AN ONLINE MOODLE EXPERIENCE IN PHYSICS AT HIGHER SECONDARY LEVEL

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The researcher reports the use of a Moodle platform for designing a Problem-Solving Learning Environment to teach solving of problems in physics. The sample consisted of 113 higher secondary students of Class XI who were taught solving of problems using an instructional module with the schema based problem solving method on Moodle. The instructional module addresses all the problem types for the topic 'One Dimensional Motion' as prescribed in the NCERT textbooks of Class XI. A feedback of the learners regarding the user friendliness, effectiveness and drawbacks of the course was analysed. This was compared with the feedback of another group taught with the same framework of problem solving learning environment without Moodle support. The effect of using Moodle as a courseware on Problem-Solving Ability was studied. For this, a quasi-experimental study was designed with two experimental groups and a control group. The first group was taught with schema based instruction with Moodle, the second group was taught schema based instruction without Moodle and the third group was taught using drill method. A one way ANCOVA was performed to determine if a statistically significant difference existed between the methods of instruction on the Problem-Solving Ability controlling for Nonverbal Intelligence and Logical-Mathematical Intelligence. The ANCOVA results reveal that schema based instruction using Moodle significantly increases the gain in Problem Solving Ability compared to schema based Instruction without Moodle and the drill method of teaching problem solving.

Keywords: Solving Ability, Problem-Solving Learning Environment, Moodle

Introduction

Moodle is a Virtual Learning Environment (VLE) that is based on open source principles and the educational philosophy called social constructivism. It is a free learning management system that enables one to create powerful, flexible, and engaging online learning experiences. The Moodle platform lets one assume either of the three roles administrator, teacher or student. The teacher's role allows one to customize the course by adding subject content and other resources. It also allows one to create activities such as assignments and quizzes to evaluate the students.

In this study, Moodle platform is used to construct a problem solving learning environment that would help learners to practise physics problems in a unique way called schema based learning. The physics problems which serve as the application part of the theory portion of the content matter appear at the end of each chapter of a physics textbook. The problems are called story problems as they present a problem on the base of a shallow story context. These problems are very important for higher secondary students as the admission tests for higher education are mostly based on the excellence in the performance of solving such story problems. The drill method is the

usual way of practising story problems and is followed in classrooms as well as in coaching centres.

It is generally assumed that students with high content knowledge have high ability to solve problems. Panitz (1998) described about the experience of physics professor Eric Mazur who was shocked at the dismal results on basic understanding of physics of his students who excelled in difficult story problems. Unfortunately, most of the students solve problems in physics by memorizing equations and standardised problem solving procedures without caring for the conceptual structure of the problems. The successful way to solve story problem is to comprehend the 'problem space' presented in the problem. This involves the situational aspects and structural aspects of the problem. The problem solver should build an internal mental model (schema) to accommodate the situational model, structural model and the algorithmic model ingrained in the problem. This conceptual model helps one to comprehend and associate the elements of the problem with the problem schema. The conceptual model also helps to select the appropriate equation that could operate upon the problem structure. This is ended with solving the equation and assigning appropriate units. Jonassen (2011) suggests a reflection on the results thus obtained and matching with the situational aspects presented in the structure, with a provision to redo the process in the event of a mismatch.

Story–Problem Solving Learning Environment

Usual learning experiences limited by curriculum in the school context may not significantly enhance Problem Solving Ability (Praveen, 2016). Meaningful practice in

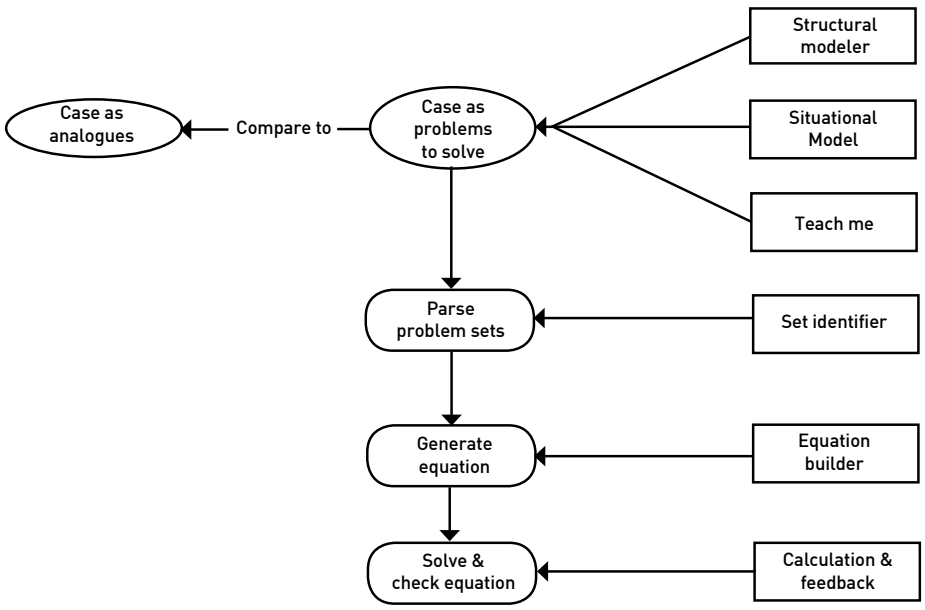

Fig. 1: Jonassen's model of Story-Problem Solving Learning Environment.

problem solving demands creating problem solving learning environments in line with the nature of the conceptual structure of the problem to be parsed. To construct a learning environment that provides practice and exposure in solving story problems, we need to make use of the components that constitute the conceptual structure of a story problem. Thus, it would contain the text of the problem in the verbal form. Each type of problem will have a different structure, therefore, the Story–Problem Solving Learning Environment (SPSLE) should contain a problem schema that acts as template which could address the structure of the problem. A diagram or animation that depicts the situation presented in the problem should also form part of SPSLE. There should be a provision to match the set identifiers on to the structural model. And at last, the learning environment should provide for reflecting the result on the situation presented in the problem. A diagrammatic representation of SPSLE as adapted from Jonassen (2011) is presented in Fig. 1. Jonassen's model advocates using situational and structural models to analyse the conceptual structure of the problem. He suggests analogical story problems to compare and contrast the structural aspects of different story problems. A set identifier will parse the problem sets and an equation builder will solve the algorithm. A feedback mechanism will perform reflection and ensure correctness of the result. The composition of a Story Problem Solving Learning Environment has four basic components: the structure map, problem schema, worked examples, and practice problems.

Methodology

The sample for the present study comprised 113 students of Class XI from three schools of Kozhikode city in Kerala. The present study is a quasi-experimental one and the design applied here is pre-test post-test non-equivalent groups design. The three groups were statistically equated using Logical Mathematical Intelligence and Nonverbal Intelligence as covariates. The effect of the schema based instruction on problem solving ability was examined using ANCOVA. Also the feedback on the experience on Schema Based Learning was also collected using a questionnaire and the responses were analysed.

The design of the study is summarised in Table 1. It shows the interventions made on the control group as well as the experimental groups during the different stages of the study.

Table 1

Design of the Study

Stage	Experimental Group 1 (Sample size =33)	Experimental Group 2 (Sample size =49)	Control Group (Sample size =31)
Pre-testing	Measurement of Non-verbal Intelligence Logical-Mathematical Intelligence Problem Solving Ability	Measurement of Non-verbal Intelligence Logical-Mathematical Intelligence Problem Solving Ability	Measurement of Non-verbal Intelligence Logical-Mathematical Intelligence Problem Solving Ability

Treatment	Teaching problem solving through schema based instruction module with 'Moodle' (7 Hours of face to face teaching of theory + About 3 hours of online engagement for problem solving)	Teaching problem solving through schema based instruction without the 'Moodle' (7 Hours of face to face teaching of theory + About 3 hours of engagement for problem solving)	Teaching problem solving in drill method. (7 Hours of face to face teaching of theory + About 2 hours of engagement for problem solving)
Post-testing	Measurement of Problem Solving Ability	Measurement of Problem Solving Ability	Measurement of Problem Solving Ability

The tools used in the study are given in Table 2.

Table 2

Tools used in the Study

S. No.	Test	Reliability	Validity
1.	Raven's Standard Progressive Matrices to measure non verbal intelligence of the students.	The reliability coefficients as reported by Raven vary from 0.80 to 0.90	
2.	Logical-Mathematical Intelligence constructed and standardised by Praveen and Vijesh (2016)	Test-retest reliability 0.74 (N=31)	Construct validity based on subcomponents of the construct of Logical-Mathematical Intelligence of Howard Gardner.
3.	Problem Solving Ability Test in Physics constructed and standardised by Praveen (2016)	Cronbach Alpha method (0.78)	Content validity based on the NCERT textbook for Class XI and expertise of the investigator.

To conduct this study, a teaching module for story problem learning environment was framed as a sequence of progressive chunks through which the learner is escorted with proper cognitive scaffolds. This included 5 steps (Praveen, 2016)

Step I Identify the problem type.

Step II Identify the problem schema.

Step III Imagine and draw the situation.

Step IV With situation in mind, superimpose data on problem schema.

Step V Substitute, Calculate and Reflect.

In Experimental Group 1, the students were taught the theory of one dimensional motion (using the expository method of teaching) during the usual class hours in the face to face mode and the problems were asked to be done as home work in the virtual learning environment on the Moodle platform (using schema based learning). This software gave the necessary instructions towards introducing schema based learning, the necessary conceptual background of the theory portion in physics and then did stepwise hand-holding of doing physics problems. Later after getting familiarised with worked examples, the software would also test

them by giving practice problems in a self paced manner. The course can be accessed through a guest password (4444) available at http://courses.prama.org.in/login/index.php.

In the Experimental Group 2, the theory portion was taught in the usual expository method of teaching and the problems were dealt in the schema based method of instruction but without Moodle (using the chalk and talk method).

In the Control Group the theory portion was taught using the expository method of teaching and the problems were dealt in the usual drill method by a regular teacher in the school.

The same set of problems was given to the experimental groups and control group for practice and homework. The difference between the post-test and the pre-test (the gain score) was taken as a measure of the Problem Solving Ability.

Logical-Mathematical Intelligence and the dependent variable – gain in Problem Solving Ability respectively for the three study groups are given in Table 3a and 3b.

Table 3a

Distribution of non-verbal intelligence in the study groups

Study Group	N	Mean	Std. Deviation
EG 1	33	48.00	4.366
EG 2	49	44.98	4.356
CG	31	48.45	4.668

EG: Experimental Group, CG: Contol Group

Table 3a shows that the mean and standard deviation of non verbal intelligence in the three groups do not vary too much *prima facie*.

Table 3b

Distribution of Logical-Mathematical Intelligence in the study groups

Study Group	N	Mean	Std. Deviation
EG 1	33	18.42	3.734
EG 2	49	18.12	4.111
CG	31	18.48	4.411

EG: Experimental Group, CG: Control Group

Table 3b shows that the mean and standard deviation of Logical-Mathematical Intelligence of the three groups do not vary too much *prima facie*.

Results

The feedback towards schema based learning was studied with the help of a simple questionnaire with eight items and the responses were subjected to percentage analysis. The consolidated responses along with questions are presented in Table 4 for both the groups – with LMS and without LMS.

Table 4

Analysis of Responses of the Students

Question Item	With LMS/ without LMS	Totally agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Totally Disagree (%)
1. I carefully attended to the schema based problem solving procedures of all the worked examples.	Without LMS	73.91	21.73	4.34	0	0
	With LMS	51.52	48.48	0	0	0

2. It was easy to understand the worked examples.	Without LMS	54.34	41.30	4.34	0	0
	With LMS	45.45	54.55	0	0	0
3. The explanation and teaching style of the Online course / teacher was student friendly.	Without LMS	84.78	13.04	2.17	0	0
	With LMS	48.48	51.52	0	0	0
4. The diagrams and figures related to schema based problem solving are interesting.	Without LMS	54.34	43.47	2.17	0	0
	With LMS	66.67	33.33	0	0	0
5. I enjoyed doing my home work.	Without LMS	39.13	45.65	13.04	0	2.170
	With LMS	66.67	33.33	0	0	0
6. I think that schema based problem solving is helpful in doing problems.	Without LMS	67.39	28.26	4.34	0	0
	With LMS	36.36	60.61	0	3.03	0
7. I will use schema based problem solving in future if I get right opportunity.	Without LMS	54.34	39.13	4.34	2.17	0
	With LMS	27.27	69.7	0	0	3.03
8. I did all the homework questions given to me.	Without LMS	45.65	39.13	13.04	2.17	0
	With LMS	78.79	21.21	0	0	0

The analysis of feedback suggested that schema based learning was equally appreciated by both groups of learning — with LMS and without LMS. When we further look into the responses, we find that those questions 1,3,6, and 7, which depends on the personal qualities of the teacher, were highly appreciated by the group that did not use LMS whereas those questions 2,4, 5, and 8 represent the strength of the LMS, namely easiness to comprehend worked examples, interesting diagrams and illustrations, and ease of doing homework.

The effect of the Instructional Strategy upon the Problem Solving Ability was tested using ANCOVA. A one way ANCOVA was performed to determine if a statistically different significant difference existed between schema based instruction using Moodle, schema based instruction without Moodle, and drill method of instruction on the Problem Solving Ability (gain score of Problem Solving Ability). Table 5 shows the result of the ANCOVA performed for the total sample.

The variables Nonverbal Intelligence and Logical-Mathematical Intelligence were controlled as the investigator felt that these were the major confounding variables that would affect the dependent variable of this study.

Table 5 describes the one-way ANCOVA conducted to compare the effectiveness of three instructional strategies whilst controlling for Nonverbal Intelligence and Logical-Mathematical Intelligence. Levene's test ($F(2,110) = 1.079$, $p=.344$) and normality checks using normalised Q_Q plots (Figure 2)

Table 5

Summary of ANCOVA of Problem Solving Ability

Source	Sum of Squares	df	Mean Square	F	p-level	Partial Eta Squared
Nonverbal Intelligence	8.680	1	8.680	.442	.508	.004
Logical-Mathematical Intelligence	90.550	1	90.550	4.612	.034	.041
Instructional Strategy	472.944	2	236.472	12.045	.000	.182
Error	2120.361	108	19.633			

were carried out and the assumptions met. There was a significant difference in mean gain of Problem Solving Ability [F (2,108) =12.045, p=.000] between the instructional strategies. The partial Eta Squared value indicates the effect size is small (0.18). Post hoc tests showed that there was a significant difference between Instructional Strategies 1 and 3 (p = 0.000) and Instructional Strategies 2 and 3 (p = 0.007). Comparing the estimated marginal means showed that the most gain of Problem Solving Ability was achieved on schema based instruction using Moodle (mean=12.502 scores) compared to drill method of instruction (7.095 scores). Similarly, schema based instruction using Moodle was superior to the drill method of instruction (mean=10.449 scores, 7.095 scores, respectively). And the post hoc test suggests that using of the learning management system is in no way inferior to the instructional strategy in which the teacher directly teaches using schema based problem solving. In fact, the estimated marginal means suggest an improvement in scores (even though not statistically significant) while employing the learning management system—Moodle to teach problem solving by the schema based learning method.

Comment

This result supports the research studies which show that schema based instruction is highly effective in increasing Problem Solving Ability in doing word problems. The result is

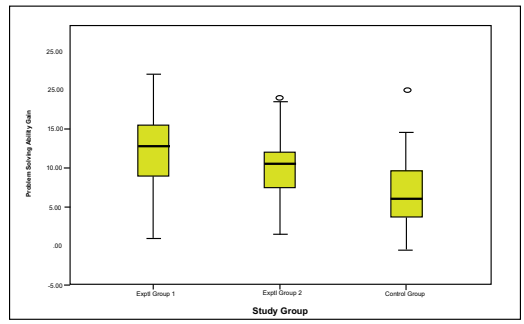

Fig. 2: Categorised Box Plot for the study groups for the dependent variable: Problem Solving Ability.

also in tune with earlier studies suggesting Moodle platform as a good learning environment to foster problem solving skills (Triyanto, et al., (2016); Lin (2011)). This new study combining the two strategies, viz; the schema based instruction and Moodle based learning environment has produced a very productive and promising result on increasing Problem Solving Ability in solving story problems.

Conclusion

The feedback from students reveal the strength of the LMS, namely, easiness to comprehend worked examples, interesting diagrams and illustrations, and ease of doing homework.

We realise that for teaching problem solving, schema based learning with Moodle increases the Problem Solving Ability of higher secondary school students in physics when compared to the usual drill method of teaching. As the schema based learning is superior to the usual drill method of teaching problem solving, one may suggest using this method in the higher secondary classrooms. But as this would demand lot of training for teachers and great effort and expertise from the part of teachers, it may not be a suitable option to insist teachers to gain expertise in schema based problem solving and to employ this strategy instead of the traditional drill method. A learning management system (LMS) with standardised modules using schema based learning can certainly help teachers to recommend the appropriate modules in the LMS to be done by the students in a self paced manner.

Thus if an LMS is prepared by pool of expert teachers using the elements of schema based learning and if this is hoisted on an online learning environment such as Moodle, it could benefit the students to gain expertise in solving story problems in a non-threatening and homely environment. This will also take away the burden of an ordinary higher secondary school teacher who struggles to complete the theory portion in time and finds it difficult to devote quality time to teach solving of story problems in physics.

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