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Effects of Guided Inquiry-Based Model on Pre-Service Biology Teachers Attitude Towards Invertebrate Zoology Learning

Ageze Abza [1,2*], Habtamu Wodaj [1], Sutuma Edessa [1]

[1] Department of Science and Mathematics Education, Addis Ababa University, Addis Ababa, ETHIOPIA
[2] Department of Biology, Hossana College of Teachers Education, Hossana, ETHIOPIA
***Corresponding Author:** tsinatageze@yahoo.com

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ABSTRACT

Although attitude is a key to achieve competency of contemporary science education overlooked in many Ethiopian schools and institutions. The purpose of current study was to investigate the effects of guided inquiry based instructional model on pre-service biology teachers' attitude towards invertebrate zoology learning. The research used quantitative research method and non-equivalent quasi-experimental pretest-treatment-posttest design. 128 pre-service biology teachers registered on invertebrate zoology course was selected using convenient sampling method. Three intact groups were assigned into two treatment groups (TG1&TG2) and a comparison group (CG). The treatment and comparison groups were instructed for eight consecutive weeks with guided inquiry based instructional model and conventional method of teaching respectively. Likert scale questionnaire was administered to collect pretest and posttest data from participants. The data were analyzed using one-way ANOVA and factorial ANOVA. The results of the study revealed that there were significant differences between groups in overall, dimension-1 and dimension-2 of attitude. In relation to gender guided inquiry based instructional model had no significant effect on attitude of pre-service biology teachers in invertebrate zoology learning. In conclusion guided inquiry based instructional model on pre-service biology teacher's overall attitude have sound effects towards invertebrate zoology learning.

Keywords: attitude, guided inquiry based instructional model, gender, invertebrate zoology learning, pre-service biology teachers

INTRODUCTION

A 21st century society requires creative and innovative learning to foster student attitude towards effective scientific learning (Derilo, 2019). The reason is because; attitude is a key to achieve contemporary objectives of science learning and improving students' performance in `science education (Ogembo et al., 2015). As a result, research confirmed that a positive attitude being developed in prior schools' experience have great influences on motivation of students learning science (Kemp et al., 2019). Mwanda et al. (2017) argue that developing positive attitude on students have great effect on both student outcomes and latter position of science in life process.

Hence, attitude is the mind framework of learners to particular phenomena on science learning (Prayitno et al., 2017; Widiyatmoko & Shimizu, 2018). According to Fareo (2019), attitude is described as a complex construct; however, fairly stable emotional tendency to respond often to some specific thing, condition, individual and groups. For example, individual's attitude can only be inferred from his/her response to a particular activity based on cognitive, affective, and behavioral measurements. As a result, cognitive component of attitude includes beliefs and ideas of a person preference to object, affective component of attitude encompasses persons feelings about like and dislike to objects and behavioral aspect of attitude also comprises about doing of tasks in a particular way to certain objects (Fareo, 2019; Jurik et al., 2013). Moreover, Jurik et al. (2013) summarized that attitude is an opinion that comprises assessment of happening along a range from negative to positive and predispose to act in certain ways towards materials, individual or event. Accordingly, altitude has several benefits on position of students towards learning science education (Hinneh, 2017).

Some of the benefits of attitude for science learning includes understanding of scientific knowledge (Widiyatmoko & Shimizu, 2018), encouraging students to science learning (Fareo, 2019), enhancing performance of students (Mulatie, 2018), increasing students' interest to attain certain tasks (Sitotaw & Tadele, 2016; Villafañe & Lewis, 2016) and

involving students for authentic scientific investigation (Kang & Keiononen, 2016).

Regardless of its benefits, there are several encounters to achieve objectives of science curriculum (Aktamis et al., 2017) such as learner related variables (self-concept, place of control, and motivation) and school related variables (environments, teachers, and administrative style). Besides, students' attitude to biology learning also influenced at large by methods of teaching (Chin et al., 2014; Fareo, 2019). Thus, students' attitude towards science in biology learning is influenced by teacher selection of teaching methods (Sarwar et al., 2017).

Mulyana et al. (2018) stated that in science learning inquiry-based strategy is a constructivist approach helpful for students to develop positive attitude towards science learning. Correspondingly, inquiry-based strategy is process by which students actively explore their real-life situation with questioning and looking for answers to their questions (Mwanda et al., 2017) and used for enhancing their attitude towards science learning (Tan et al., 2020). Furthermore, study revealed that appropriately implementation of inquiry-based model increases students' attitude towards science learning (Aktamis et al., 2017; Mwanda et al., 2017). Contrary, conventional method of teaching did not raise students' attitude towards science learning (Widiyatmoko & Shimizu, 2018). For instance, lecture dominating teaching method in science learning emphasizes content knowledge instead of process of science and attitude (Zeidan & Jayosi, 2015; MoE, 2018).

Theoretical Framework

The study is framed on pre-service biology teachers' overall and dimensions of attitude (such as enthusiasm, course, science process skills, and its relevance in real-life context) towards invertebrate zoology learning using guided inquiry based instructional model. The phases of the guided inquiry based instructional model includes planning, retrieving, processing, creating, sharing, and evaluating (Ismail & Shade, 2006; Learning, 2004). In addition, guided inquiry based instructional model in each phase has been coined with Vygotskian (social constructivist approach) principles such as proximal development zone (PDZ), scaffolding, social interaction, and cooperative learning (Vygotsky, 1980). For the purpose of anticipating enhancing pre-service biology teachers attitude dimensions to invertebrate zoology learning (Kazeni et al., 2018). The inquiry based instructional model encourages students' attitude to biology in invertebrate learning with real-life context (Mwanda et al., 2017). With this regards, pre-service biology teachers able to develop experience working with peers collaboratively and focusing on teacher probing questions and providing pertinent guidance (Njoku & Nwagbo, 2020).

Therefore, guided inquiry based instructional model is a constructivist approach used for enhancing pre-service biology teachers' attitude in invertebrate zoology learning. However, attitude of gender towards science learning is inconsistent in the research reports (Hacieminoglu, 2016; Sofiani et al., 2017).

Gender Relation to Biology Learning

Throughout education system learning biology appears to be a gender-neutral science (Njoku & Nwagbo, 2020). Thus, gender is one of the concepts which requesting study about students' attitude towards biology learning. However, study findings showed that attitude of gender to biology learning always contradictory (Mehmood & Answer, 2020). Hacieminoglu (2016) found that males have positive attitude towards science learning than females. In other study, reported that students' attitude towards science is not found gender difference (Sofiani et al., 2017). Likewise, Hu et al. (2018) testified that there were significant differences in attitude towards science learning among the gender. Therefore, current study was intended to investigate the attitude of gender in pre-service biology teachers' invertebrate zoology learning with guided inquiry based instructional model.

Attitude in Science Learning

In Ethiopian education system, policy documents encourage attitude as a component of science, students became competent in science education learning. Accordingly, Ethiopian education curriculum designed learners to attain the major core competency such as knowledge, skills [science process skills], and attitude (MoE, 2002, 2018). Similarly, Prayitno et al. (2017) reported that attitude is components of science learning like science process skills and content knowledge in science education. In the same way, Widiyatmoko and Shimizu (2018) reported that attitude is a core component of science learning. However, research reported that attitude is not considered as component of science learning at varies grade levels and overlooked the developments of students' attitude in schools and institutions (Alemu, 2018; Aulia et al., 2017; Bialangi et al., 2016; MoE, 2018; Zeidan & Jayosi, 2015). Ding and Mollohan (2015) detailed that particularly at colleges of teacher educations attitude in science subject was done little research. With this regards study conducted on Ethiopian institutions the findings showed that students' attitude towards science teaching (Sitotaw & Tadele, 2016) and achievements (Tesfaye, 2014) is declined. In addition, baseline study conducted on National Educational Assessment and Examinations Agency (NEA and EA) (2014) and National Agency for Examinations (NAE) (2016) in biology subject grade 8, 10, and 12 reported that achievements scores of students were less than minimum requirement established by Ministry of Education (MoE, 1994).

Hence, it is important to enhance students' attitude towards biology learning with student centered strategy. Therefore, current study was underlined to investigate attitude of pre-service biology teachers in invertebrate zoology learning using guided inquiry based instructional model.

The aim of this study was to investigate pre-service biology teachers' attitude towards guided inquiry based instructional model in invertebrate zoology learning. To address the purposes following research questions were formulated.

1. Is there a significance mean score difference between groups in terms of overall and dimensions of attitude in

pre-service biology teachers in invertebrate zoology learning?

2. Is there interaction effect between gender and groups in overall attitude of pre-service biology teachers towards invertebrate learning?

METHODOLOGY

Research Design and Method

The study followed quantitative research method because it is helpful to quantity the understanding, briefs, and practices (Cohen et al., 2007). The design of the study was a quasi-experimental non-equivalent pre-test, intervention, and post-test design. Quasi experiment design is useful for implementing intervention without intervening learning context of the study groups. Three intact groups were assigned into two treatment groups (TG1 & TG2) and remaining a comparison group (CG). Treatment groups were instructed with guided inquiry based instructional model (planning, retrieving, processing, creating, sharing, and evaluating) for eight successive weeks. TG2 was used as replication. The aim of replication was to make data more credible, transferable in the context and reduces threats of quasi experimental design (Creswell, 2012). A CG was also taught with conventional teaching method.

Research Site, Sampling Method, and Sample

Hossana College of Teacher Education (HCTE) and Arbaminch College of Teacher Education (AMCTE) was the site of the research study. Both colleges are located in Southern Nation Nationalities and Peoples Regional States (SNNPRs) in Ethiopia. The two CTEs were selected purposive sampling method to get rich data. In other side, 128 participants of PBTs registered for invertebrate zoology course in 2020/21 academic year were selected convenient sampling method. Among 128 participants 70 were males and 58 were females.

Data Collecting Instrument

Invertebrate zoology attitude questionnaire (IZATQ) was used to collect data. The IZATQ was adapted in literature (Kaur & Zhao, 2017). The English version of questionnaire was translated into Amharic version by two language experts for minimizing language barriers.

The Amharic version was back translated into English version and congruence of the back translation was also cross-checked by language experts. The 5-point scale questionnaire was rated 1: strongly disagree, 2: disagree, 3: not sure, 4: agree, and 5: strongly agree. Pre-service biology teachers (PBTs) invertebrate zoology learning opinion with respect to dimension of attitude such as: enthusiasm to invertebrate zoology learning (dimension-1), invertebrate zoology learning as course (dimension-2), invertebrate zoology learning as science process skills (dimension-3) and relevance of the course for real-life situation (dimension-4) were measured and computed with mean scores of groups. Hence, instrument was contained 28 scale questionnaires with equivalent size of positive and negative statements. In the process of data mean scores provides to offer the average value for groups to the items in dimensions of the attitude.

Table 1. The results of pre-test scores of dependent variables across groups

Dependent variables	Groups	n	M	SD	F	df	p*
Pre-IZATQ	TG1	44	3.97	.45			
	TG2	40	3.87	.46	.1.27	2	.28
	CG	44	3.82	.43			
Pre-dimension-1	TG1	44	3.91	.52			
	TG2	40	3.75	.63	1.45	2	.23
	CG	44	3.71	.53			
Pre-dimension-2	TG1	44	4.09	.75			
	TG2	40	3.79	.88	1.87	2	.16
	CG	44	4.11	.84			
Pre-dimension-3	TG1	44	3.80	.62			
	TG2	40	3.80	.67	.003	2	.98
	CG	44	3.85	.64			
Pre-dimension-4	TG1	44	4.17	.71			
	TG2	40	3.97	.68	2.58	2	.80
	CG	44	3.80	.61			

Validation of the Instruments

The validity of the instrument such as face, and content validity were checked by biology teacher educators, colleagues, and curriculum and instruction experts. The comments and suggestions of experts' like avoiding of vague words, omission of contents and re-writing of the sentences were amended accordingly. In addition, to address validity of the research study early communication to research sites, establishing of research methods and familiarizing context of research sites were well thought-out a head of the research study. Pilot testing in the same population was administered for analyzing scale questionnaires and its reliability. The internal consistency of overall and dimensions of IZATQ reliability was checked with Cronbach's alpha coefficient and it was found to be: overall attitude=.71, dimension-1=.78, demension -2=.78, dimension-3=.69 and dimension-4=.74.

Data Analysis

Invertebrate zoology attitude scale questioners' data were analyzed using statistical package for social sciences (SPSS) software version 20. One-way ANOVA and factorial ANOVA test were employed to analyze data after checking assumption of parametric test.

RESULTS

Pre-Test Overall and Dimensions of Attitude Result of Pre-Service Biology Teachers

Overall pretest invertebrate zoology attitude questionnaires (pre-IZATQ) and pretest enthusiasm of invertebrate zoology learning (pre-dimension-1), pretest invertebrate zoology learning as a course (pre-dimension-2), pretest invertebrate zoology learning as process (pre-dimension-3) and pretest relevance of invertebrate learning for future life (pre-dimension-4) were administered to assess attitude of PBTs invertebrate zoology learning. One-way ANOVA was computed if there is a statistically significant difference between groups after checked major assumptions like normality and homogeneity. The assumption was not violated to run ANOVA. ANOVA result revealed that there was

Table 2. Descriptive statistics results of overall post-IZATQ scores across groups

Dependent variable	Groups								
	TG1			TG2			CG		
	n	M	SD	n	M	SD	n	M	SD
Post-IZATQ	44	3.14	.45	39	2.81	.41	43	2.87	.55

Table 3. ANOVA test result of post-IZATQ

Independent variable	Dependent variable	Type III sum of square	df	F	P	η^2
Group	IZATQ	2.65	2	3.91	.02	.06

Table 4. Post-hoc comparison test result

Dependent Variable	(I) Group	(J) Group	Mean Diff. (I-J)	Std. Error	*P*
post-IZATQ	TG1	TG2	.25	.11	.1
		CG	.33*	.12	.02
	TG2	CG	.08	.13	.8

Table 5. Descriptive statistic results of posttest dimensions of attitude scores across groups

Dimension attitude	Groups								
	TG1			TG2			CG		
	n	M	SD	n	M	SD	n	M	SD
Dimension-1	44	3.51	.55	39	3.13	.58	43	3.25	.67
Dimension-2	44	3.45	.57	39	3.07	.54	43	3.11	.52
Dimension-3	44	3.00	.57	39	2.72	.59	43	2.87	.70
Dimension-4	44	2.68	.86	39	2.49	.82	43	2.44	.80

Table 6. ANOVA test results of dimension of attitude across groups

Independent variable	Dependent variables	Type III sum of squares	df	F	p	η^2
Groups	Dimmension-1	3.23	2	4.44	.01	.07
	Dimmension-2	3.86	2	6.51	.00	.10
	Dimmension-3	1.67	2	2.14	.12	.03
	Dimmension-4	1.41	2	1.03	.36	.02

not a statistically significant mean scores difference between groups in pre-IZATQ, pre-dimension-1, pre-dimension-2, pre-dimension-3, and pre-dimension-4 (**Table 1**). Therefore, PBTs overall and dimensions of attitude in invertebrate zoology have similarity before intervention.

Post-Test Overall and Dimensions of Attitude Results of Pre-Service Biology Teachers

The post-invertebrate zoology attitude questionnaire (post-IZATQ) was administered to assess PBTs. First PBTs overall attitude towards invertebrate zoology learning and second each post-dimension of attitude in invertebrate zoology were analyzed. The statistical differences between groups were analyzed using ANOVA test.

In terms of post-overall attitude of descriptive statistics mean scores groups of PBTS were different across groups as presented in **Table 2**.

Next to descriptive statistics results of groups to see if there is a statistically significant differences mean scores between groups ANOVA test was computed. There was a statistically significant difference between groups mean scores, F(2, 126)=3.91, p=.02, η^2=.06 (**Table 3**).

The effect size of groups in dependent variables, eta squared (η^2=.06). Based on Cohen (1988) guideline the effect size value is medium value. This eta squared (η^2) value shows that 6% of post-IZATQ mean scores were obtained due to intervention.

To see significant difference between groups post hoc analysis was computed. Post hoc analysis result revealed that there was a statistically significant difference between TG1 and CG with (p=.02) but there was no significant difference between TG1 and TG2 with (p=.10) and TG2 and CG with (p=.08), respectively in post-IZATQ mean scores (**Table 4**).

In relation to post-dimensions of attitude questionnaire of invertebrate zoology (post-attitude D1-4 of IZATQ) descriptive statistical results were presented in **Table 5**.

Subsequently, to evaluate if there is statistically significant difference between groups in post-IZATQ, ANOVA test was used. In **Table 6**, result of ANOVA showed that there was a statistically significant difference between groups in post-post-IZATQ mean scores, F(2, 126)=4. 44, p=.01, η^2=.07 and F(2, 126)=6.51, p=.00, η^2=.10 for dimention-1 and dimension-2, respectively.

The eta squared (η^2) 7% value is medium value and 10% large value for dimension-1 and dimension-2, respectively according to Cohen (1988). The mean score difference between groups were associated with intervention. But there was no statistically significant difference between groups mean scores, F(2, 126)=2.14, p=.12, and F(2, 126)=1.03, p=.36 for dimention-3 and dimention-4, respectively.

Table 7. Post-hoc comparison test result dimensions of attitude

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	*P*
Dimension-1	TG1	TG2	.38*	.13	.01
		CG	.26	.13	.1
	TG2	CG	-.12	.13	.66
Dimension-2	TG1	TG2	.38*	.12	.01
		CG	.34*	.12	.01
	TG2	CG	-.04	.12	.95

Table 8. Descriptive statistics results of post-IZATQ gender and groups

Variables		Groups								
		TG1			TG2			CG		
	Gender	n	M	SD	n	M	SD	n	M	SD
Post-IZATQ	M	21	3.01	.35	22	2.83	.61	25	2.73	.47
	F	23	3.26	.52	17	2.96	.83	18	2.91	.68

Table 9. Factorial ANOVA test results of main and interaction effects

Independent variables	Dependent variables	Type III sum of squares	df	F	p	η^2
Treatment groups	Post-ATIZQ	2.317	2	3.43	.02	.05
Gender	Post-ATIZQ	1.10	1	3.27	.07	.03
Gender*group	Post-ATIZQ	.06	2	.08	.92	.00

After that, to see which group is statistically significant post-hoc analysis test was applied. The post-hoc analysis test result attested that there was a significant difference between TG1 and TG2 with (p=.01). But there was no statistically significant difference between TG1 and CG with (p=.1) and TG2 and CG with (p=.66) in dimension-1 mean scores. In the same regard, in dimention-2 there was a statistically significant mean scores difference between TG1 and TG2 with (p =.01) and TG1 and CG with (p=.01) but there was no significant difference between TG2 and CG with (p=.95) as presented in **Table 7**. The differences between groups were associated with intervention.

Post-Test Analysis Results of Gender and Groups Interaction Effect

Descriptive statistics analysis of mean scores of males and females were different between groups in post-IZATQ (see **Table 8**). The mean score of males in TG1 (M=3.01), TG2 (M=2.83), and CG (M=2.73), respectively were presented in **Table 8**. Likewise, mean scores of females in TG1 (3.26), TG2 (2.96), and CG (2.91) were obtained in post-IZATQ. Further, PBTs in TG1, TG2, and CG mean scores of females were higher than males.

To understand if there is a statistically significant different between genders across groups' factorial ANOVA test was computed. There was a statistically significant groups main effects between groups on post- IZATQ scores of PBTs, F(1,126)=3.43, p=.02, η^2=.05. The eta square for groups was about .05. The eta squared (η^2) 5% value is medium value according to Cohen (1988). But there was no a statistically significant main effects gender on post-IZATQ scores of PBTs, F(1,126)=3.27, p=.07, η^2=.03 as presented in **Table 9**.

So, there was no significant interaction between gender and groups for outcome variables mean scores, F(2,126)=.08, p=.92, η^2=.00, respectively in **Table 9**. This means the interaction (gender*group) was not significant. This implied that effect of groups is the same for both males and females.

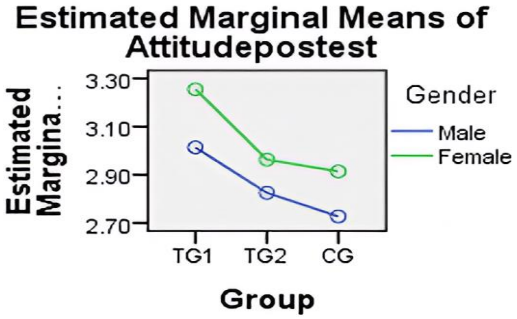

Figure 1. Profile plots for gender and groups' interaction for outcome variable

In addition, **Figure 1** also depicts non-appearance of interaction effects between gender and groups on outcome variable. The separate line attested that females and males PBTs attitude towards guided inquiry-based learning model have not interaction effects on invertebrate zoology learning.

DISCUSSION

Research question 1 was about study of significance of overall and dimensions of attitude between groups of PBTs in invertebrate zoology learning. The findings of ANOVA results revealed that there was a statistically significant difference between groups of PBTs in overall post-IZATQ means scores in PBTs. Likewise, there were statistically significant difference between attitude in dimension-1 and dimension-2. Disagreeing, for PBTs in post-IZATQ dimension-3 and dimension-4 there were no statistically significant difference between groups (**Table 3** and **Table 6**). Hence, findings of the study showed that overall and attitude dimension-1and dimension-2 PBTs have significant difference between groups. However, attitude dimension-3 and dimension-4 has no effect between groups.

In science teaching and learning attitude plays countless roles to enhance engagement, concept understanding and performance of students (Kustijono et al., 2018). The lack of

attitude towards specific subject or course can affect engagement and motivation of students in science learning (Bialangi et al., 2016; Derilo, 2019). Thus, promoting science education with student centered teaching like inquiry-based instruction largely recommended to achieve a competency such as attitude towards science learning (Aktamis et al., 2017; Mwanda et al., 2017; Pulungan et al., 2021).

The current study findings are consistent with previous study findings in that GIBIM more effective increasing eagerness of students' attitude and process skills more than conventional method of teaching (Almuntasheri et al., 2016; Zulfiani & Herlanti, 2018). Likewise, Shahali et al. (2017) argue that learning through GIBIM improves students' attitude towards science subject. This line with Tan et al. (2020) found that GIBIM increase students' attitude to attain components of science learning with real life situation. Moreover, study conducted on invertebrate animals about disgust reduction in and out of school using active method of teaching enhances attitude of learners towards learning invertebrate animals (Joseph et al., 2017; Wüst-Ackermann et al., 2018).

Contrary, in other study findings reported that GIBIM had no significant effect in attitude towards learning science topics. The justification is that attitude towards science does not change over a short intervention period (Aktamis et al., 2017; Zeidan & Jayosi, 2015). Hence, previous study findings may support the current study findings regarding to attitude dimension-3 and dimension-4 about invertebrate zoology learning as process skills and relevance with real-life situation. Thus, we concluded that if PBTs instructed with GIBIM, they able to develop positive overall attitude towards investigation of the phenomena of invertebrate animals.

Research question 2 was about study of interaction effects of gender and groups in attitude of pre-service biology teachers. In **Table 9**, findings were attested that only groups have effects in post-attitude of dependent variable. But there was no significant main effect on gender and interaction effects in the two independent variables. The current study finding is consistent with previous study for instance, study conducted on enhancing students' achievement and attitude in biology through innovative strategies, the findings of the study revealed that there was no interaction effect between learning strategy and gender on attitude of students in biology learning (Njoku & Nwagbo, 2020). In other study findings depicted that there was no statistically significant mean score difference between males and females in achievement, science process skills, conceptual understanding, and attitude in science learning through active based instructional strategy (Mehmood & Anwer, 2020; Mwanda et al., 2017; Mulatie, 2018; Wodaj & Belay, 2021). Therefore, we can conclude that GIBIM in invertebrate zoology learning have not seen sound significance differences between genders.

Moreover, other study finding showed that gender have effect on attitude of science learning through inquiry-based strategy (Hadjichambis et al., 2015; Keles & Hand, 2017; Ogembo et al., 2015). Hence, from this study we considered that inference of findings about effects GIBIM on gender as main effect and interaction effects were not consistent in the study findings.

CONCLUSIONS

The findings of current study shows that PBTs overall attitude towards GIBIM have positive effective in invertebrate zoology learning more than using conventional method of teaching. On the other side, findings of the study found that GIBIM have no similar significant effects in each dimension of attitude in PBTs invertebrate zoology learning. In attitude dimension-1 and dimension-2 there were differences between groups of PBTs. But, in dimension -3 and dimension-4 the GIBIM did not attribute change between groups of PBTs. So, the infusion of the GIBIM with curriculum of invertebrate zoology learning encourages pre-service biology teachers attitude. Therefore, the attitude of PBTs learning effectivness using GIBIM depends on the specific topics or dimentions of the courses. Moreover, GIBIM on gender did not contribute on attitude for groups of PBTs in invertebrate zoology learning.

Recommendation

At the first place the study recommended that integration of attitude in the components of science learning with GIBIM enhance pre-service biology teachers towards the course/subject. Hence, the study suggested that curriculum material developer at the colleges of teacher education should be considered attitude as core competency of science learning with active method of teaching like GIBIM for effective learning. Besides, using GIBIM attitude of gender needs further study in other fields of biology and science discipline.

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