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Understanding students behavior during the adoption of modular robotics in learning

F Kamal*, C W Budiyo and A Efendi

Informatics and Computer Education, Faculty of Teacher Training and Education,
Universitas Sebelas Maret, 57126 Surakarta, Indonesia

faifz.k@gmail.com

Abstract. Pre-teacher students undergo a set of stages in their training including a preparation course that familiarises them with classroom situation. The provided skills taught in training are intended to devise pre-teacher students for future assignment at schools. This research sheds lights on how students learning behaviour can be charted during the introduction of modular robotics in learning. The Kolb's Theory has been adapted to chart student's responses while learning the Introduction of Modular Robotics. A qualitative inquiry was carried out by a group of pre-service-teacher students who experienced their first-time observation with Lego Mindstorm in their research. They were assigned to design learning module using LEGO robotics. After completing their assignment, the students were, then, interviewed for their own experience and their fellow students' account of the event. The exploration over the interviews is interpolated with Kolb's learning style theory to obtain the understanding of the phenomena. The student's behaviour during implementing LEGO robotics in STEM courses was explained using Kolb's theory. Finally, we found that Kolb's theory on way of learning explains student teachers attitude toward the use of LEGO robotics in STEM Courses. The increased understanding of the use of robotics in STEM learning is evaluated for application in the real classroom environment.

1. Introduction

Pre-teacher students undergo a set of stages in their training including a preparation course that familiarises them with classrooms situation. It is understood that teaching in a clear and understandable manner is critical for transmitting learning material effectively [1]. The understanding on good teaching method is intended to devise pre-teacher students with the skills required for future assignment at schools [2], as a good method facilitates the communication of teaching goals, expectations, and the anticipated outcomes.

It has been argued that teachers maintain a significant role in introducing students' interest in science, technology, engineering, and math (STEM) [3, 4]. Wherein, the interest in STEM would likely increase the number of students to pursue higher education, and career, as well as students, STEM literacy [5]. Mastering alternatives to STEMS instruction, therefore, is considered a critical skill should be possessed by pre-teacher students [6].

Educational robotics has been increasingly adopted as a learning and teaching method especially in science, technology, engineering, and math (STEM) [7]. Exploring the adoption of robotics as the means of delivering subjects other than robotics itself, moreover, may engage young learners in a wider range of interest [8] such as art and music. In contrast to the commonly held belief that robotics



merely accounted for the formal operations of the devices (robots) and programming knowledge. The experiential, constructivist, and edutainment brought forward by robotics devices can be associated with learning by making approaching [9] and deemed successful in various learning scenarios [7].

The implementation of such constructivist learning environment, however, may not be suitable for each student. Individual's learning dominant ability may perceive similar stimulant distinctively [10]. Wherein, the responses may be expressed in a certain pattern as identified as Kolb Experiential Learning Theory [11]. The identification of students' learning characteristics is considered significant to ascertain the engagement by students' learning style.

This research sheds lights on how students learning behaviour can be charted during the introduction of modular robotics in learning. The learning activities involved designing and building a robot out of Lego Mindstorm®. The researchers adopt the Kolb's Experiential Learning Theory to make sense of students' responses to constructivist learning instructions. Although the design of research was covering overarching aspects of learning, the research is preliminary to the extent that the article reports the analysis of findings from a handful of research participants attending the sessions.

2. Conceptual background

2.1. Kolb experiential learning

The variation of culture, cognitive, and psychology of human makes learning style is diversified into several domains [1, 12]. The lack of instruments to compare learning styles made it is difficult to determine which style is appropriate for a particular personality trait [13]. Wherein, the David Kolb's theory of learning style offers an overarching approach to identify individual's learning style into four domains: accommodators, divergers, convergers, and assimilators [14].

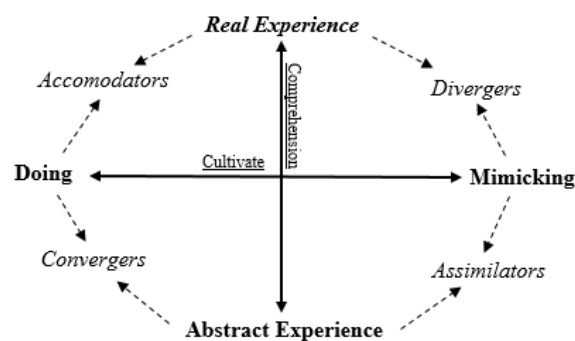


Figure 1. Kolb's Diagram adopted from Gooden, D. J., Preziosi, R. C., & Barnes, F. B. (2009).

The four domains of learning style are defined as follows.

2.1.1. Accommodators. Accommodators is a practical and intuitive learning rather than logical thinking; then they are motivated by 'what would happen if..' type of question in their mind. Known as trial and error learning, the individual that has this domain is very adaptive and like to challenge his/her self [15]. However, accommodators rely on other's information to solve a problem that is faced, but these learners are good with complexity [16].

2.1.2. Divergers. The domain of learning emphasises an action while learning process with good problem solving, imaginative and investigator [15]. Usually, are they motivated with 'why?' type of question. Learners fall within this domain tend to see a problem from several perspectives while having good social interaction with others [17]. However, divergers' type of learners are easily distracted by other people [18].

2.1.3. Assimilators. Learners under Assimilators domain possess a higher level of cognitive than others, wherein they tend to think of something deeply and attributed to the capability to be a good a planner [19]. They can create a new theory because of their capability to focus on ideas and abstract [15]. They motivated with ‘what is..’ type of question. However, they hesitate to explore further [18].

2.1.4. Convergers. Technical and real-world problems are more suitable for Convergers type of learners [14]. They are good at problem-solving and decision making with good control of emotion than the others [15]. They are motivated with ‘how’ type of question.

2.1.5. Conceptual Scheme. From those four domains, we conclude the conceptual scheme based on Kolb research:

Table 1. Conceptual scheme of kolb’s theory.

	Advantages	Instructional method
Accommodators	Adaptive Seeking new approach	Trial and error
Divergers	Diverse perspective Problem-solving	Investigation and imagination
Assimilators	Create a new theory Good planner	Lecture and demonstration
Convergers	Decision maker Good control of emotion	Computer learning

2.2. Constructivism educational approach

Robotics as a learning tool will make new knowledge and understanding of learner, that’s the definition of constructivism [20]. Several studies say, knowledge formed from human thought through their senses, then establish the knowledge by itself and not from outside sources [20, 21]. In other words, human learning by themselves through their experience of learning, those the base theory of constructivism teaching.

Learner, need a guide on how educational robotics explain specific knowledge [22]. Hussain, Lindh, and Holgersson affirm teacher’s role; their research shows that the teacher has a significant role to contribute to learner’ understanding and give them positive influence [23, 24]. Within constructivism perspective, teachers are an adviser and do not directly give their knowledge through lecturing. The teachers play as a facilitator until learners construct some knowledge by themselves through the diversity of experience. Nevertheless, based on Sjöberg research, there were arguments that constructivism theory is an old theory and most of the books on constructivism are not reliable [21]. However, other literature suggests guidelines and construct on constructivism that it could be considered as a firm and confidence theory [21].

2.3. Adopting robotics in learning

Sullivan call scholar’s attention that educational robotics environment combined with specific educational approach speed up learner’s thinking process [25]. There are several environmental designs of educational approach in his research that affects thinking skills as follow including (1) the rich of natural environment tool, (2) the instantaneous feedback, and (3) comprehensive student inquiry [25].

A unit of LEGO Mindstorm® was employed in this research. Several requirements were determined to ensure the conduct of the research was effectively facilitating learning. Specifically, LEGO requires a large space to work, then learner "play around" and experience some of the knowledge for every task they face [25]. These “play around” concept means there is constructivism in

educational robotics, so there is a connection between the learners and the learning material. Constructivism is a part of learning theory [21], and Robotic is a part of constructivism. Last but not least, there is an advantage of using constructivism in educational robotics, that is an enhancement of motivation and considerable incoming information to learners [26].

3. Method

This study adopted the mixed method design. The approach enables the exploration both on quantitative and qualitative approaches [27]. Afterwards, various lessons were designed to explore about LEGO was given to the subject to find reliable data based on method approach. It is important to give a chance for learners to explore the LEGO before assigned them to work on tasks and challenges [28]. The tasks were given to learners, while it must be both relevant and realistic to solve. Since we need to know that learners must felt that they can relate the knowledge to their everyday life [23]. Williams suggests that short lessons and task that attach to the problem-solving activities could increase learners' understanding of knowledge [28]. However, we decide to use tasks and some challenges to learners because we believe that constructivism learning will appear in their experience.

3.1. Participant

Participant divided into several groups, the groups should not be too big (maximum 2–3 learners/Kit) [23]. The participants were ten pre-teacher students without previous knowledge on LEGO Mindstorm. The pre-teacher students were able to explore freely without any limit of the times or author's modules

3.2. Setting

Each learner, need eleven sessions to finish the course. Tasks and lessons can be done by participants after finishing the quiz. Learners need maximum three days to finish each session as follows: in the 1st session, we introduced robotics and LEGO Mindstorm through instructional media. Upon the 2nd session, participants choosed which modul they want (theoretical modul or materialistic modul such video and robotic bricks), then distinguished participants into the suitable learning style. In the end and 4th sessions, participants were given tasks to troubleshoot some logical and physical problem. In the 5th and 6th sessions, researcher set up a robot, so participants can be able to reuse and recycle it. In the 7th and 8th sessions, learners working on block programming provided by LEGO. In the 9th and 10th sessions, the difficulty of the tasks were increased to practice participant's computational thinking and constructivism skills. Lastly in the 11th session, participants were given a final challenge. Each session has done privately, so the researcher can see the perspective of each respondent/group. Then we took questioner after the seminar has been completed.

3.3. Data collection and analysis

The design of the research proposes several methods of data collection to make sure the diversity of data [27]. Qualitative data obtained by interview, observation and simple questioner, then researcher proceed the qualitative findings into a quantitative result. In addition, the difficulty of every task increased, to test the increment of computational thinking skills of the participant. Since we are at the beginning our research, however, this paper merely presents observation as the source of data collection.

4. Preliminary results

This research was a seminal work to integrate robotics into ordinary teaching and learning in a pre-service teacher training program. Students of an informatics department were selected purposively for their familiarity with the context. Apart from the condition that students have acquired skill in programming and the descent of knowledge in robotics, the use of modular robotics such as Lego Mindstorm was relatively a novelty.

The first group of participating students comprised of six people. Their identities are presented in Table 2. Half of the participating students were female. Whereas, only one of the female students chosen Programming as her major. The rest of the female students were in networking stream of specialization.

Table 2. Participating students' identity.

Student ID	Gender	Major
Student A	Male	Programming
Student B	Male	Programming
Student C	Male	Programming
Student D	Female	Programming
Student E	Female	Networking
Student F	Female	Networking

After a short introduction to Lego Robotics, the participating students were asked to unbox a set of Lego Mindstorm® EV3. Without previous knowledge about the subject, the response of the individual student was taped and observed for further analysis. The visual observation, then, extracted for analysis under the descriptive analysis discipline.

The following is a report of the visual observation on each student's responses to the instruction to build a robot out of a newly introduced Lego Mindstorm robotics.

- Student A
He was one of the first responders to the instruction to build a robot and quickly opened up the box. He identified each component by sorting out according to colour and shape. He built a model out of his imagination without any reference.
- Student B
He was the second person of the first responder to the instruction. He looked for a user guide in the box and helped Student A identified the components. He searched for examples of a Lego model from the internet before built the model from scratch.
- Student C
Once he had the instruction, he reached for his laptop and stay focused on it for a period. He, moments later, exclaimed that there is an alternative to visual programming that used to program Lego Mindstorm. He waited until Student A and Student B finished their model, before started his model.
- Student D
She was calmly waited for her turn to try the robotics module. While waiting, she assisted Student B to find the required parts to build his model. She contemplated on the model built by Student B and suggested a correction if any. She did not build any model during the session.
- Student E
All along the session, she did not join the commotion and stayed clutching her mobile. Occasionally, she responded to colleague in-attentively. She did not seem interested in the activities.
- Student F
During the session, she actively passed objects and parts to her friends. She also contributed to the discussion by suggesting some ideas for others to execute. She did not build any model by herself.

5. Discussion

Using Kolb's Experiential Learning theory [10] as the lenses, the observation report was examined to discern the participating student's behaviour during the event. The pattern of learning styles of the participants is depicted in Table 3.

Table 3. The pattern of individual learning style.

Student ID	Type
Student A	Converging
Student B	Converging
Student C	Diverging
Student D	Assimilating
Student E	Accomodating
Student F	Accomodation

Student E and **Student F** seem to maintain the tendency to learn from primarily 'hands-on' experience [10]. They seek the cooperation of others to get assignments done. They rely heavily on people for information than on their technical analysis to solve problems they happen to encounter. The characteristics are perceived as the tendency for an **Accomodating** style.

Student D tends to seek the understanding of a wide range of information and deriving it into a concise, logical form. She seems to be interested in ideas and abstract concepts rather than technical aspects of Lego robotics. We categorise her to fall into an **Assimilating** learning style [10].

Student A and **Student B** indicate their ability to solve problems and make a decision by finding the appropriate solutions for the instruction. They seem best finding practical uses of ideas and theories. Therefore, we categorise them as the individual with a **Converging** [10] learning style.

Student C demonstrated the interest to seek many different points of views before solve a problem. We categorised him as a **Diverging** learning style [10] person for his likelihood to gather information from broad sources and acts based on the accumulated knowledge.

6. Conclusion

Transactions between people and their environment shape the above patterns of behavior associated with the four basic learning styles. Upon the completion of the analysis, we conclude that the combination of Kolb's Experiential Learning Theory and qualitative observation approach altogether could become an appropriate means of charting student's learning behaviour. Kolb's behavioural pattern helps determine student approaches to learning. Beyond our preliminary findings, therefore, future research aims for more comprehensive studies on Kolb's five levels of behaviours including personality types, educational specialiizsation, professional career, current jobs, and adaptive competencies.

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