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Original Article

The Effects of Personalized Learning on Achieving Meaningful Learning Outcomes

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ABSTRACT

Background: The modern world demands an effective educational approach to meet its requirements. In this study, the modern taxonomy of significant learning was applied to investigate the impact of personalized learning on achieving learning objectives.

Methods: The study utilized an experimental pretest-posttest control group design. Thirty undergraduate educational sciences students from Allameh Tabataba'i University participated in our study. They enrolled in the media education course in the spring semester of 2019-2020, and were randomly assigned to experimental and control groups. The learning topic was "media message analysis," and lesson objectives were defined based on the taxonomy of significant learning required for modern world. Personalized learning was implemented in an online environment for the experimental group. By choosing authentic assignments, we provided the students with learning paths based on their cognitive styles and gave them a sense of control over their own learning. Students in the control group received an online "one-size-fits-all" education. The engagement questionnaire was used to evaluate integration, human dimension, and categories of significant learning taxonomy; to measure students' ability to control their learning, an online self-regulated learning questionnaire was employed. A researcher-made exam was designed to measure content mastery in fundamental knowledge and application categories. All three measurement tools were applied at baseline and two weeks after the intervention. The independent t-test was used to compare the two groups in each related category.

Results: The results revealed that a personalized learning approach could lead to significant improvement in content mastery, cognitive, agentic, and emotional engagement, as well as self-regulated learning in the experimental group (P=0.007, 0.02, 0.048, 0.048, <0.001, respectively).

Conclusion: Teachers can help students achieve different categories of significant learning taxonomy through applying personalized learning to their courses. Therefore, implementing a personalized learning environment is recommended for higher education.

Keywords: Personalized learning, Taxonomy of significant learning, Academic achievement, Engagement, Self-regulation

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Introduction

The concept of education in the Information Age needs to be differentiated from its Industrial Age counterpart, which was perceived as a process of mass production wherein learners all studied the same thing at the same time and were assessed in the same way (1). If higher education intends to make a more meaningful educational experience for students, an efficient approach needs to be taken that focuses on the quality of student learning (2).

Personalized learning as a learner-centered approach has become significantly important in modern societies; however, it has not been fully adopted in our educational systems (3, 4). National Academy of Engineering has listed advanced personalized learning as one of the 14 Grand Challenges of the 21st century alongside the advancements in reverse-engineering the brain and engineering better medicine (5).

The personalized learning approach should focus on individual learners and best respond to their needs, accommodating their choices and goals rather than developing a system that automatically adapts to individuals' characteristics (3). Although personalized learning has been a topic of much research, there is no readily agreed-upon definition of the term (6–8). The U.S. Department of Education (9) defines personalized learning as "instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional approaches, and instructional content (and its sequencing) all may vary based on learner needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests, and often self-initiated" (p. 7).

Walkington and Bernacki (10) have conceptualized three dimensions to describe different approaches to personalized learning. First, personalized learning can take place at various levels of depth, implying the extent to which authentic experiences of learners are taken into account. Second, it can be defined at different grain sizes where the learning process is personalized for individuals in small or large groups based on similar characteristics. And finally, personalized learning can provide learners with different degrees of control in their learning process. Based on these dimensions, in this research, the personalized learning approach was applied to small groups clustered by learners' cognitive styles, and they were able to choose among authentic assignments.

Alamri et al. (6) conducted a qualitative comparison study, examining the perceived efficacy of personalized learning on students' psychological need satisfaction and intrinsic motivation, as well as exploring its effect in terms of meeting learners' needs and interests in an online course. Overall, the study results showed that having a choice in selecting the course project leads to learner satisfaction and intrinsic motivation. In addition, interview results revealed that providing a personalized learning path based on learner needs and interests could augment the learning experience.

Walkington et al. (11) implemented personalized learning among 24 Algebra students. Sets of story problems and personalized problems based on students' out-of-school interests were presented. The results revealed that personalization had an impact on the performance of the students with poor mathematical achievement, and improved their problem-solving skills for complicated mathematical structures. Students made fewer conceptual errors in dealing with personalized problems and described them as easier and more relevant to their lives. Therefore, establishing a connection with learners' real life is an essential factor.

The existing literature has mostly focused on evaluating the effects of personalized learning on content mastery, performance, and attitude towards learning environments. To achieve significant learning goals, it is also essential to improve student attitudes towards the study subject itself, taking into account the human dimensions and individual approaches in learn skills, as elaborated in this study.

To implement personalized learning, teachers need to choose the personalization

parameters that are consistent with learner characteristics and course specifications. A personalization parameter defines a number of individual needs and characteristics such as prior knowledge, cognitive style, and motivation (12). Cognitive style represents relatively stable patterns in an individual's manner of information processing, which can be conceptualized as distinct adaptations to the surrounding world (13). In their study, Tsianos et al. (14) evaluated "whether the construct of cognitive style can constitute a meaningful personalization factor" (p. 248). The empirical evaluation in their study revealed that information retention among users was more accurate and efficient, both in terms of their performance in the online exam and assigned task, and completing the task on time (14).

To determine the quality of personalized learning approach, different criteria can be evaluated. People may have different views on what constitutes quality education; however, without a doubt, students' academic achievement is a critical part of education quality. "Academic achievement is the degree to which learning objectives are realized in students" (15). Therefore, to evaluate the quality of education, we must pay attention to students' academic achievement and their related learning objectives accordingly.

Learning objectives must be redefined to address the concerns about applying an effective educational approach and to meet the skill requirements in modern age. When asked about the expected outcomes of their courses, many teachers may point to Bloom's well-known taxonomy of educational objectives, formulated in the 1950s. However, Fink (2) believes that learning objectives have to be defined differently within the concept of "learning-centered higher education". In this sense, Bloom's taxonomy does not cover all aspects of learning, which are essential in the modern age, including learning how to learn, the ability to adapt to change, interpersonal skills, ethics, communication skills, character, tolerance, and leadership. Therefore, Fink (2) introduced the taxonomy of significant learning with six categories listed in Table 1.

Table 1. Taxonomy of significant learning

Category	Sub-categories
Foundational Knowledge	Conceptual understanding
Application	Critical thinking
	Practical thinking
	Creativity
	Managing complex projects
	Performance skills
Integration	Interdisciplinary learning
	Learning communities
	Learning and living and working
Human dimension	Leadership
	Ethics, character building
	Self-authorship
	Multicultural education
	Teamwork
	Citizenship
	Serving others (local, national, world)
	Environmental ethics
Caring	Wanting to be a good student
	Becoming excited about a particular activity or subject
	Developing a commitment to live well
Learning to learn	How to be a better student
	How to inquire and construct knowledge
	How to pursue self-directed or intentional learning

The underlying question is how educators can be confident about the quality of personalized learning as a means of preparing students to meet the modern world's required skills. This research utilizes the taxonomy of significant learning as a suitable taxonomy for learning-centered higher education, and thereby aims to evaluate the quality of personalized learning by the degree to which learning goals are achieved. Therefore, the main hypothesis of this research is that there is a difference between students receiving personalized learning and those receiving common "one-size-fits-all" education in achieving significant learning goals.

Methods

Study Design

This was an experimental study with pretest-posttest design and control group.

Participants

Eligibility Criteria for Participants

The inclusion criteria were all undergraduate students who enrolled in the Media Education Course and willing to participate in the study. All the students who were reluctant to continue their participation in this study were also excluded.

Setting

The study population included undergraduate educational sciences students of Allameh Tabataba'i University who enrolled in the Media Education Course in the spring semester of 2019-2020.

Intervention

The experimental group received online personalized learning, and the control group received common online lessons, both using the Moodle learning management system (LMS). The Moodle was chosen because students at this university were already using it, and there were not any interfering variables regarding using the system. The chosen learning topic in this study was "media message analysis". After completing the pretest, students had two weeks to study the lesson and complete the assignments. They could access the lesson materials anytime and anywhere. At the end of two-week deadline, the posttest was taken.

Since media message analysis is a problem-based lesson and requires information processing skills, cognitive style was chosen as an appropriate personalization parameter in this research. In addition to the pretest, students in the experimental group responded to the cognitive style indicator (CoSI) (16) with a 0.79 Cronbach's alpha coefficient to determine their cognitive style. Students in the experimental group were assigned to three subgroups based on their cognitive style to receive personalized instructional strategies on their learning path. The three subgroups were 'knowing', 'planning', and 'creating'. People with a 'knowing' style look for facts and data. They want to know precisely the way things are and tend to retain many facts and details. Therefore, the 'knowing' subgroup in this study encountered a learning environment that provided them with details of each learning content and its reason. Planners like to organize and control and prefer a well-structured work environment. Therefore, the 'planning' subgroup faced a learning environment that gave them an overview of all the steps and showed them where they were on their learning path. People with a 'creating' style tend to see problems as opportunities and challenges, like uncertainty and freedom. Therefore, students in the 'creative' subgroups faced a learning environment that allowed them to go through any content they were curious about.

In the experimental group, students could also choose between assignments associated with their interests, preferences, or background knowledge. Assignments were authentic and problem-based. Students had to solve the problems by analyzing a media message in their chosen context and extracting meaningful elements of the message from it.

A discussion forum was also designed for each subgroup as a means of scaffolding and interaction between the instructor and students and students by themselves. The

instructor analyzed one media message example step by step based on the rules instructed. Students could ask and discuss any questions regarding the solved problem or their own media message analysis problems. After submitting the first assignment, each student received personal voice feedback regarding his/her chosen assignment.

In the control group, all students received similar instructional content in their LMS. They had no option to choose between assignments and were obligated to deliver the same assignment indicated by the instructor. The control group faced a common online learning environment that served "one-size-fits-all" education. They received general feedback on their assignment.

Data Collection Tools

To evaluate academic achievement, the learning objectives and their mode of assessment have to be defined. The learning objectives of the media message lesson are defined based on the significant learning taxonomy shown in Table 2. To measure the degree of attaining these objectives, three measurement tools were used in this research:

1. Reeve and Tseng's engagement questionnaire was used to assess the integration, human dimension, and caring categories of significant learning taxonomy indicated in Table 2. This questionnaire has

Table 2. Significant learning objectives for media message lesson

Significant Learning objective	Category in the taxonomy of significant learning	How to measure it
Define media message concept. Define media message analysis. Explain important factors in selecting a media message to analyze. Explain the three approaches in analyzing media messages. Define the analytical dimension concept. Explain the four steps of media message analysis.	Fundamental knowledge	Exam
Determine the appropriate approach to apply for a particular media message analysis. Determine the analytical dimension of a media message. Identify components of an analytical dimension. Extract message elements associated with specific analytical dimension components	Application	Exam
Try to connect media messages analysis skill to their real-life experiences. Try to relate what they are learning to what they already know. Try to make all the different ideas of media message analysis approaches fit together and make sense. Makeup their own examples to understand the concepts.	Integration	Engagement questionnaire (Cognitive engagement subscale)
Let their teacher and classmates know what they need and want to accomplish the lesson. Let their teachers and classmates know what they are interested in media messages analysis. Express their preferences and opinions about media messages analysis skills. Ask questions to help them learn.	Human dimension	Engagement questionnaire (agentic engagement subscale)
Getting curious about media messages surrounded them in the real world. Getting interested in analyzing media messages by identifying their analytical dimension, components, and elements.	Caring	Engagement questionnaire (Emotional engagement subscale)
Acquire self-regulation skills in conducting their study and their steps toward analyzing a media message.	Learning to learn	OSLQ

17 items using a 1-7 Likert-type scale, having values ranging from the maximum score of 7 for 'strongly agree' to the minimum score of 1 for 'strongly disagree'. It measures four aspects of student engagement: agentic engagement, behavioral engagement, emotional engagement, and cognitive engagement. The cognitive, agentic, and emotional engagement subscales are particularly appropriate for measuring the stated objectives in Table 2. The questionnaire has a 0.85 Cronbach's alpha coefficient (17) and a 0.92 Cronbach's alpha coefficient in the Persian version (18).

2. The Online Self-regulated Learning Questionnaire (OSLQ) (19) was used to measure self-regulation in our online learning environment to assess the learning to learn category. It has 24 items using a 1-5 Likert-type scale, having values ranging from the maximum score of 5 for 'strongly agree' to the minimum score of 1 for 'strongly disagree'. Its Cronbach's alpha coefficient for the online environment is 0.90 (19) and in the Persian version is 0.89 (20).

3. A researcher-made exam was designed to measure content mastery in the fundamental knowledge and application categories. The exam's face and qualitative content validity were confirmed by five professors from Allameh Tabataba'i University, experts in media education. The exam had 10 multiple-choice questions with a minimum score of 0 and a maximum score of 1 for each question. Prior to the intervention, the exam's test-retest reliability was assessed at an interval of 15 days by another group of undergraduate educational sciences students. The result revealed appropriate reliability with a Pearson's correlation coefficient of $r(28) = 0.81$, $P<0.001$.

Sample Size and Randomization

The mixed sampling method was used in this study. In the first stage, by applying the convenient sampling method, 32 undergraduate educational sciences students of Allameh Tabataba'i University who enrolled in the media education course in the spring semester of 2019-2020 were selected. The reason behind choosing the convenient sampling method was that the media education course was suitable for authentic problem-based assignments, which are the elements of personalized learning.

In the second stage, they were randomly assigned into experimental and control groups by applying the simple randomization technique. Fifteen students were allocated to the experimental group, and 17 students were allocated to the control groups.

Statistical Methods

To test the main hypothesis of this research, "there is a difference between students who receive personalized learning and students who receive common "one-size-fits-all" education in achieving significant learning goals," the data from three measurement tools were collected and analyzed by SPSS 25. The normality of pretest and posttest data in the experimental and control groups was verified, and independent t-tests were applied to compare the two groups.

Ethical Considerations

The research proposal was approved by the Graduate Education Council of the psychology and educational sciences department of Allameh Tabataba'i University. All participants were fully aware of the study's nature and confidentiality. They were told in advance that their information would remain confidential and would not affect their score. They could also decline to continue their participation at any stage of the research.

Results

Thirty-two students were recruited through simple random sampling. Two students from the control group declined to continue their participation; therefore, their data were eliminated. In the end, there were 12 females and 3 males in the experimental group and 14 females and 1 male in the control group, making the study size equal to 30 participants. The two groups were homogenous in terms of demographic data (Figure 1).

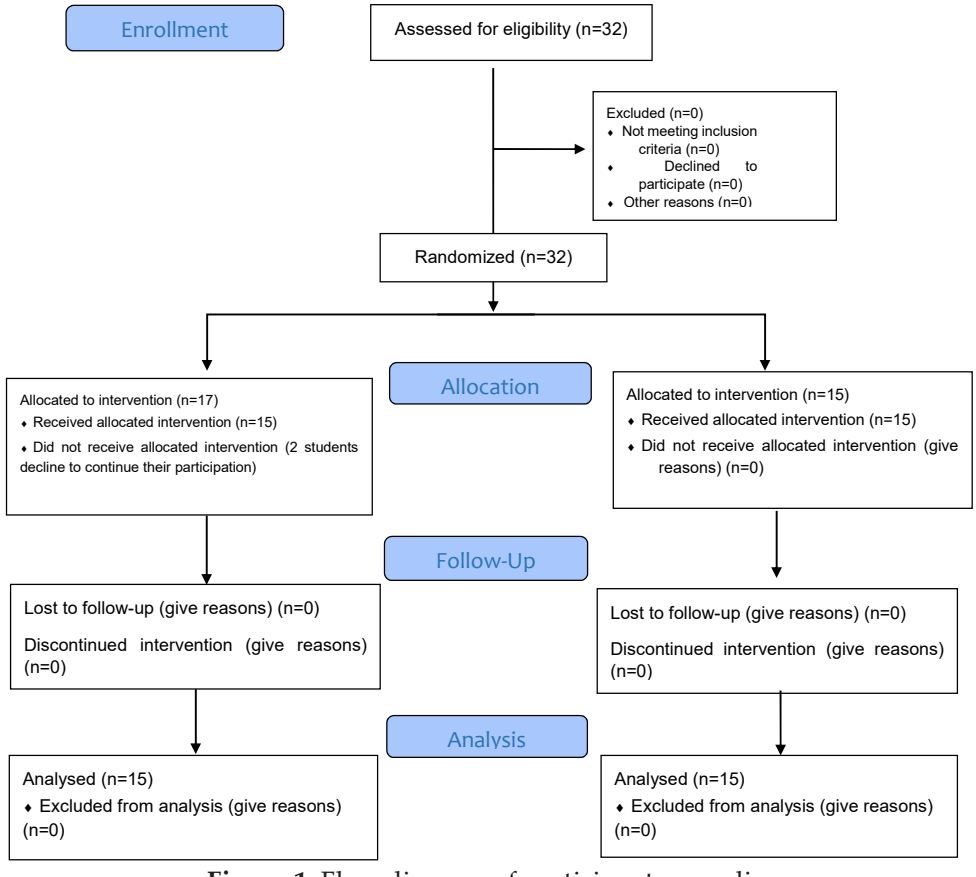

Figure 1. Flow diagram of participants sampling

To verify the initial knowledge, engagement, and self-regulation equality of two groups, the groups' pretest results were compared by employing the independent t-test as shown in Table 3.

The P values of all independent t-test of pretests were above 0.05, confirming no significant differences between the content mastery, engagement, and self-regulation of students in experimental and control groups.

To test the main hypothesis, the results of all three measurement tools had to be verified in order to achieve the significant learning goals, according to Table 2. Independent t-test results of posttest by reducing the pretest effect for all three measurement tools were computed as shown in The P values of the independent t-test of the exam and OSLQ were less than 0.01, indicating that with a 99% confidence level, there was a significant difference between fundamental knowledge, application, and learning to learn students' goals and achievements in the experimental and control groups.

The three subscales of cognitive, agentic, and emotional in the engagement questionnaire were in accordance with the integration, human dimension, and caring categories in the taxonomy of significant learning presented in Table 2; therefore, the results of those are reported in Table 4. The P values of cognitive, agentic, and emotional engagement were less than 0.05, indicating that with a 95% confidence level, there were significant differences between achieving integration, human dimension, and caring goals in experimental and control groups.

Main Results

By studying the results of independent t-tests on data collected from all the three measurement tools, we concluded that with at least 95% confidence level, the main hypothesis of this research is approved, and there is a significant difference between students who receive personalized learning and students who receive standard "one-size-fits-all" education in achieving significant learning goals.

Table 3. Comparing pretest results of two groups (equal variances is assumed)

Measurement tool	Group	N	Mean	Std. Deviation	Mean Differences	t-test	df	P value
Exam	Experimental	15	4.33	1.45	-0.27	-0.512	28	0.61
	Control	15	4.60	1.40				
Cognitive engagement subscale	Experimental	15	4.57	1.26	0.38	0.758	28	0.45
	Control	15	4.18	1.5				
Agentic engagement subscale	Experimental	15	3.93	1.4	0.32	0.569	28	0.57
	Control	15	3.61	1.67				
Emotional engagement subscale	Experimental	15	3.68	1.28	-0.9	-1.59	28	0.12
	Control	15	4.58	1.78				
OSLQ	Experimental	15	16.01	3.23	-1.56	-1.3	28	0.21
	Control	15	17.57	3.35				

Table 4. The exam, OSLQ, and engagement t-test results (equal variances is assumed)

Measurement tool	Group	N	Mean	Std. Deviation	Mean differences	t-test	df	P value
Exam	Experimental	15	3.2	1.74	2.2	2.9	28	0.007
	Control	15	1	2.36				
OSLQ	Experimental	15	3.8	2.00	3.7	4.64	28	<0.001
	Control	15	0.14	2.35				
Cognitive engagement	Experimental	15	1.03	0.85	1.01	2.39	28	0.02
	Control	15	0.02	1.4				
Agentic engagement	Experimental	15	0.96	0.8	1.02	2.06	28	0.048
	Control	15	-0.07	1.75				
Emotional engagement	Experimental	15	1.03	1.01	0.97	2.06	28	0.048
	Control	15	0.07	1.5				

Discussion

The results revealed that by applying the personalized learning approach, students' content mastery, engagement, and self-regulation are enhanced and can effectively reach different aspects of significant learning categories.

As the learning paths and their instructional strategies are designed based on each student's cognitive style, the learning environment is compatible with how each student processes information in his/her brain. Therefore, cognitive style as a personalized learning parameter can significantly affect content mastery, cognitive engagement, and self-regulation. The result of (14) also confirms that cognitive style can serve as a meaningful personalization parameter and affect the accuracy and efficiency of a learner's information retention. Moreover, these results follow the results of (21, 22), which considers cognitive style as an environmentally sensitive individual difference in cognition and as a variable in e-learning, and (23) explored the impact of cognitive style profiles on different learning approaches.

A variety of assignments related to students' real-life were also designed in this study. Students in personalized learning subgroups had control over their learning process. They had a choice of selecting their assignments, and their selections were based on their own interests and their background knowledge of a specific assignment. Having a choice enhanced intrinsic motivation, task performance, and perceived competence, which led to cognitive and emotional engagement in this experiment. The result of qualitative research (24) also confirms that teachers may benefit from balancing freedom and limitations in personalized learning

classes by framing choices and bringing students' voices into account.

As the assignments were about analyzing authentic media messages, students faced real-world challenges. When students selected an authentic assignment, they tried to connect what they were learning to what they had already known and connected them to their real world, leading to cognitive engagement. This design follows the learner-centered paradigm of education advocated by (25) and follows the personalized task selection principle in the universal principle of personalized instruction proposed by (3). The results revealed that being independent, having control over the learning process, and solving authentic problems, which are components of the personalized learning approach, can affect achieving significant learning goals. These results are also confirmed by the results of (6, 11), where task relevance to students' real world augments their attitude and performance.

An active discussion forum allowed the students to express themselves and let the instructor become aware of their issues, which could lead to agentic engagement. Personal feedback and instructional strategies on how to learn the media message analysis skill helped the students acquire the learning how to learn skills for this specific lesson. The discussion forum was also used in the study of (6) to provide opportunities for discussing topics within the different pathways and across the pathways and provided opportunities for students to receive feedback from others with similar learning pathway interests. The qualitative results of (6) confirm that students found these interactions useful for their learning.

Therefore, by implementing different aspects of personalized learning in this study, which are personalized learning paths, control over choosing the assignments, authentic assignments, and scaffolding technique application through a discussion forum and personal feedback, students could achieve different categories of significant learning taxonomy effectively.

Limitations

This research revealed that the personalized learning approach could help teachers make lasting changes in their students' learning. However, designing, developing, and maintaining a personalized learning environment increases teachers' workload and requires learning more technical skills. Besides teacher training, it is strongly recommended that educational technologists be engaged more seriously in all higher education institutes to design, develop, evaluate, and maintain the personalized learning environment needed for modern higher education.

Ethical Considerations

The research proposal is approved by the Graduate Education Council of the psychology and educational sciences department of Allameh Tabataba'i University. All participants were fully aware of the study's nature and confidentiality. They were told in advance that their information would remain confidential and would not affect their score. They could also decline to continue their participation at any stage of the research.

Authors' Contributions

This study was excerpted from R.A.'s doctoral dissertation under M.NA's and F.T.'s supervision, and in consultation with K.A. and S.PA.

Conflict of Interest

The authors declare that they have no conflict of interest.

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