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The effect of employing project-web learning approach in teaching mathematics instruction methods course on developing the mind habits among Dhofar University students

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Abstract

The aim of the current research is to evaluate the impact of utilizing project-based learning (PBL) approach through online platforms in teaching mathematics teaching methods on the cultivation of students' habits of mind at Dhofar University. The study employed an experimental approach, specifically a semi-experimental design with a single group (pre-post). The research sample consisted of 33 students enrolled in the third year of the mathematics education program within the college of arts and applied sciences at Dhofar University in Salalah. Data collection was conducted by administering the habits of mind scale to the sample during their enrollment in the mathematics teaching methods course. This scale comprised 48 items, equally distributed across 16 mental habits. The experimental treatment was implemented over a duration of 15 weeks. Statistical analysis of the data was performed using the SPSS software (version 22), employing measures such as mean, standard deviation, t-test for correlated samples, and eta-square (η^2). The research findings revealed statistically significant differences ($p < 0.01$) between the pre and post applications of the habits of mind scale among the research sample, favoring the post-application phase. Based on these results, the research recommends the inclusion of PBL approaches via online platforms in teacher preparation programs, particularly those specializing in mathematics education. This would facilitate the development of students' habits of mind, consequently positively impacting their academic performance and future students' performance.

Keywords: e-learning, project-web learning approach, mind habits, mathematics instruction methods, Dhofar University, Oman

INTRODUCTION

Mathematics is widely recognized as a vital field of knowledge and a cornerstone of scientific and human development. It holds significant applications across various domains and is characterized by its inherent qualities of flexibility, cumulativeness, inference, and synthesis. This has earned it the reputation of being the foremost discipline or "queen of all sciences," as referred to by Elsayed and Aloufi (2023).

Habits of the mind play a crucial role in the teaching and learning of mathematics. They are fundamental outcomes that enhance learners' comprehension of mathematics in all its branches (Costa & Kallick, 2003). Moreover, they serve as the framework and bedrock for learners to engage in diverse mathematical thinking skills. Possessing the requisite thinking skills and strategies alone is insufficient if learners lack the inclination or motivation to develop and apply them appropriately within specific contexts and situations (Tishman, 2000).

Mental habits are characterized by intelligent behavior patterns that facilitate the generation of knowledge, rather than mere recall or reproduction of existing information (Marzano, 1998). It is noteworthy that cultivating mental habits aids learners in organizing

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Contribution to the literature

- This study explores the integration of Problem-Based Learning (PBL) with online platforms in teaching mathematics methods to prospective teachers, focusing on developing 16 specific habits of mind.
- Conducted at Dhofar University in Oman, it provides empirical evidence from a less-represented context, contributing to the global relevance of PBL and technology-enhanced learning.
- The findings suggest that fostering habits of mind in pre-service teachers can positively influence both their future performance and that of their students, adding to the literature on teacher preparation.

their knowledge, effectively managing their ideas, and training them to approach problems from new perspectives, thereby enhancing their problem-solving capabilities (Johnson, 1992).

To uphold the significance of mathematics and its potential to achieve diverse learning outcomes, particularly through the application of various habits of the mind, the National Council of Teachers of Mathematics (NCTM) (2000) emphasizes the importance of prioritizing understanding in In this regard, numerous recommendations have been put forth advocating the utilization of multiple teaching approaches and strategies in mathematics education. These approaches should prioritize the acquisition and development of concepts, while also promoting the practice of different habits of mind during the teaching and learning processes (Abu Al-Rayyat, 2014; Elsayed & Almahri, 2023; Mandacı Şahin & Kendir, 2013).

One of the emerging educational portals in recent years is the web-based project-based learning (PBL) platform, which combines e-learning with PBL. This platform is considered an integrated, interactive, and effective learning environment (Saraya, 2014).

Web-based PBL aligns with constructivist learning approaches, which emphasize that learning is an active, reflective, and constructive process taking place within a realistic social context. It encourages the practice of social negotiation skills within authentic learning environments that are rich in diverse learning resources. These methods encompass various educational strategies and systems, such as problem-based learning, cooperative learning, realistic learning, deep learning, and discovery learning (Ching, 2016).

This platform is regarded as a suitable teaching and learning method for preparing, training, and developing the skills of students and teachers. It enables the use of web-based electronic tools to engage students and foster collaboration in the implementation of their projects. Additionally, it allows for the utilization of electronic resources available on the web to access and exchange information between students and their teachers (Abdul Karim, 2020; Ibrahim, 2015).

Therefore, the current research aims to conduct an experiment involving the implementation of a web-based PBL approach in the methods of teaching mathematics course for students at Dhofar University. The primary objective is to evaluate the influence of this approach on the cultivation of habits of mind among these students.

Research Problem and Questions

Based on the researcher's extensive practical experience of 15 years in teaching educational courses to students at the college of arts and applied sciences at Dhofar University, it has become evident that a significant number of these students exhibit a low level of engagement in practicing habits of mind during the learning process. This observation was further confirmed through a prospective study conducted by the researcher, which involved analyzing the performance indicators of 60 female students in the final exams of courses such as methods of teaching mathematics, developing mathematics curricula, and methods of evaluating mathematics during the academic year 2020/2021. Specifically, the study focused on assessing the students' performance on questions that measure higher-order cognitive abilities such as analysis, synthesis, and evaluation.

The findings revealed that the average achievement of these students on the higher-order cognitive questions was only 3 marks out of a maximum score of 10, representing a mere 30% of the total possible points. In contrast, their performance on questions assessing lower-order cognitive abilities such as knowledge, understanding, and application yielded an average score of 21 out of 30, corresponding to 70% of the total points. These results strongly indicate a lack of practice in habits of mind and critical thinking skills among the students during their learning process.

These findings highlight the pressing need to address and improve students' engagement in habits of mind and higher-order thinking skills. By doing so, it is expected that students will enhance their academic performance and develop the necessary cognitive abilities for success in their studies and future endeavors.

The findings of the previous exploratory study were consistent with the results of another study conducted by Al-Sayed and Al-Saadi (2022). In this study, a measurement tool assessing habits of mind was administered to 34 female students from the department of education at Dhofar University on April 6, 2021. The average score obtained by these students on the scale

was 163 out of a maximum score of 240, corresponding to a percentage of 67.91%.

Despite the efforts made by the Ministry of Education in the Sultanate of Oman to enhance mathematics education through initiatives like the Cambridge curriculum series and participation in international assessments such as TIMSS, the teaching and learning of mathematics still heavily emphasizes knowledge acquisition rather than the practice of thinking skills and habits of mind. The results of the TIMSS tests indicated a relatively low performance of Omani students in basic education compared to students from other countries. The average score of Omani students in those tests was 416 points, whereas the international average was 500 points (Ministry of Education, 2018).

Several studies, including those conducted by Abdel-Wahhab (2007), Al-Hinai et al. (2020), Al-Sayed and Al-Saadi (2022), and Sadiq (2011), have emphasized the importance of developing habits of mind among Omani students in the context of mathematics and science education. They have highlighted the positive impact of habits of mind on students' academic achievement, critical thinking, problem-solving abilities, effective communication, and as essential requirements for success in the 21st century.

These recommendations align with the stance of prominent educational organizations such as NCTM, the National Research Council, and the National Assessment of Educational Progress. These organizations emphasize the significance of students acquiring habits of mind as a fundamental outcome of learning mathematics (Al-Moatham & Al-Manoufi, 2017; Ovez, 2012).

Therefore, the current research tries to answer the following questions:

1. What are the habits of mind that should be practiced by the students of Dhofar University during their learning of the method of teaching mathematics course?
2. What is the appropriate instructional design to employ the PBL approach via the web in teaching the course of methods of teaching mathematics to the students of Dhofar University?
3. What is the effect of employing the web-based project learning approach in teaching mathematics teaching methods on the development of habits of mind among Dhofar University students?

Research Limits

The current research was limited to the following limits:

1. Collaborative projects via the web, considering the nature of the course and the needs of students. Collaborative projects are distinguished from individual projects by several advantages, the most important of which is the development of communication and cooperation skills between students, and the production of works characterized by accuracy.
2. The basic habits of the mind represented in (self-regulation, critical thinking, and innovative thinking), and what they contain of 16 sub-mental habits, because they are the most suitable habits for the nature and characteristics of the female students in the study sample, as well as the age and academic stage that they go through.
3. Third year female students majoring in mathematics education at the college of arts and applied sciences at Dhofar University, Salalah, Sultanate of Oman.
4. Mathematics teaching methods course that is taught to these students, because the content of this course includes many aspects of learning that are compatible with different thinking skills and habits of mind, and it is taught inside the mini-teaching room that is equipped with various technological means and methods.
5. The study was conducted during the academic year (2021/2022).

Search Terms

The researcher adheres to the following procedural definitions of the research terms:

1. **PBL on the web:** Learning is based on a structured set of procedures and steps that enable third-year students specializing in mathematics education at Dhofar University to engage in activities, assignments, and projects within an electronic learning environment. Through the use of tools and interaction techniques, students are guided and supervised by the course instructor to develop and enhance their habits of mind.
2. **Habits of mind:** Habits of mind refer to a set of cognitive behaviors that enable third-year students specializing in mathematics education at Dhofar University to effectively utilize their mental abilities in acquiring the various aspects of learning covered in the methods of teaching mathematics course. These habits of mind involve leveraging their existing knowledge, experiences, and capabilities within their cognitive framework to enhance their performance and proficiency. By employing these habits, students can generate innovative solutions to challenges and problems they encounter, as well as enhance their decision-making and judgment skills. The measurement of these habits of mind is assessed through the use of a dedicated scale specifically designed for this purpose.

Research Hypothesis

The analysis of the data collected using the habits of mind scale revealed statistically significant differences at a significance level of 0.01 between the pre-application and post-application results. These differences were observed in favor of the post-application phase, indicating that the implementation of the PBL approach via the web had a positive impact on the development of habits of mind among the study sample.

Research Objectives

1. Determining the habits of mind that should be practiced by the students of Dhofar University during their learning of the course on methods of teaching mathematics.
2. Preparing an appropriate instructional design to employ the web-based project learning approach in teaching mathematics teaching methods for students of Dhofar University.
3. Identifying the impact of employing the web-based project learning approach in teaching mathematics teaching methods on the development of habits of mind among Dhofar University students.

The Importance of Research

This research is a response to the recent trends advocating for the integration and utilization of technology and web tools in teaching and learning processes. These tools have proven effective in developing knowledge and skills, particularly in the realm of mathematics. The research also aligns with modern approaches to teaching and learning mathematics, which emphasize the importance of cultivating habits of the mind and higher-order thinking skills rather than relying solely on memorization and indoctrination.

Furthermore, this research offers valuable insights and implications for teachers, especially those in the field of mathematics education, who can utilize PBL through web platforms in their various courses. This approach has the potential to enhance the development of academic, educational, and research skills among their students. The research provides students with a wide range of activities, learning resources, materials, and modern technological tools, empowering them to independently discover information, make predictions, and apply their knowledge in real-world situations. These opportunities will have a positive impact on their future performance and research skills.

Moreover, this research encourages researchers in the field of curricula and methods of teaching mathematics to explore the implementation of the PBL approach via the web in other research areas. There is a particular focus on developing habits of the mind for different age groups. By expanding the application of this approach, it is possible to uncover its benefits in diverse educational contexts and further enhance the development of critical thinking skills.

THE THEORETICAL BACKGROUND OF THE RESEARCH

Project-Based Learning Portal Via the Web

The PBL web portal is an e-learning platform that harnesses the full potential of the web. It provides students with the opportunity to gain practical experience, engage in meaningful communication, interact, and collaborate with their peers electronically, all while working towards achieving specific learning objectives through clear steps and assigned tasks for each individual within the group (Elsayed & Albaraami, 2023).

Learning through web projects is rooted in the principles of constructivist theory, emphasizing the learner's central role in the educational process. Students construct their own knowledge through purposeful activities and problem-solving experiences (Abdel Aal, 2014). This approach is seen as an effective educational model for fostering social negotiation skills among students when implementing educational projects or plans, facilitated through the use of synchronous and asynchronous electronic communication tools such as email and discussion forums (Shadiev & Huany, 2015).

Muhammad (2021) describes PBL as a learner-centered approach that empowers students to work independently or in small collaborative groups, enabling them to construct their own learning. It involves providing topics that require research and inquiry, thus enhancing collaborative work and decision-making skills.

The PBL web portal allows students to actively participate in the educational process by practicing various research skills and applying acquired knowledge and skills to real educational situations under the guidance of a teacher. It facilitates deeper understanding of the curriculum and serves as an effective means of integrating technology into education, fostering positive communication and cooperative relationships among students (Mohamed, 2018).

There are two types of PBL on the web. The first is individual-based, where each student works on a different project or works individually on the same project. The second is collaborative-based, where projects are implemented in groups, with each group selecting a specific project and dividing the work among its members, with each student having a designated role to fulfill (Abdul Karim, 2020; Albritton, 2016).

Web-based projects follow a series of stages, including:

1. Project selection, where students choose a project that aligns with their abilities and is feasible, relevant to the educational objectives, and beneficial to their learning.
2. Project planning, where students develop an implementation plan under the supervision of the teacher. Students have the freedom to distribute roles and responsibilities, collect information, and design the project plan, which is then submitted to the teacher for approval.
3. Project implementation, where each student carries out their assigned tasks, records the results achieved by the group, identifies encountered problems, and strives to overcome them under the teacher's guidance.
4. Project follow-up and evaluation, where each team presents their project, and both the teacher and peers evaluate the projects individually.

This stage provides students with insight into their individual contributions within the group effort, and each group reflects on the educational benefits, challenges faced, and problem-solving strategies employed (Mohamed, 2018; Riyanti, 2017; Sabry, 2020; Tilchin & Kittany, 2016).

In this context, numerous local and international studies have been conducted, all of which have demonstrated the effectiveness of utilizing web-based PBL in various subjects, particularly mathematics, for the development of different variables. For instance, Omran's (2020) study highlighted the effectiveness of using the PBL strategy, supported by Web 2.0 tools, in teaching web design skills to middle school students. Sabry's (2020) study found that a proposed program based on learning theories for the fourth industrial revolution, incorporating digital learning strategies, effectively enhanced mathematical proficiency, enjoyment, and appreciation among preparatory year students.

Abdul Karim's (2020) study investigated the effectiveness of blended PBL (combining electronic and traditional methods) in developing students' skills in creating electronic tests and exercises within the computer teacher preparation division. Mohamed's (2018) study focused on the effectiveness of a proposed program using PBL via the web in developing research awareness and reducing teaching anxiety among student mathematics teachers. Risnani's (2017) study discovered the effectiveness of PBL in enhancing students' behaviors and attitudes.

Ibrahim's (2015) study explored the effectiveness of two styles of PBL via the web, individual and participatory, in developing e-book development skills among student teachers and their attitudes towards this learning strategy. Stozhko et al.'s (2015) study utilized a project-based, interdisciplinary web-based learning approach to improve students' performance and levels. Al-Zawaidi (2014) investigated the impact of employing social media software based on the PBL strategy, along with the BLACKBOARD learning management system, on students with varying levels of achievement motivation and their attitudes towards learning.

Furthermore, Muhammad's (2021) study focused on designing an electronic portfolio using PBL to foster problem-solving skills among students of educational technology.

These studies collectively provide substantial evidence supporting the effectiveness of PBL via the web across different disciplines, showcasing its potential in enhancing various skills, attitudes, and learning outcomes.

Based on the information presented above, it is evident that the introduction and utilization of PBL in the educational process is of great importance. PBL offers numerous benefits for all parties involved in the learning process. It is worth noting that learning through collaborative projects via the web differs from individual projects via the web in several aspects. Collaborative projects promote cooperation among students, allow students to benefit from each other's knowledge and skills, and encourage the production of high-quality final products.

In light of these considerations, the current research focuses on implementing collaborative projects via the web as a means to foster the development and enhancement of habits of mind among third-year students majoring in mathematics education at Dhofar University.

Habits of Mind

Habits of the mind represent learned intellectual behaviors that are consciously chosen to engage in thinking and lead to productive action. A habit is often a specific pattern of behavior that is acquired through repetition, shaping an individual's characteristics and becoming a fixed feature of their mind or personality (Oxford, 2005).

Therefore, the habit of a productive mind is defined as a combination of skills, attitudes, past experiences, and tendencies (Costa & Kallick, 2005). It involves making choices about which mental operations to use when faced with a problem or new experience that requires the effective use of high-level skills and mental processes (Al-Sabbagh, 2015; Elsayed et al, 2022).

Researchers have approached habits of the mind from different perspectives and used various terms. Some referred to it as meditation (Rogers, 2008), others as high-level thinking (Chuska, 1995), and some as metacognitive processes (Marzano, 1998). It is also seen as the ability to extract new knowledge from previous knowledge and recognize discrepancies (Costa, 2001).

While acquiring information and knowledge is important for students, it is equally crucial for learners to develop productive mental habits and enhance their self-learning skills to navigate future experiences (Elsayed & Albaraami, 2023).

Educators and teachers need to focus on fostering these mental habits in learners, as they prepare them to tackle uncertain and challenging situations. Marzano (2000) emphasized the need for educators to cultivate these habits to harness the potential energy of the mind when faced with challenges (Elsayed & Aloufi, 2023).

Costa and Kallick (2005) suggest that educational systems should align their goals with the belief that abilities are expandable repertoires of skills. They emphasize that intelligence can grow through human efforts when learners are encouraged to ask questions, accept challenges, seek unconventional solutions, interpret concepts, justify ideas, and seek information. These habits of the mind are associated with higher-level learning.

In this context, Tishman et al. (1993) identified seven habits of intelligent behavior: being adventurous, curious, seeking comprehension, being strategic, exercising intellectual caution, seeking reasons and evaluating them, and thinking beyond knowledge.

Costa and Kallick (2005) identified habits of the mind in general in 16 mental habits, which can be summarized, as follows:

1. **Perseverance:** It is the individual's ability to commit and continue working on the assigned task until it is completed. This includes knowing how it starts, and what steps need to be performed? What data is to be generated or collected?
2. **Controlling impulsiveness:** It is the ability to reflect on alternatives and results from alternative points of view, and to postpone the issuance of judgments and reduce errors by collecting information.
3. **Listening with understanding and empathy:** It is the ability to listen and empathize with the other person's point of view, respect his ideas and opinions, and respond to him.
4. **Thinking flexibly:** It is the ability to think of alternatives, options and solutions by processing a package of data in different ways and giving it a different framework.
5. **Thinking about thinking (supra-cognitive):** It is the individual's ability to develop an action plan, then reflect on it and evaluate it upon completion, explain the steps of his thinking, and evaluate the productivity of his thinking.
6. **Al-Kifah for accuracy:** It is the ability to work continuously professionally and proficiently without errors with economy in the exerted effort.
7. **Questioning and problem-solving:** It is the ability to understand situations in terms of the contradictions that exist between them and to accurately monitor and organize information through questioning and problem-solving.
8. **Applying previous knowledge in new situations:** It is the ability to benefit from previous experiences to retrieve knowledge stock as sources of support for data, and extract meaning to apply it in new situations.
9. **Communication clearly and accurately:** It is the ability of the individual to accurately communicate what he wants to say through the use of accurate language, whether it is written or oral, while not elaborating on the generalization.
10. **Collecting data using all senses:** It is the ability to collect information through the different senses.
11. **Creativity, perception and innovation:** It is the individual's ability to improve his style by envisioning himself in different roles that enable him to examine alternative possibilities in order to achieve more fluency and originality.
12. **Responding with desire and enjoyment:** It is the ability to enjoy solving problems, communicating with the world around it, curiosity, and feeling enthusiastic and loving towards learning, investigation, and mastery.
13. **Calculated risk:** It is the ability to deviate from the ordinary and start experimenting with new strategies and ideas.
14. **Reciprocal group thinking:** It is the ability to justify ideas, test the validity of others' solutions, accept feedback, communicate with others and be sensitive to their needs.
15. **Responding to humor:** It is the ability to respond to different situations, and to accept and approve of the jokes of others.
16. **Capacity for continuous learning:** It is the individual's ability to continuously learn and possess confidence coupled with curiosity and continue research for self-development.

In this context, numerous Arab and foreign studies have been conducted on habits of the mind, their measurement, and development. These studies have consistently shown that habits of the mind can be developed among students through effective teaching strategies and approaches that align with their nature and characteristics. Moreover, habits of the mind have been found to have a positive impact on various variables, including academic achievement and conceptual comprehension.

Some notable studies in this area include the following:

1. A study conducted in the Arab Republic of Egypt found a positive and statistically significant relationship between critical thinking, habits of mind, and their sub-dimensions among middle school students (Tashtoush et al., 2023).
2. Research has shown that practicing productive habits of mind positively affects general academic achievement and academic achievement in mathematics across different educational stages (Rogers, 2008; Sabbagh, 2015).
3. A program based on habits of mind was found to have a significant impact on the development of creative thinking and mathematical skills among first-grade intermediate students in Makkah Al-Mukarramah (Rayani, 2012).
4. Among second-year secondary students, a program based on active learning was used to develop habits of mind (Mohamed, 2012).
5. Habits of mind were developed among tenth-grade students in Palestine through a teaching strategy that focused on activating these habits to acquire knowledge (Sabry, 2010).
6. The effectiveness of Marzano's (1998) dimensions of learning model in developing conceptual comprehension and some mental habits was investigated among sixth-grade students in the Kingdom of Saudi Arabia (Mandour, 2011).
7. A proposed strategy combining brainstorming and problem-solving was employed to develop habits of mind and critical thinking skills in mathematics among primary school students (Mohammed, 2021).
8. A positive and statistically significant correlation was found between the level of mathematics teachers' possession of habits of mind and their application of teaching practices aimed at developing these habits among their students (Al-Sahli & Al-Harbi, 2021).

These studies highlight the importance of cultivating and developing habits of the mind among students, emphasizing the positive impact they have on various aspects of learning and academic achievement.

METHODOLOGY

Research Community and Sample

The research sample consisted of all the third-year students majoring in mathematics education at the college of arts and applied sciences, University of Dhofar for the academic year 2021/2022. The total number of students in the sample was 33. The same group of students constituted the sample on which the research was conducted, and the selection of the sample was based on a comprehensive inventory system.

Research Materials and Tools

A list of habits of mind that should be practiced by Dhofar University students during their learning of the mathematics teaching methods course

After conducting a thorough review of relevant literature and previous studies on habits of the mind, including works by Abu Latifah (2019), Al-Sabbagh (2015), Campbell (2006), Costa and Kallick (2005), Marzano (1998), and Rogers (2008), as well as analyzing the characteristics and abilities of the female students in the study sample and the nature of the course on methods of teaching mathematics in its primary form, a preliminary list of habits of mind to be practiced by Dhofar University students during their learning was developed. The initial list included three main mental habits and thirteen sub-mental habits. The preliminary list was then presented to five experts who specialize in curricula, methods of teaching mathematics, educational technology, and educational psychology. Based on their feedback and recommendations, some habits were modified and additional habits were included. The final version of the habits of mind list was prepared, consisting of three main mental habits and a total of sixteen sub-mental habits, as presented in **Table 1**.

Appropriate design to employ the learning portal through projects via the web in teaching the mathematics teaching methods course

The web-based project learning approach was employed in teaching mathematics teaching methods for female students, members of the study sample, according to the well-known five-stage ADDIE educational design model, due to its simplicity, ease of implementation, and suitability for designing any type of education, as follows:

1. **Analysis phase:** This stage included the following steps:
   a. Analysis of the educational needs of third-year female students majoring in mathematics education at Dhofar University, which was represented in the low level of practicing their habits of mind as confirmed by the survey and previous studies.
   b. Analyzing the characteristics of the students, as it became clear through teaching these students, who are in the first and second grades, whether face-to-face or through distance education during the corona pandemic, that they possess the skills of e-learning.
   c. Analyzing the characteristics of the educational environment, where the learning resources related to the course topics and training topics were designed and presented to the students through the officially approved

Table 1. Habits of mind to be practiced by the students of Dhofar University during their learning of the course on methods of teaching mathematics in its final form

No	Basic mental habits	Characterization of sub-mental habits
1	Self-regulation	1. Be aware of the thinking process while performing it. 2. He cares about planning. 3. He is aware of the available capabilities and has the ability to use them. 4. Has sensitivity and the ability to benefit from feedback. 5. He has the ability to evaluate the effectiveness of his performance.
2	Critical thinking	1. He strives for accuracy. 2. Be clear and seek clarity. 3. Be open-minded and flexible in thinking. 4. Be less impulsive and reckless. 5. He defends his positions and opinions. 6. Be sensitive to others.
3	Creative thinking	1. Participates in and integrates tasks and activities even if the correct answers or solutions to them are not clear and cannot be reached immediately. 2. He is enthusiastic and insists on using the potentials and knowledge he has to the maximum degree. 3. Reach and maintain personal standards of evaluation. 4. Create new, unfamiliar ways to deal with situations. 5. Apply previous knowledge in new situations.

educational platform within the University of Dhofar (MOODLE), as that platform includes about 37 e-learning tools, and allows This platform is the ease of employing many web tools through it. Also, the Big Blue Button and Zoom meeting programs were mainly used to provide some lectures and group discussion seminars. The mini-teaching room was used as a teaching hall, as it includes all the e-learning tools that may be needed, such as a smart board, a computer, and a data show. Which was represented in the availability of e-learning requirements in the classroom.

d. Analysis of course objectives and content, where the course objectives were analyzed based on the description of the courses included in the Dhofar University catalog, then divided according to the three axes approved by the quality unit at the university (knowledge, cognitive skills, and general competencies). The course content was analyzed according to the three aspects (concepts, generalizations, and skills), and distributed over a period of 15 weeks, considering the achievement of the desired goals.

2. **Design phase:** This stage included several steps:
   a. Determining the objectives of employing the learning portal through web projects in the current research, all of which were based on the development of habits of mind among the students of the research sample, noting that the objectives for each topic of the course were formulated in a procedural manner and in line with the course description approved by the University of Dhofar.
   b. Determining and organizing the course content, as the content was determined based on the course description approved by the University of Dhofar, and in line with its various objectives, noting that the course content was organized in the form of seven educational modules related to the various course topics over a period of 15 weeks. Each module included a number of training sessions that depend on self-learning, considering that the content is diverse in activities and educational media that consider the theoretical and applied aspects and were made available on the MOODLE educational platform. An introductory lecture was also given to the students through the Big Blue Button program, in order to make them aware of the nature of the course and its topics, and how to learn and evaluate it through the use of the proposed entrance. **Table 2** shows the course content.
   c. Determine the educational activities and media, where a number of multimedia and learning resources were identified for each subject of the course. pdf text files; video clips; simultaneous virtual classes, and enrichment sites related to course topics.
   d. Determining learning methods and strategies: The following methods have been relied mainly on:
      – The electronic discussion method, by creating an educational forum for the research sample students, in which many questions and discussions that depend on thinking about the educational content of the course modules were raised.

Table 2. Educational modules for course content

No	Educational modules	Course topics
1	What is mathematics and its nature	1. Basic concepts and principles in teaching mathematics. 2. The nature of mathematics and its teaching objectives.
2	Mathematics curriculum system and its development	1. Mathematics curriculum system and how to build it. 2. Developing mathematics curricula.
3	Mathematics curriculum content structure	1. The content structure of mathematics curricula and how to teach it (concepts). 2. The structure of the content of mathematics curricula and how to teach it (generalizations). 3. The content structure of mathematics curricula and how to teach it (skills).
4	Micro teaching	1. The concept of micro-teaching, its types, principles, uses and skills. 2. Micro-teaching skills (preparation, introduction, pre-learning identification, presentation of lesson content, use of the blackboard, use of teaching aids). 3. Micro-teaching skills (communication during the lesson, use of classroom questions, reinforcement and diversification of stimuli, closure, evaluation).
5	Methods and strategies for teaching mathematics that depend on reading	1. Methods and strategies for teaching mathematics that depend on reading and training in it. 2. Follow the methods and strategies of teaching mathematics that depend on reading, and training in them.
6	Methods and strategies for teaching mathematics that depend on discussion	1. Methods and strategies for teaching mathematics that depend on discussion and training on it. 2. Follow the methods and strategies of teaching mathematics that depend on discussion, and training on it.
7	Methods and strategies for teaching mathematics that depend on asking questions	1. Methods and strategies for teaching mathematics that depend on asking educational questions and training on them. 2. Follow the methods and strategies of teaching mathematics that depend on asking educational questions and training on them.

- The electronic brainstorming method, through the research sample students doing brainstorming to generate project ideas under the management and guidance of the researcher with the aim of presenting and generating the largest possible number of teaching problems and ideas for the course topics, which can be implemented in the form of projects, provided that the project ideas are sent via discussion forums and email.
- The electronic lecture method, through the researcher creating virtual classes via the MOODLE platform, through which the students of the research sample are introduced to the course objectives, content, learning outcomes, evaluation methods, how to design projects related to the course topics, and how to implement and evaluate them.
- The self-learning method, through the research sample students accessing the course via the MOODLE platform, studying its content completely on their own, interacting with it, and practicing many activities related to each of its topics.
- The cooperative learning method, where the research sample students were divided into 7 cooperative groups, so that each group consists of 4-5 students, so that the students of each group interact and cooperate separately in solving the various activities and implementing the projects entrusted to them through discussion forums Which was created for each group through the Big Blue Button and Zoom Meeting programs, which are located on the MOODLE platform.
- Training workshops, through educational videos and PowerPoint files for training workshops related to the course topics, which were placed on the MOODLE platform by the researcher and made available to the students. In addition, face-to-face mini-teaching sessions were implemented by the students in the mini-teaching room, with appropriate feedback provided to them.

e. Determining the stages of training using PBL via the web, where this step was implemented by selecting several activities and projects related to the course topics and assigning students to implement them in the form of cooperative groups through discussion forums for each group according to the following stages of project work (project selection stage, Project planning phase, project implementation phase, project monitoring and evaluation phase).

3. **The development phase:** This stage included the following:
   a. Preparing multimedia and learning resources for each subject of the course, represented in presentations, text files, images, audio, and enrichment sites, and then uploading them to the MOODLE platform in the part related to the current course.
   b. Educational forums were created to allow dialogue and discussion between each group of students separately, and the use of virtual classrooms to communicate between groups and provide them with educational content.
   c. Preparing worksheet questions for each subject of the course through the electronic testing tool on the MOODLE system, and a habits of mind scale was prepared using the same tool.
4. **Implementation phase:** This stage was implemented by dividing the sample students into 7 groups, so that each group consists of 4-5 students. The habits of mind scale test was applied to the sample before training them on the proposed approach, then several meetings were held with them to give them a comprehensive idea of the proposed approach, as well as to train them on it. Each group of students was assigned a number of activities, projects, and assignments related to the subjects of the mathematics teaching methods course–as previously explained in the previous steps–in order to address an educational problem or issue related to the course. Finally, the habits of mind scale was applied to the study sample post-test.
5. **The evaluation phase:** This stage was accomplished through the following:
   a. The formative evaluation that was carried out at each stage of teaching the course through the use of the electronic testing tool on the MOODLE system, as well as through the feedback that took place in the applied aspects of micro-teaching.
   b. The final evaluation that was conducted at the end of teaching the course through a comparison between the pre and post applications of the habits of mind produced on the study sample, and it was also prepared and applied by employing the electronic testing tool on the MOODLE system.

Habits of mind scale

1. **The purpose of the scale:** The scale aims to measure the extent to which students of the third year of the mathematics education major at the college of arts and applied sciences at Dhofar University practice habits of mind.
2. **Building the scale in its initial form:** The habits of mind scale was prepared in its initial form based mainly on a list of habits of mind that had previously been reached, so that it included 48 items, at a rate of three items for each sub-mental habit, so the number of items related to the main mental habit, self-regulation, was 15 items. , and the number of paragraphs related to the main mental habit of critical thinking 18 items, and the number of items related to the main mental habit of creative thinking 15 items. The paragraphs were formulated in the form of positive statements (reflecting the positive trend) and negative statements (reflecting the negative direction) according to the five-point Likert method (excellent = 5, very good = 4, good = 3, fair = 2, poor = 1) provided that This score is reflected in the case of negative vertebrae.
3. **Scale adjustment**

   Validity of the scale: The validity of the scale was verified by presenting it to 5 experts specialized in curricula and methods of teaching mathematics, educational technology and educational psychology in order to determine the validity of the items scientifically and linguistically, and their suitability and comprehensiveness to measure the productive habits of the mind, with the possibility of addition, deletion or modification in those paragraphs. In light of the opinions and suggestions of the arbitrators, five positive and three negative paragraphs were rearranged and formulated.

   The validity of the internal consistency of the scale was verified by applying it to a random group of 30 students in the department of education at the college of arts and applied sciences at Dhofar University, then calculating the correlation coefficients between the students' scores on each paragraph of the scale and the total score of the scale, and this is shown in **Table 3**.

   It is clear from **Table 3** that all correlation coefficients are statistically significant at the level 0.05, which indicates that the scale has a high degree of internal consistency.

   Scale reliability: The reliability of the scale was verified during the previous pilot experiment using Cronbach's alpha coefficient, where the Reliability coefficient reached 0.89, which gives a high indication of the validity of the scale for application to the study sample.

   Measure application time: It was calculated during the previous exploratory experiment by calculating the average times taken by the students to answer the scale, and it was found that the appropriate time for the test is 50 minutes.

Table 3. Correlation coefficients between students' scores in the items of the habits of mind scale and the scale as a whole

Item	Correlation coefficient (R)
1	0.77
2	0.76
3	0.78
4	0.69
5	0.68
6	0.77
7	0.79
8	0.82
9	0.88
10	0.78
11	0.79
12	0.71
13	0.81
14	0.74
15	0.67
16	0.85
17	0.81
18	0.84
19	0.87
20	0.69
21	0.73
22	0.76
23	0.83
24	0.85
25	0.77
26	0.76
27	0.79
28	0.71
29	0.81
30	0.74
31	0.67
32	0.85
33	.601
34	.507
35	0.71
36	0.68
37	0.90
38	0.86
39	0.70
40	0.71
41	0.77
42	0.76
43	0.71
44	0.68
45	0.69
46	0.68
47	0.77
48	0.67

Preparation of the scale in its final form: In light of the above, the habits of mind scale was prepared in its final form, including a set of instructions that explain to the student how to answer it, so that the scale consists of 48 items formulated in the form of positive and negative paragraphs, as shown in **Table 4**.

Search Variables

The search variables were the entrance to learning through projects via the web as an independent variable. and habits of mind produced as the dependent variable.

Experimental Design of Research

The current research relied on the experimental approach based on the semi-experimental design with one group (pre-post), and this is shown in the following **Figure 1**.

Experimental Procedures for Research

After selecting the research sample, they were divided into 7 groups, each group consisting of 4-5 students. The habits of mind scale test was applied to the sample before training them on the proposed program, then several meetings were held with them to give them a comprehensive idea of the proposed approach, as well as to train them on it. Each group of students was assigned a number of activities, projects, and assignments related to the subjects of the mathematics teaching methods course–as previously explained in the part related to the design of the entrance recruitment–in order to address an educational problem or issue related to the course. Finally, the habits of mind scale was applied to the study sample post-test.

Statistical Processors

The SPSS program, version 22 was used in the statistical analysis of the research data, relying on the following methods: arithmetic mean, standard deviation, t-test for correlative samples, eta square (η^2), and effect size.

SEARCH RESULTS

Results Related to the First Question

The text of the first question is: What are the habits of mind that should be practiced by the students of Dhofar University during their learning of the course on

Table 4. The habits of mind scale in its final form

No	Items	Item types	Excellent	Very good	Good	Fair	Poor
1	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 45, & 47	Positive	5	4	3	2	1
2	4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, & 48	Negative	1	2	3	4	5

Figure 1. Research experimental design (Source: Authors' own elaboration)

Table 5. The significance of the difference between the mean scores of the students in the pre- and post-measurements of the habits of mind scale

The main mental habits	Max test	Application	SS	df	MS	F	Sig.	η^2	Effect size
Self-regulation (15 items)	75	Pre-test	15.17	33	5.13	23.46	0.000	0.95	High
		Post-test	57.42	33	4.91				
Critical thinking (18 items)	90	Pre-test	21.78	33	10.51	3.46	0.000	0.95	High
		Post-test	74.06	33	7.67				
Creative thinking (15 items)	75	Pre-test	27.94	33	5.88	4.62	0.000	0.94	High
		Post-test	59.60	33	3.65				
Scale as a whole (48 items)	240	Pre-test	64.89	33	9.21	2.92	0.000	0.98	High
		Post-test	191.08	33	6.10				

methods of teaching mathematics? This question has already been answered in the part related to the research methodology (research materials and tools), where 16 sub-mental habits were identified distributed into three main mental habits (self-regulation, critical thinking, and creative thinking) that must be practiced by these students. During their learning course methods of teaching mathematics.

Results Related to the Second Question

The text of the second question is: What is the appropriate instructional design to employ the PBL approach via the web in teaching the mathematics teaching methods course for Dhofar University students? This question has already been answered in the part related to research methodology (research materials and tools), where this approach was employed according to the famous ADDIE model with five stages (analysis stage, design stage, development stage, application stage, and evaluation stage).

Results Related to the Third Question

The text of the third question is: What is the effect of utilizing the web-based project learning approach in teaching mathematics teaching methods on the development of habits of mind among the students of Dhofar University?

To answer this question, the following hypothesis was formulated: There are statistically significant differences at the level 0.01 between the pre and post applications of the habits of mind scale on the study sample in favor of the post application. In order to verify the validity of this hypothesis, the value of t was calculated for the related samples to find the significance of the differences between the mean scores of the students of the study sample in the pre and post measurements of the habits of mind scale, as shown in **Table 5**.

Table 5 clearly shows that the average scores of the students in the study sample were higher in the post-measurement compared to the pre-measurement for each main mental habit as well as for the overall scale. The statistical analysis (t-test) indicates that the differences in mean scores between the pre- and post-measurements of the habits of mind scale are statistically significant at a level of 0.01. This suggests that there are significant improvements in the students' habits of mind after employing the learning portal through web-based projects.

The effect size of the proposed approach in developing the students' habits of mind, whether for each individual main mental habit or for the scale as a whole, was found to be high. The largest effect size was observed for the combined mental habits, followed by the mental habits related to critical thinking, self-regulation, and creative thinking. This indicates that the use of this approach in teaching mathematics teaching methods effectively developed the habits of mind among the research participants, supporting the accepted hypothesis.

These positive results can be attributed to the continuous and diverse training provided to students through electronic participation groups, which enriched discussions and transformed activities into dynamic exercises focused on critical thinking, proposing solutions, and engaging in discussions. The online project learning portal also facilitated meaningful understanding of concepts and skills, providing opportunities for thinking and discussing them in collaborative learning sessions. The competitive

environment and freedom to express opinions fostered a conducive learning environment tailored to students' needs and capabilities.

The use of various learning resources, such as educational presentations, text files, images, and videos, through the MOODLE platform made the educational process interesting and encouraged students to engage in various mental operations. The diversity of training methods, including discussions and electronic brainstorming, provided an interactive social environment that promoted communication and participation in both synchronous and asynchronous discussions, enhancing group thinking skills during learning. Immediate feedback and continuous collaborative evaluation methods were also instrumental in identifying and addressing students' weaknesses while reinforcing their strengths, enabling them to apply this knowledge in new situations, analyze it, synthesize it, and evaluate it.

The findings of this research align with previous studies that employed different teaching approaches and strategies across various fields of education, demonstrating their effectiveness in developing habits of mind among students at different education levels. Examples include the IMPROVE strategy in mathematics with tenth-grade students in Oman (Al-Sayed & Al-Saadi, 2022), a proposed strategy based on brainstorming and problem-solving in mathematics with primary school students in Egypt (Mohammed, 2021), engineering design in science with eighth-grade students in Oman (Al-Hinai et al., 2020), Marzano's (1998) dimensions of learning model in science with sixth-grade students in Saudi Arabia (Mandour, 2011), and thinking maps in chemistry with eleventh-grade female students in Oman (Abdel-Wahhab, 2007).

These findings also support the existing body of research emphasizing the importance of developing habits of mind in mathematics education to enhance learning outcomes and achievement. Several studies have highlighted the positive impact of habits of mind on academic performance and various other variables (Culler, 2007; Niemivirta, 2008; Sabbagh, 2015; Tashtoush et al., 2023).

RECOMMENDATIONS AND SUGGESTIONS

Based on the previous findings, the researcher strongly recommends expanding the implementation of the web-based PBL approach in various courses within teacher preparation programs, particularly those focused on training mathematics teachers. This approach has demonstrated a positive impact on enhancing students' motivation to learn and developing their academic and educational skills. Furthermore, it is crucial to enhance mathematics teacher preparation programs in colleges and universities by emphasizing students' engagement in productive habits of mind. Evaluation methods should also be revised to place greater emphasis on measuring cognitive aspects rather than solely relying on quantitative achievement in knowledge and concepts as a criterion for students' progress.

Additionally, further research should be conducted to investigate the effects of utilizing the web-based PBL platform on the development of other variables. Moreover, comparative studies should be conducted to assess the differential impact of the web-based PBL approach in comparison to other methodologies on the cultivation of habits of mind among students at different educational stages.

By incorporating these recommendations, teacher preparation programs can enhance their effectiveness in fostering students' learning and the development of their cognitive abilities. This will contribute to advancing the field of mathematics education and improving educational outcomes.

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