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IMPACT OF PHENOMENON-BASED LEARNING MODEL ASSISTED BY VIRTUAL BOOK-BASED DIGITAL COMICS ON ELEMENTARY-SCHOOL STUDENTS' AGILE INNOVATION AND INDEPENDENCE IN SCIENCE LEARNING

B. S. Bachri*[1], M. Tegeh[2], I. N. L. Jayanta[3]

[1]Educational Technology, Universitas Negeri Surabaya, Surabaya, Indonesia
[2]Educational Technology, Universitas pendidikan Ganesha, Indonesia
[3]Elementary School Teacher Education, Universitas Pendidikan Ganesha, Indonesia

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ABSTRACT

This study aims to analyze the impact of the Phenomenon-based Learning (PhBL) model assisted by virtual book-based digital comics on elementary school students' agile innovation and independence in science learning. This study used a quasi-experimental method with a quasi-experimental with a post-test control group design. The research sample consisted of 58 students, 30 in the experimental group and 28 in the control group. Research data collection used tests and questionnaires. Data analysis was performed using quantitative descriptive analysis methods and inferential statistical analysis. The data analysis technique used was MANOVA, with the results showing a significance value of 0.00, less than 0.05. The study results show that using a phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics positively impacts the development of students' agile innovation and independence, both partially and simultaneously. The mean score of agile innovation and independence in the group taught using the PhBL model assisted with virtual book-based digital comics is higher. Therefore, the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics can be recommended as one of the innovative learning models to overcome the not-yet-optimal students' agile innovation and independence.

Keywords: agile innovation; phenomena based learning; virtual book

INTRODUCTION

The increasingly complex development of the times and the global world requires individuals to have higher competitive abilities. One of the crucial abilities in this context is the ability of agile or adaptive innovation. Agile innovation refers to the ability to adapt quickly to change, identify new opportunities, and develop innovative solutions. This ability is essential because the environment constantly evolves rapidly, and organizations that adapt quickly have a competitive advantage (Niewöhner et al., 2019; Setemen et al., 2023). Students with agile innovation abilities have an attitude of flexibility or the ability to adapt, creativity, innovative thinking, and a collaborative attitude (Dupont, 2019; Rahmawati & Ramadan, 2021). Having flexibility and dexterity to recognize potential solutions when faced with challenges is what is meant by agility (Jatmika & Puspitasari, 2019). Agility-driven individuals will actively engage in self-reflection, seek out challenges, and apply their experiences to unfamiliar circumstances (Lee & Song, 2022). Agile learners can lead others well (Liao & Zhang, 2020). A conducive learning environment is essential to support the development of these abilities. In this environment, students can develop their abilities and talents optimally. In addition, a conducive environment also plays a role in shaping the independence of students.

***Correspondence Address**
E-mail: bachtiarbachri@unesa.ac.id

Independent students no longer require teachers' perpetual assistance (Shepley et al., 2018; Kertih et al., 2023). They are highly motivated, have the capacity to reflect on what they have learned, can set clear goals for their learning, and do not solely rely on teacher direction (Henri et al., 2018; Ratminingsih et al., 2018; Nguyen & Habók, 2021). Respect for personal principles and self-expression is frequently linked to independence (Magnusson & Zackariasson, 2019). This ability can be observed from students' awareness of themselves, their situation, and their ability to self-regulate (self-regulation). Planning, organizing, and evaluating learning is essential to develop students' independence (Tseng et al., 2020). This independence is obtained through active and effective learning experiences (Orakci & Gelisli, 2017; Orakci & Gelisli, 2019). Increasing the students' independence also impacts cognitive (Orakcı, 2021). Therefore, educators need to develop active learning because independence can be obtained through planning, implementing, and evaluating learning that focuses on developing students' 21st-century skills (Tseng et al., 2020). Thus, for students to deal with the advancement of science and technology, independence is crucial.

In science learning, agile innovation and independence are indeed crucial. These skills and mindsets are valuable assets that help students get ready for success in a world that is changing quickly. Agile innovation and independence are valuable assets because they equip students with the skills, mindsets, and abilities needed to navigate a dynamic and uncertain world successfully. They enable individuals to survive and thrive in a rapidly changing environment, contributing to their personal growth and the progress of society as a whole.

In the context of learning science, agile innovation means encouraging students to become creative thinkers and agile problem solvers. Students must combine existing knowledge and skills to deal with complex scientific problems and adapt to scientific changes and developments. With agile innovation, students can develop critical thinking, collaboration, and creativity skills to solve science problems effectively. It is the same with independence. In learning science, independence is essential because students must be able to lead their learning process. They need to be able to gather information, conduct research, develop and test hypotheses, evaluate results, and make their conclusions. With independence, students can develop lifelong learning skills, self-confidence, and strong motivation to explore the world of science. Students with agile innovation and independence will be better prepared to face challenges and develop innovative solutions to solve natural problems. They will be able to apply scientific knowledge creatively and take the necessary steps to achieve a deep understanding of natural phenomena and problems encountered.

The expected conditions related to students' agile innovation and independence in learning science have not been fully achieved. It can be seen that students struggle in solving given problems, especially in science materials that require solutions in the form of products. They tend to provide answers or produce learning products similar to existing ones without innovation. These results explain that Indonesian students' average scientific literacy can only recognize basic facts. They have not been able to relate this ability to various scientific topics and societal issues, let alone apply concepts (Kimianti & Prasetyo, 2019). This condition certainly does not just happen. Several factors trigger this condition. Science learning is still conventional, where teachers give most demonstrations, explain, and prepare experimental tools according to their wishes. Statements regarding traditional teaching strategies and the complexity of the content that students study lend credence to this condition (Fajriyanti et al., 2018; Ariana et al., 2020). The learning activities the teacher implements are less innovative and less creative. The method is still traditional and does not take into account how students will participate (Pujawan et al., 2022). It may result in less chances for students to acquire the agile innovation and independence required in a science context.

Concrete steps are needed in learning science to overcome this challenge. Educators must apply innovative and creative learning approaches and make students actively actively involve. Project-based learning, student-to-student collaboration, and hands-on experimentation can encourage agile innovation and independence. Several steps can be taken to increase students' agile innovation and independence, such as applying a learning approach that promotes critical thinking, collaboration, and exploring new ideas. One of the innovative learning models that can be used is Phenomenon-based Learning (PhBL). PhBL is a learning approach developed in Finland in 2016 (Taufek, 2021) and aims to prepare students to face real life. PhBL is a cross-curricular learning activity in which real-life phenomena are explored from various perspectives and involve material from various disciplines (Kangas & Rasi, 2021). This approach is based on knowledge concepts related to natural phenomena, and students collaborate in creating new solutions using a multidisciplinary approach (Lonka et al., 2018). Students' skill sets in creativity, critical thinking, communication, play-based learning, and teamwork are all significantly enhanced by PhBL, as seen by its many positive outcomes (Wakil et al., 2019). Therefore, the presence of PhBL in the learning process positively impacts students' learning readiness in dealing with everyday life. This is why research on implementing PhBL is carried out because this approach can significantly increase students' agile innovation and independence.

Several studies have been conducted related to Phenomenon-based Learning (PhBL). The study results state that the PhBL model has an impact on increasing students' scores and allows them to store and maintain the skills acquired for longer (Wakil et al., 2019). PhBL also impacts the quality of learning outcomes and overcomes the learning loss phenomenon in elementary schools (Andriani et al., 2023). The results of other studies state that the use of the PhBL model can improve students' learning outcomes (Putri et al., 2018), develop metacognitive thinking skills (Akkas & Eker, 2021), and develop critical thinking skills (Pratiwi et al., 2021). Based on these descriptions, PhBL impacts learning outcomes, overcomes the learning loss phenomenon, and improves students' higher-order thinking skills.

In addition to learning models, learning media are also needed to create conducive learning. One medium that can be used is digital comics based on virtual books. Virtual book-based digital comics are developed as electronic files that can be accessed and read via computers, tablets, or e-readers. This digital format lets readers read comics interactively using features like zoom, animation, sound, and smooth page transitions. Virtual book-based digital comics offer a more interactive reading experience than traditional printed comics. Virtual book-based digital comics can be developed by adding additional features, such as sound effects, music, dynamic page movement, more vivid colors, and other interactive features to enhance the reading experience (Jannah et al., 2017). Virtual book-based digital comics impact students positively, such as improving learning outcomes (Kurnia, 2022), nurturing interests (Darmayanti & Abadi, 2021), increasing attention and enthusiasm, and motivating students to be passionate about learning (Zulfiah et al., 2021; Syahmi et al., 2022).

Therefore, this study aims to analyze the impact of the PhBL model assisted by virtual book-based digital comics on students' agile innovation and independence in science learning. This research differs from previous research because it uses a dependent variable that focuses on agile innovation and independence of elementary school students. In terms of agile innovation, this research will examine flexible, creative, innovative, and collaborative attitudes. Meanwhile, in the aspect of independence, this study will measure behavioral, emotional, and independence values. This research is expected to increase the students' agile innovation and independence. By applying the PhBL model in the learning process, students are expected to develop a flexible, creative, innovative, and collaborative attitude that can help them face changes and challenges in real life. In addition, by measuring and improving behavioral, emotional, and independence values, students are expected to become more independent in managing themselves, taking the initiative, and managing their learning. This research makes a valuable contribution to improving students' agile innovation and independence so that they can be more prepared and adaptive in dealing with the fast and complex developments of the times.

METHODS

This study used a quasi-experimental method and design with a post-test control group (Rogers & Revesz, 2019). The group was divided into experimental and control to conduct the research. The experimental class was given learning treatment with the PhBL model assisted by digital comics based on virtual books, while the control group was given learning treatment without the PhBL model assisted by digital comics based on virtual books. A post-test was administered to the experimental and control groups to measure their respective levels of agile innovation and independence.

This study involved a population of fourth-grade elementary school students comprising six study groups from six schools, with 190 students. An equivalence test was conducted to determine the research sample using One-way ANOVA in six study groups in six elementary schools in Cluster IV, Pupuan District, Tabanan Regency. After that, two schools were chosen at random via a lottery as research samples using a simple random sampling technique. To identify the experimental and control groups, another draw was performed. Following the draw, the experimental class consisted of 30 students, whereas the control class consisted of 28.

In this study, data was collected using a project assessment test. Students were given questions in the form of problems or phenomena in the field and were asked to design solutions in the form of products. The assessment process was carried out at the end and during the manufacturing and finishing. The assessment was carried out using product assessment sheets and observation sheets. This observation sheet is inseparable from the indicators of agile innovation: flexibility, creativity, innovation, and collaboration. These four aspects were developed into 20 terminals and then tested by five instrument experts. Based on the expert analysis results, this instrument was declared fit for use with a CVI value of 0.95, indicating very good validity based on content validity criteria. Testing the validity of the content of the assessment sheet using SPSS yielded a value of 0.873, which indicates very strong validity. Questionnaire reliability testing using SPSS yielded a Cronbach's Alpha value of 0.933, indicating that the developed questionnaire was reliable. The level of independence was measured using a questionnaire with five answer choices: strongly agree, agree, sufficient, disagree, and strongly disagree. Three dimensions were created into fifteen indicators, making a total of thirty items in the instruments. Behavioral autonomy, emotional autonomy, and value autonomy are the three dimensions. Table 1 presents the full content outline. There are three things that need to be tested in the instrument for independence: reliability, validity of instrument content, and validity of instrument. The content validity of the questionnaire instrument is tested using the CVR formula. According to the validation criteria for each instrument item in the CVR formula, the instrument is valid if the total CVR of all instrument items is 30, and the CVR result from the calculation of each instrument item is 1. With a score of 0.873, the questionnaire's content validity as determined by SPSS analysis is quite strong. By utilizing SPSS to examine the reliability of the questionnaire, the generated questionnaire was found to be reliable with a Cronbach's Alpha value of 0.933.

Table 1. Instrument Content Outline of Independence

No	Dimension	Indicator
1	Emotional autonomy	Identify, recognize, and understand various emotions, both positive and negative.
		Express emotions appropriately and in context through appropriate words, facial expressions, or body language.
		Establish and maintain healthy interpersonal relationships, including having empathy for others, understanding and respecting the feelings of others, and overcoming difficulties in relationships.
		Take responsibility for their emotions, including choosing appropriate responses and taking responsibility for the consequences of expressing them.
2	Behavioral autonomy	Have intrinsic motivation and initiative to achieve their goals without relying on external encouragement.
		Interact independently with others, including communicating effectively, resolving conflicts, and taking initiative in group work.
		Face obstacles and challenges with courage and persistence and seek creative solutions to overcome the problems encountered.
		Organize and manage their learning process, including choosing appropriate learning resources, managing their study time, and monitoring their learning progress.
		Identify available options, evaluate the consequences of each choice, and make decisions consistent with their values and goals.
		Express emotions appropriately and in context through appropriate words, facial expressions, or body language.
		Plan and organize their tasks, including making schedules, setting targets, and managing the necessary resources to achieve their goals.
3	Value autonomy	Have a good awareness of their values and understand why they are essential to the brand.
		Appreciate the diversity of values and understand that different values can have their validity and importance.
		Have an awareness of the embodiment of their values in social relations, including considering the impact of their values on others.
		Take moral responsibility for their actions and decisions based on their values.
		Maintain the integrity of their values, stay unaffected by pressure from other parties, and stick to the principles they believe in.

Descriptive and inferential statistical analysis were used in this study's data collection process. With an emphasis on post-test data, descriptive analysis was carried out utilizing SPSS 26.0 for Windows. The average, standard deviation, maximum value, and minimum value are among the values that are determined during the descriptive analysis. The ANOVA test was applied to the post-test data for inferential statistical analysis. The normality test using the Kolmogorov-Smirnov test, the homogeneity test using Levene Statistics and Box's Test of Equality of Covariance Matrices, and the multi-correlation test were all conducted prior to the MANOVA test. For the MANOVA and prerequisite tests, SPSS 25.0 for Windows was employed.

RESULTS AND DISCUSSION

After analyzing according to the learning design, the results showed differences in the agile innovation and independence of students who were taught using the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics and those who were taught without using it. The results of a descriptive comparison comparing the mean scores of the experimental and control groups are presented in Figure 1. Based on the research findings, there are significant differences in students' agile innovation and independence, which is indicated by the difference in mean scores between the groups taught with the PhBL model assisted with virtual book-based digital comics and those not. The difference in the mean agile innovation scores between the group taught using the PhBL model assisted with virtual book-based digital comics and the group that did not have a difference of 5.10. The mean score of agile innovation in the group taught using the PhBL model assisted with virtual book-based digital comics was higher. The average difference in students' independence between the group taught using the PhBL model and the group that was not was 3.92. The mean score of independence in the group taught using the PhBL model assisted with virtual book-based digital comics was also higher. The results also show that the agile innovation variable has a more significant impact than independence, indicated by the greater score difference in agile innovation.

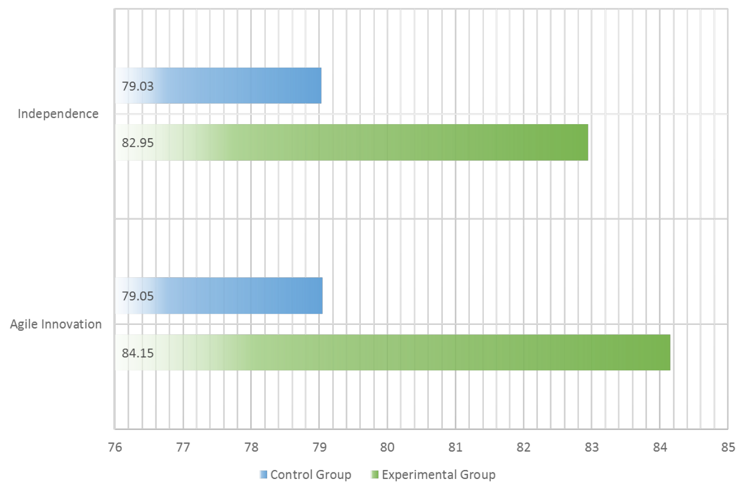

Figure 1. Comparison of Mean Score in Experimental and Control Groups

This study carried out analysis prerequisite tests, including data distribution normality tests, variance homogeneity tests, multivariate homogeneity tests, and dependent variable linearity tests. The first prerequisite test performed was the normality test using the Kolmogorov-Smirnov. The analysis results show that all data come from groups of data with a normal distribution. It is shown by the value of Sig. > 0.05.

After the normality requirements are met, the following prerequisite test is carried out: the homogeneity test. The homogeneity test was carried out by homogeneity of variance test using Levene's Test of Equality and multivariate homogeneity test using Box's Test of Equality of Covariance Matrics.

The results of the homogeneity analysis show that the research data come from homogeneous data groups, as seen from the Sig. on any test greater than 0.05. In Levene's Test of Equality, the value of Sig. for agile innovation is 0.40, while for independence, it is 0.98. In contrast, the homogeneity test with the Box's Test of Equality of Covariance Matrices produces a value of Sig. of 0.822 and an F value of 0.942. Furthermore, a multicollinearity test was conducted to ensure no linear relationship between variables. The analysis results show that the VIF and tolerance values are close to 1, so it can be interpreted that the agile learner and independence variables have no significant correlation. Thus, the test prerequisites for MANOVA analysis have been fulfilled. The research data has a normal distribution and homogeneity; no linear relationship exists between variables. Therefore, hypothesis testing using MANOVA can be done. The complete analysis results are presented in Table 2 and Table 3.

Table 2. MANOVA Test Analysis Result

	Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	0.997	10296.081	2.000	55.000	0.000	0.997
	Wilks' Lambda	0.003	10296.081	2.000	55.000	0.000	0.997
	Hotelling's Trace	374.403	10296.081	2.000	55.000	0.000	0.997
	Roy's Largest Root	374.403	10296.081	2.000	55.000	0.000	0.997
Treatment	Pillai's Trace	0.245	8.913	2.000	55.000	0.000	0.245
	Wilks' Lambda	0.755	8.913	2.000	55.000	0.000	0.245
	Hotelling's Trace	0.324	8.913	2.000	55.000	0.000	0.245
	Roy's Largest Root	0.324	8.913	2.000	55.000	0.000	0.245

MANOVA test analysis results in Table 2 show simultaneous differences between groups of students taught with the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics regarding agile innovation and independence. The coefficient F is 10296.081 with a value of Sig. 0.00 indicates a significant difference between the two groups.

Table 3. Tests of Between-Subjects Effects Analysis Result

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Agile Innovation	340.469	1	340.469	17.582	0.000	0.239
	Independence	201.731	1	201.731	12.280	0.001	0.180
Intercept	Agile Innovation	349011.641	1	349011.641	18022.727	0.000	0.997
	Independence	343786.352	1	343786.352	20927.862	0.000	0.997
Treatment	Agile Innovation	340.469	1	340.469	17.582	0.000	0.239
	Independence	201.731	1	201.731	12.280	0.001	0.180
Error	Agile Innovation	1084.445	56	19.365			
	Independence	919.924	56	16.427			
Total	Agile Innovation	380183.000	58				
	Independence	375850.000	58				
Corrected Total	Agile Innovation	1424.914	57				
	Independence	1121.655	57				

The Tests of Between-Subjects Effects analysis results in Table 3 show a significant impact of the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics on agile innovation. The F value is 17,582 with Sig. 0.00, which is smaller than 0.05, indicates that the PhBL model assisted with virtual book-based digital comics has a significant impact on increasing students' agile innovation.

Table 4 also shows a significant impact of the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics on students' independence. The F value is 12,280 with Sig. 0.000, which is smaller than 0.05, indicates that the PhBL model assisted with virtual book-based digital comics has a significant impact on increasing students' independence. Thus, these findings show that the PhBL model assisted with virtual book-based digital comics has a positive and significant impact on increasing agile innovation and independence in students.

Virtual comics can significantly enhance the learning experience in Phenomenon-Based Learning (PhBL) by offering various benefits that align with the principles of this pedagogical approach. Incorporating virtual comics into PhBL can make learning more dynamic, interactive, and engaging for students. They can serve as a valuable resource for introducing and exploring phenomena while encouraging inquiry, critical thinking, and independence central to PhBL.

The study results show that using a phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics positively impacts the development of students' agile innovation and independence, both partially and simultaneously. The PhBL model, assisted by virtual book-based digital comics, allows students to be involved in projects that require creative, innovative thinking and complex problem-solving. In the PhBL model, students are given challenging assignments or projects that involve applying science concepts in everyday life. It attracts students because they can see the relevance and importance of the subject matter in real life. Thus, learning becomes more meaningful and motivates students to participate actively. Applying the phenomenon-based learning model assisted with virtual book-based digital comics also allows students to develop abstract thinking skills. Science material is often abstract and requires the ability to think abstractly to understand it in depth. In the phenomena-based learning model projects, students face real situations requiring problem-solving and thinking abstractly. It helps students practice their abstract thinking skills, essential in producing good problem-solving. In addition, in the PhBL model assisted with virtual book-based digital comics, students can also develop independence in learning. They are responsible for managing time, planning projects, gathering information, collaborating with colleagues, and presenting their work. In this process, students learn to take initiative, be responsible, and manage their learning. It supports the development of students' independence and enhances their ability to work independently.

Phenomenon-Based Learning (PhBL) is an educational approach that can help students become more independent and foster agile innovation through its student-centered, inquiry-based, and real-world application principles. Phenomenon-based learning promotes independence and agile innovation by empowering students to explore real-world phenomena, ask questions, collaborate, apply knowledge, and adapt their approaches. This student-centered approach equips students with the skills and mindset needed to become independent, innovative thinkers who can thrive in a rapidly changing world. Using the PhBL model in science learning can significantly benefit developing students' agile innovation and independence. This model provides relevant context, involves abstract thinking, and encourages students' independence in the learning process. In the long term, it will help students face complex scientific challenges and prepare them to become agile innovators in future changes.

The most common steps used in the phenomenon-based learning model assisted by virtual book-based digital comics are orienting students to a real phenomenon related to the subject, organizing study groups, individual or group investigations, presenting the results of phenomena investigations, and analyzing and evaluating phenomenon (Symeonidis & Schwarz, 2016; Naik, 2019). The PhBL model makes learning more interesting because the learning process improves students' participation. Many observations state that the learning process with PhBL is healthier and more effective. Healthy and effective learning is inseparable from the learning process carried out holistically, providing knowledge about the future and learning about the past, present, and future, which is related to phenomena students face in everyday life. Through a phenomenon-based learning model, students get freedom within certain limits to investigate individually or through question-and-answer sessions with teachers and other students to solve problems from phenomena the teacher gives. With these activities, students' critical thinking skills begin to increase.

The phenomenon-based learning model assisted by virtual book-based digital comics can attract students' learning interest. With this model, students must find concepts through problems the teacher gives from phenomena that students often encounter in everyday life, such as leading problems and questions or brief explanations regarding the material. From there, students feel interested in knowing physics problems in everyday life, whether in processes, causes, symptoms, or results, to improve their learning outcomes (Pareken et al., 2015). Motivation is a significant factor and can foster student enthusiasm for learning. In the PhBL model, students must be more active in making observations of daily activities or connecting learning with phenomena or natural events that are under the concept so that it can become their learning motivation (Simatupang et al., 2017). Based on these descriptions, PhBL provides opportunities for students to learn based on phenomena they experience or encounter daily, both in natural phenomena and those that occur in technological developments. The phenomenon-based learning process begins with observing a phenomenon from a different perspective. PhBL has five dimensions: holistic, authenticity, contextuality, problem-based inquiry learning, and learning process (Symeonidis & Schwarz, 2016). The educational theory known as holistic education is based on the notion that one can discover their identity, meaning, and purpose by interacting with society, the environment, and human values like compassion and peace. Holistic can be interpreted as thinking as a whole and bringing together various layers of rules and experiences that are more than just narrowly interpreting humans (Maragustam, 2017). That is, every child has something more than he knows.

Authentic learning uses real-world problems that allow students to explore and discuss them in relevant ways (Antara et al., 2020; Wiranata et al., 2021). Students no longer learn rote facts but are based on experience and information based on reality (Momang, 2021). Authentic learning allows students to learn the real world using higher-order thinking skills (Rahmawati et al., 2019), involving students to work professionally. Investigation activities train students' thinking skills and metacognition, discourse between student communities, and through student empowerment choices. Contextuality relates to the atmosphere or circumstances. Contextual learning gives students the resources they need to tackle any problem in the real world by strengthening, extending, and applying their academic knowledge and skills in a variety of classroom and non-classroom contexts (Herliana & Anugraheni, 2020). When students apply what they have learned to actual issues related to their roles and obligations as workers, students, families, and communities, they are engaging in contextual learning (Nendasariruna et al., 2018; Adijaya et al., 2023). With contextual learning, teachers provide opportunities for students to develop the competencies to find the meaning of the material and apply the knowledge they gain.

The act of posing and obtaining responses to scientific queries can be interpreted as inquiry. The inquiry approach is essentially a procedure that starts with problem formulation, followed by the development of hypotheses, evidence collection, hypothesis testing, and conclusion drawing. Inquiry is a learning approach in which the teacher presents an event that raises a puzzle and motivates students to solve problems (Mutmainah et al., 2019). In authentic inquiry learning, the events or problems presented are closely related to students' real lives (Wahyuni et al., 2019). In the learning process, teacher-student interaction activities and reciprocal communication occur in educative situations to achieve learning objectives (Aufa et al., 2021). Teachers and students are inseparable components of the learning process. Teacher and student collaboration in sharing and processing knowledge is the foundation of the learning process so that the knowledge provided is helpful for students and becomes the basis for continuous learning. Better changes to achieve improvement are also expected, marked by changes in individual behavior to create an effective and efficient teaching and learning process (Abdulrahaman et al., 2020).

The phenomenon-based learning model assisted by virtual-book-based digital comics emphasizes a holistic, authentic, contextual, problem-based learning process. Emphasis on the learning process can increase the ability of agile innovation and student independence. In the context of this research, students are allowed to learn actively and given the confidence to solve problems with their efforts. This opportunity will increase students' sense of responsibility for their work. In addition, by providing opportunities for students to innovate, they can develop creativity, freedom of thought, and better collaboration skills. Flexibility, innovation, creativity, and collaboration are aspects of agile innovation. By providing this kind of freedom, students can develop the ability to adapt to change, generate new ideas, and work together with others to achieve common goals. Agile innovation refers to the ability to adapt quickly to change, identify new opportunities, and develop innovative solutions. This ability is essential because the environment constantly evolves rapidly, and organizations that adapt quickly have a competitive advantage (Niewöhner et al., 2019). Students with agile innovation abilities have an attitude of flexibility or the ability to adapt, creativity, innovative thinking, and a collaborative attitude (Dupont, 2019). In addition, agility relates to facing difficulties by having the flexibility and dexterity to see existing solutions (Jatmika & Puspitasari, 2019). People with high agility will use their experiences in new situations, seek challenges, and actively self-reflect (Lee & Song, 2022). Agile learners can lead others well (Liao & Zhang, 2020). Thus, by applying the PhBL model, it is hoped that students will develop better agile innovation and independence. This model provides a learning environment that supports students to be more active, creative, and collaborative in the learning process.

In addition, holistic, authentic, contextual, problem-based learning models that emphasize the learning process will help students become more independent in managing mindsets, being responsible, and solving problems. In other words, students will reduce their dependence on other people, including educators. They will have independence in learning. Students with good independence no longer need constant encouragement from educators (Shepley et al., 2018). They can organize their learning with clear goals, do not rely entirely on teacher guidance, and have high motivation and the ability to reflect on learning (Henri et al., 2018; Nguyen & Habók, 2021). Independence is often associated with respect for individual values and self-expression (Magnusson & Zackariasson, 2019). This ability can be observed from students' awareness of themselves, their situation, and their ability to self-regulate (self-regulation). Planning, organizing, and evaluating learning is essential to develop students' independence (Tseng et al., 2020). This independence is obtained through active and effective learning experiences (Orakci & Gelisli, 2017; Orakci & Gelisli, 2019). Increasing the students' independence also impacts cognitive (Orakcı, 2021). Therefore, educators need to develop active learning because independence can be obtained through planning, implementing, and evaluating learning that focuses on developing students' 21st-century skills (Tseng et al., 2020). Thus, independence is essential for students in dealing with the development of science and technology.

CONCLUSION

The study results show that using a phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics positively impacts the development of students' agile innovation and independence, both partially and simultaneously. It is indicated by the difference in mean scores between the groups taught with the PhBL model assisted with virtual book-based digital comics and those not. The mean score of agile innovation and independence in the group taught using the PhBL model assisted with virtual book-based digital comics is higher. The results also show that the agile innovation variable has a more significant impact than independence, indicated by the greater score difference. Therefore, the phenomenon-based learning (PhBL) model assisted with virtual book-based digital comics can be recommended as one of the innovative learning models to overcome the not-yet-optimal students' agile innovation and independence.

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