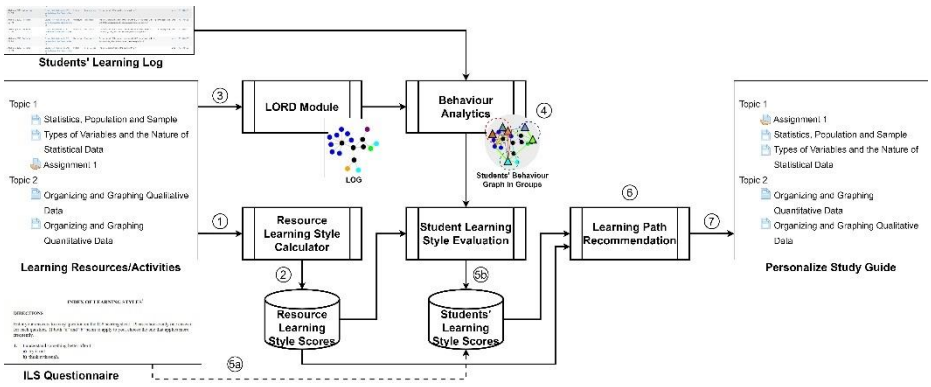

Fig. 1. The system flowchart.

At the first stage, the Resource Learning Style Calculator module examines the types of the learning resources/activities and assigns the learning style weights on the learning resources/activities according to the analysis of the relationship between learning object and learning styles [1]. The weights are stored in the Resource Learning Style Scores. The PSG can (optionally) includes the LORD (Learning Object Relation Discovery) Module [KWTC22] to analyze the relationships among learning resources/activities to build the Learning Object Graph (LOG) for teachers to effectively use the Behaviour Analytics plugin clustering students' learning behaviours (see Stage 3 in Fig. 1). Despite of using the optional LORD module or not, the PSG adopts the Behaviour Analytics module [9] to cluster students into different groups according to their learning behaviours stored in Students' Learning Log by as Stage 4 in Fig. 1 shows.

With the ILS Questionnaire, student responses are stored in the Students' Learning Style Scores database (refers to Stage 5a). In th case when teachers to opt out the ILS Questionnaire, the Student Learning Style Evaluation module will adopt the student clustering results according to their behaviour patterns (see Stage 5b). The Student Learning Style Evaluation module first identifies which group the student belongs to according to the analysis results (refers to Stage 4) from the Behaviour Analytics module and then finds what learning resources/activities this group of students frequently visited. The learning style scores in these common visited learning resources/activities are summed up to determine what would be the learning style this group of the students might be.

For example, the most frequently visited activities the students in Group A are listed in Table 1. When the Student Learning Style Evaluation module sums up the weights of each activity as: {active: 1.24, reflective: 0.55, sensitive: 0.66, intuitive: 0.41, visual: 0.73, verbal: 0.66, sequential: 0.38, global: 0.27}, the students in Group A are classified to the learning style: (active, sensitive, visual, sequential).

Table 1. An example of calculating the learning style of the student group with the frequently visited learning materials/activities.

	Learning Style Weights							
Materials/Activities	Act	Ref	Sen	Int	Vis	Verb	Seq	Glb
Turtle and For Loop	0.04	0.22	0.04	0.17	0.30	0.04	0.17	0.00
Examples of Turtle Graphics	0.26	0.13	0.19	0.00	0.26	0.06	0.06	0.03
Project 2 Description	0.38	0.05	0.19	0.05	0.05	0.19	0.05	0.05
Discussion – Turtle Graphics	0.21	0.00	0.14	0.14	0.07	0.29	0.00	0.14
Quiz – Turtle Graphics	0.35	0.15	0.10	0.05	0.05	0.08	0.10	0.05
Sum	1.24	0.55	0.66	0.41	0.73	0.66	0.38	0.27

In Stage 6, the Learning Path Recommendation module compares the similarities of the student's learning style and the learning resources/activities' learning style scores. The learning resources/activities with higher similarities (in either a unit or in the whole course, depending on the course teacher's decision) will be placed in the beginning of the recommended learning path for the students. At the end, the Learning Path Recommendation module presents the personal study guide according to the generated learning path to the students on Moodle (refer to Stage 7 in Fig. 1).

4 The Moodle Plugin

When a course teacher signs in the Moodle, he or she can go to the setting page of the Personalized Study Guide, where (as Fig. 2 shows) he or she can decide how the PSG generates the personal learning paths for students. The first option – **Personalise within sections** – tells the PSG to generate the personal study guide by following or not following the current designed course section structure. If "within sections" is *checked*, then the rearranged content will still follow the section or unit or week structure the course has. On the other hand, the PSG will generate personal study guide for students by rearranging everything presented in the course – therefore, the students might see some content from the later semester/term at the beginning of the course if the teacher *unchecks* the option.

Fig. 3 is the system snapshot (with some extra information revealing for readers) when the option "Personalise within sections" is *checked*. The PSG follows the original section order: Course general section, Introduction du cours, Methodologie de la veille, Stocker, memoriser, traiter, Diffuser les resultats de la veille, and Topic. The activities under each section (e.g., Flux RSS, Introduction du cours, Activité 1, Act 1, etc. under the section **Introduction du cours**) are reorganized according to the signed in student's learning style calculated from either the ILS scores or the student clustering results (see the top first line on Fig. 3).

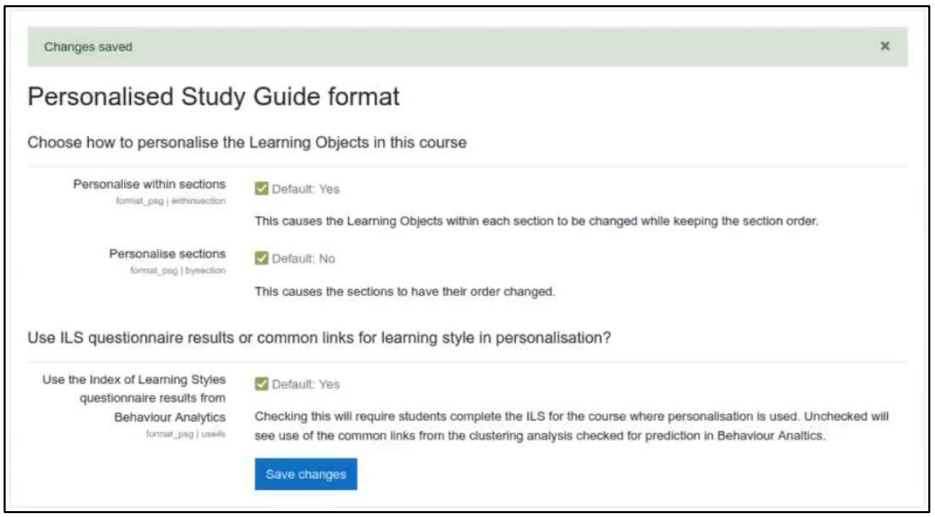

Fig. 2. Configuration of the Personalized Study Guide

Fig. 3. Generated personal study guide following the original section order.

Take the section **Introduction du cours** for example, the Flux RSS activity is scored 1 and is the best option for the signed in student to read first comparing to other activities that were scored as 0s in the same section.

On the other hand, if the teacher *checked* the option "**Personalized sections**" in Fig. 2, the PSG will also consider the section scores and rearrange the sections accordingly. Take Fig. 4 for example, compared with Fig. 3 the rearranged section sequence became section **Topic 5** (scored 1) first followed by Course general section (scored 0.67), Diffuser les resultats de la veille (scored 0.5), Introduction du cours

(scored 0.25), Methodologie de la veille (scored 0), and Stocker, memoriser, traiter (scored 0).

Fig. 4. Generated personal study guide with the rearranged section order.

5 Evaluation Plan

To understand whether the generated personal study guide can help students in learning, the research team plans to work with two university professors (who are the course instructor of Academic Writing in English and English Presentation for Social Sciences) in different countries in Asia. The evaluation process is separated into two stages are Table 2 shows.

At the very beginning of the experiment, all students will be asked to fill out a built-in 44-item learning style questionnaire (i.e., the Inventory of Learning Styles, ILS) that the Behaviour Analytics plugin has. During the first stage (e.g., before the mid-term exam), the Personalized Study Guide plugin will be set to re-arrange learning activities according to student's learning style based on the ILS results. At the end of the first stage (approximately before mid-term exam), the students will be asked to fill out another built-in 10-item System Usability Scale questionnaire so the research team could know how they perceive the usability of the PSG when the PSG uses ILS scores to generate the personal study guide for them.

During the midterm exam, the teacher needs to use the Behaviour Analytics plugin to group students according to their learning behaviour on Moodle. If the teacher believes the clustering results are inappropriate, he or she can manually drag-and-drop the selected students from a group to another. The teacher is also asked to put notes to each student group explaining his/her observations and thoughts on the characteristics of the students in the group.

At both first and the second stage, students can freely decide to switch back and forth to the original study guide or the personal study guide at any time. The PSG will have the choice changes recorded so the research team could also understand student preference and even getting know more about whether the changes are related to their

perceived usability as well as whether the changes contribute to their academic performance (i.e., the mid-term and final exam marks or the final grades they received for the course at the end).

Table 2. The evaluation plan for the Personal Study Guide plug-in

Stage	PSG	Activity	Collected Data
1	Is set for using ILS responses to generate personal study guide. Can be manually turned on/off by students	Students fill out the entry survey at beginning of the course	Students' ILS responses
		Students study in Moodle with the PSG plug-in	Students' learning behaviour log in Moodle as well as when they turn on/off PSG and how many times they turn on/off PSG
		Students fill out the first exit survey	Students' responses toward the perceived system usability of the PSG
Mid-term	N/A	Students take the midterm exam	Students' midterm marks
		The teacher adjusts the student groups clustered by the Behaviour Analytics plugin and takes notes on the potential observations and student characteristics that each group might have	Students' group and the observation notes from the teacher
2	Is set for using student clustering results to generate personal study guide. Can be manually turned on/off by students	Students study in Moodle with PSG plug-in	Students' learning behaviour log in Moodle as well as when they turn on/off PSG and how many times they turn on/off PSG
		Students fill out the second exit survey	Students' responses toward the perceived usability of the PSG
Final	N/A	Students take the final exam	Students' final exam marks and final grades

At the end of the second stage, the students will be asked to fill out another built-in 10-item System Usability Scale questionnaire so the research team could know how they perceive the usability of the PSG when it uses the student clustering results for rearranging the learning activities/resources. If the second stage has similar or better perceived usability than the first stage, then it might indicate that in the future we don't really need students to fill out a learning style questionnaire, but the computer can cluster students automatically and help to provide them personal study guide (i.e., rearrange learning activities according to the clustering results).

6 Conclusion

This research designs the Personal Study Guide Moodle plugin which generates personal learning path according to students' learning styles. By using existing Moodle plugin (i.e., the Behaviour Analytics) and following the earlier found relationships between learning styles and objects/pedagogy, the PSG calculates the learning style

scores for each learning resources/activities in Moodle and rearranges the best matching learning activities/resources for students accordingly.

The research team plans to conduct an experiment described in the previous section in 2023 in order to evaluate the system usability and effectiveness of the Personal Study Guide in learning. In the next stage, the research team will evaluate the collected data to determine whether the calculation of students learning styles by using their learning behaviour is accurate.

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