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Preliminary Needs Analysis for Developing Student Worksheets Based on the Teams Games Tournament Cooperative Model on Acid–Base Learning in High School

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Abstract

Acid–base chemistry demands both conceptual understanding of multiple acid–base theories and procedural skills such as pH/pOH calculation and interpretation of indicator pH ranges, making it prone to learning difficulties. This study used educational design research (EDR) with Plomp's model and reports its preliminary research phase, whose contribution is an empirically grounded analysis of the problem, learner characteristics, and learning context that informs subsequent design decisions. Data were collected at SMAN 2 Batang Anai through a teacher interview, a questionnaire completed by 66 Grade XII students, and a 10-item comprehension test, and were analyzed descriptively. The mean test score was 42.3 out of 100, with 86.4% of students below the learning objective achievement criterion (KKTP ≥ 80) and the lowest mastery in indicator pH range analysis (21.2%). Only 47.0% of students found the existing LKPD helpful, whereas most preferred group learning (84.8%), games (84.8%), and team competition (78.8%); the teacher had not yet applied cooperative learning but recognized its potential. These findings reveal a gap between current learning conditions and student needs, and point to a TGT-based LKPD that combines group collaboration with game-based competition as a relevant design direction. As a single-site purposive sample with a test that was not formally validated, the results serve only as an initial basis for prototyping, and the effectiveness of the LKPD remains untested.

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INTRODUCTION

Acid–base material in Phase F (Grades XI–XII) of senior high school/Islamic senior high school (SMA/MA) requires students to master both concepts and procedural skills. The material covers the Arrhenius, Brønsted–Lowry, and Lewis theories, acid–base strength, pH, pOH, and acid–base indicators, all of which demand the ability to connect concepts, perform calculations, and interpret the properties of solutions (Salame et al., 2022). Recent studies continue to report that this topic is challenging because it combines several theoretical models, abstract representations, and contextual applications (Putriawati & Chiani, 2025), and because difficulty in linking these abstract concepts often becomes a major obstacle to understanding (Giawa et al., 2026). Difficulties are also found in understanding indicators and applying concepts to problem solving (Atika & Latisma, 2022). This condition shows the need for learning that not only presents information but also provides activities that help students construct and apply their understanding.

These problems were found among Grade XII students of SMAN 2 Batang Anai, who had studied the material in Grade XI. The results of a comprehension test given to 66 students showed a mean score of 42.3 out of 100, with 86.4% of students (57 of 66) scoring below the Learning Objective

Achievement Criterion (KKTP) of 80. No indicator was answered correctly by more than 56.1% of students, with the lowest percentages on pH range analysis from three-indicator data (21.2%) and the relationship between pH, pOH, and OH^- ion concentration (30.3%). The interview with the teacher also showed that students had difficulty with pH calculations and that student engagement in learning was not yet optimal. These findings indicate a need for learning that can accommodate conceptual understanding, structured practice, and more active student engagement.

This need also relates to the teaching materials used. A total of 93.9% of students stated that the teacher used LKPD, but 95.5% judged that the LKPD mostly contained material summaries and practice questions, and only 47% felt that the LKPD helped them understand acid–base material. An LKPD, which functions as a learning activity tool, should be able to guide students to carry out learning activities systematically (Widiastuti & Priantini, 2022). The questionnaire results also showed that 84.8% of students found it easier to understand the material through group learning, 84.8% were more motivated by games, and 78.8% were more enthusiastic about competition between groups. These data show a gap between the characteristics of the LKPD currently used and students' learning needs.

The Teams Games Tournament (TGT) cooperative learning model has characteristics that match these needs because it integrates teamwork, academic games, and tournaments into the learning process. Previous research has shown that TGT-based LKPD have been developed for chemical bonding (Hsb & Alizar, 2025), and atomic structure (Putri & Alizar, 2025). Other studies have also integrated game activities with TGT in chemistry learning (Herawati et al., 2025), and the application of TGT in chemistry learning has also been examined in relation to learning outcomes and student engagement (Suliastifah, 2023). These findings provide a basis that TGT can be used as a learning structure that integrates cooperation and competition into learning activities.

Although research on TGT and the development of TGT-based LKPD has been conducted, the present study differs from it in three ways. First, TGT-based LKPD have been developed for other topics, namely chemical bonding (Hsb & Alizar, 2025) and atomic structure (Putri & Alizar, 2025), so their activities were not designed around the difficulties specific to acid–base material, such as the relationship between H^+ and OH^- ion concentrations and pH and pOH values and pH range analysis from indicator data. Second, studies that applied TGT in chemistry learning focused on learning outcomes and student engagement (Herawati et al., 2025) rather than on determining what the LKPD itself should contain. Third, research on acid–base LKPD has mostly used Problem Based Learning with Culturally Responsive Teaching (Hanifa & Andromeda, 2025), Discovery Learning (Haetami et al., 2022), and inquiry with the SETS approach (Antoro et al., 2021). To the extent of the authors' literature review, studies that map students' difficulties, the condition of the LKPD currently used, and teachers' needs as a basis for developing an acid–base LKPD with the TGT model in Phase F remain limited. This gap is important to examine because a needs analysis determines which activities the LKPD should contain.

This study contributes to the early stage of product development by presenting a needs mapping that links students' learning difficulties, the condition of teaching materials, learning characteristics, and preferences for group work, games, and competition to the needs of TGT LKPD development. These needs are interpreted through two frameworks combined into a single design basis. The Deep Learning principles of mindful, meaningful, and joyful (Fatihah & Wiji, 2026) provide the pedagogical orientation by stating what kind of learning experience is intended. Cognitive load theory explains how that experience can be achieved with acid–base material: tasks whose elements depend on one another and must be processed simultaneously (high element interactivity) burden the working memory of students whose schemas have not yet formed (Chen et al., 2023), and

therefore need to be managed through worked examples that are gradually faded toward independent problem solving (Renkl & Atkinson, 2003). Each Deep Learning principle is thus operationalized by a specific cognitive load mechanism within the TGT syntax, as detailed in the Discussion. This study aims to analyze the needs for developing an LKPD with the Teams Games Tournament (TGT) cooperative learning model on Phase F SMA/MA acid–base material as a basis for designing a product that suits the characteristics of the material and students' needs.

RESEARCH METHODS

This study is part of a development research project using the Educational Design Research (EDR) approach of the Plomp model (Plomp, 2013). This article reports the needs analysis in the preliminary research phase as the basis for designing the LKPD in the next stage. This stage used a descriptive approach with qualitative and quantitative data to obtain a picture of the learning conditions, teaching materials, students' difficulties, and LKPD development needs from the perspectives of the teacher and students. The research subjects consisted of one chemistry teacher at SMAN 2 Batang Anai who teaches acid–base material in Grade XI and 66 Grade XII students from two science classes who had studied acid–base material in Grade XI in the 2025/2026 academic year. Phase F of the Merdeka Curriculum covers Grades XI and XII of SMA/MA (Badan Standar, Kurikulum, dan Asesmen Pendidikan [BSKAP], 2025), and according to the school's learning objective flow (alur tujuan pembelajaran, ATP), acid–base material is taught in Grade XI, while titration, buffer solutions, and salt hydrolysis are taught in Grade XII. The subjects were selected purposively because the teacher and students were directly involved in acid–base learning. Grade XII students were chosen because data collection was carried out in August 2026, at the beginning of the 2026/2027 academic year, when the students who had been in Grade XI in the previous academic year had completed the acid–base material. The data therefore reflect mastery after a gap and the difficulties students remember, not conditions during.

Data were collected through an interview, a questionnaire, and a comprehension test. The semi-structured interview consisted of 15 questions exploring learning conditions, teaching materials, students' difficulties, experience in implementing group learning, and the teacher's views on games and competition in acid–base learning. The student needs questionnaire consisted of 16 closed statements with Yes/No answer options covering the use and condition of the LKPD, learning difficulties, engagement in learning, and needs regarding group learning, games, and competition. The comprehension test consisted of 10 multiple-choice questions on acid–base material, constructed according to ten indicators drawn from four subtopics, namely the three acid–base theories, acid–base strength, pH and pOH, and acid–base indicators, with two to three items each (Table 2), and drawn from the textbook used at the school. The interview guide and the questionnaire were reviewed by one expert, a chemistry education lecturer, and both were rated in the good category.

In contrast to these two instruments, the comprehension test did not undergo formal validity and reliability testing. This decision was based on three considerations. First, the test was used in the preliminary phase of the Plomp model to map the distribution of students' difficulties across indicators descriptively, not to measure ability precisely, test hypotheses, or generalize to a population, and no inferential statistics were used. Second, the test results were reported only as descriptive percentages at the item and indicator levels, so items were interpreted separately and, for comparison with the questionnaire, pooled by subtopic (see Table 3), and the total score was used only descriptively (the mean score and the proportion of students reaching the KKTP), not as a measure of a latent construct or for inference. Third, formal validation in the Plomp model is carried out at the prototyping stage, when the product to be developed (the LKPD) and its supporting

instruments are validated by experts (Plomp, 2013). To maintain content suitability, the test items were constructed according to the indicators being measured and drawn from the textbook used at the school. The absence of formal validity and reliability testing for the test is acknowledged as a limitation of this study, so the test results should be interpreted as an initial picture of the distribution of difficulties rather than as precise measurement. The test findings also do not stand alone, because they were compared with the results of the interview and the questionnaire, which had been reviewed by an expert, to check whether the three sources pointed in the same direction.

The questionnaire was handled in the same way: each statement was reported as a percentage of Yes/No answers and interpreted separately, without summing statements into a scale score, so internal-consistency reliability, which presupposes a scale score, was not computed.

Data collection was carried out sequentially through the teacher interview, distribution of the questionnaire to students, and administration of the comprehension test to the same students. The three activities were carried out within a short period of time so that the data obtained could describe learning conditions in the same period. The interview data were analyzed descriptively and qualitatively through three stages, namely data condensation, data display, and conclusion drawing and verification (Miles et al., 2014). In the condensation stage, the interview was recorded and transcribed, and the transcript was then selected and coded deductively, using the five aspects of the interview guide (learning conditions, teaching materials, students' difficulties, experience in group learning, and views on games and competition) as coding categories. All of the teacher's statements could be grouped into these categories. Coding was carried out by the first researcher and checked by the second researcher. The coded data were then presented as a narrative and a summary matrix for each category, and the patterns in each category were interpreted and verified. The trustworthiness of the interview data was supported by three measures: the interview guide was reviewed by an expert, the interview was recorded and transcribed so that interpretations could be traced to the teacher's own statements, and the teacher's statements were compared with the questionnaire and test data from students (source triangulation). Because the LKPD document itself was not analyzed, the teacher's statements about the LKPD (for example, that it was integrated with a discovery or inquiry model) were treated as the teacher's perception and not verified.

The questionnaire data were analyzed descriptively by calculating the percentage of answers for each statement (Arikunto, 2013). This percentage was obtained by dividing the frequency of students choosing a particular answer by the total number of respondents, and then multiplying the result by 100%.

The comprehension test was scored 1 for a correct answer and 0 for an incorrect answer, and each student's score was converted to a 0–100 scale (number of correct answers/10 × 100). The test data were analyzed by calculating the mean score of all students, the percentage of students who achieved (≥ 80) and did not achieve (< 80) the KKTP, and the percentage of correct answers for each item, each representing one indicator, using Equation (1), to map the distribution of difficulty across indicators. The proportion of students reaching the KKTP describes the size of the gap relative to the curriculum target and was not used to classify individual students. To compare the test with the questionnaire, the ten items were also pooled into the four subtopics used in the questionnaire (see Table 3). The results of the interview, questionnaire, and test analyses were then triangulated by comparing them across instruments, so that findings from one instrument were used to reinforce or confirm findings from the others (for example, the teacher's statement about difficulties in pH calculations was compared with the percentage of correct answers on pH-related items), This triangulation is across sources (the teacher, the students, and the test), not across documents, because the LKPD document itself was not analyzed; the coding and trustworthiness measures for the

interview data are described in the data collection paragraph above. This research was conducted with permission from the school and the chemistry teacher. Students' identities were kept confidential in data reporting, and completing the questionnaire and test did not affect students' subject grades.

RESULTS AND DISCUSSION

1. Description of Teacher Interview Results

The semi-structured interview with the chemistry teacher produced three groups of information. First, regarding teaching materials, the teacher stated that the LKPD used was already integrated with a discovery or inquiry model. Second, regarding learning conditions, the teacher estimated that about 60% of students had difficulty with acid–base material, particularly pH calculation, described student engagement as not yet optimal, and reported a decline in participation that the teacher linked to mobile phone use and low interest in continuing to university. Third, regarding learning strategies, the teacher had not yet applied cooperative learning, cited time management and large class size as constraints, but recognized its potential to make learning more active. These statements are the teacher's perceptions, and they are compared with the questionnaire and test results in the following sections.

2. Description of Student Needs Questionnaire Results

To determine students' learning needs and the challenges they face in acid–base lessons, a preliminary survey was conducted focusing on existing learning media, conceptual difficulties, and preferred instructional approaches. The detailed percentages of the students' responses for each measured aspect are summarized in Table 1.

Table 1. Recapitulation of Student Needs Questionnaire Results

Aspect Measured	Statement	
	Yes(%)	No(%)
The teacher uses LKPD during acid–base learning	93.9	6.1
The LKPD used so far contains only practice questions and material summaries	95.5	4.5
The LKPD used so far has helped me understand acid–base material well	47.0	53.0
I find it difficult to understand and explain the different acid–base theories.	74.2	25.8
I have difficulty distinguishing strong and weak acids/bases	78.8	21.2
I have difficulty determining the pH range and color change of indicators	87.9	12.1
I have difficulty calculating the pH and pOH of acid–base solutions	83.3	16.7
I get bored when acid–base lessons are purely lecture-based.	84.8	15.2
I am less active in acid–base learning because the methods used are not engaging	83.3	16.7
I feel able to understand acid–base material well if it is explained in an engaging way	89.4	10.6
I remain enthusiastic about learning acid–base material even when it is difficult.	30.3	69.7
I understand the material more easily when studying with friends in a group	84.8	15.2
I am more motivated to learn when there are game elements in learning	84.8	15.2
Inter-group competition makes me more enthusiastic about learning.	78.8	21.2
I feel that teacher-centered learning makes me less active in getting involved	90.9	9.1
More active and understand material easily through enjoyable learning.	90.9	9.1

Table 1 can be read in four groups of items. First, regarding the condition of the LKPD (items 1–3), almost all students confirmed that LKPD was used (93.9%) and that it contained only practice questions and material summaries (95.5%), yet only 47% felt that it helped them understand the material well. This differs from the teacher's statement that the LKPD was already integrated with a discovery or inquiry model; because the LKPD document itself was not analyzed, the data cannot

show which account describes it better. Second, regarding learning difficulties (items 4–7), every subtopic was reported as difficult by 74.2–87.9% of students, but the two subtopic that involve procedures or data reading were reported most often: indicator pH ranges and color changes (87.9%) and pH/pOH calculation (83.3%), compared with distinguishing strong and weak acids/bases (78.8%) and acid–base theories (74.2%). Third, regarding motivation under conventional methods (items 8–11), most students felt bored with one-way explanation (84.8%) and less active when the methods were not engaging (83.3%), and 89.4% believed they could understand the material if it were explained in an engaging wayOnly 30.3% said they remained enthusiastic when the material was difficult (item 11), so most students (69.7%) did not report remaining enthusiastic under that condition. A single item cannot measure learning resilience, so this finding is read only as an initial indication that students' enthusiasm or persistence may decline when they face difficult material. Fourth, regarding interest in active learning (items 12–16), preferences were high and consistent for group learning (84.8%), game elements (84.8%), and inter-team competition (78.8%), and 90.9% of students reported that teacher-centered learning made them less active and that enjoyable learning made them more active and helped them understand more easily.

3. Description of Comprehension Test Results

The comprehension test administered to 66 students produced a mean score of 42.3 on a scale of 100 (279 correct answers out of 660). A total of 86.4% of students (57 of 66) were below the KKTP (80), and 9 students reached the KKTP. The test was administered after the material had been taught in Grade XI, so the scores describe current mastery of the material. The percentage of correct answers per test indicator is presented in Table 2.

Table 2. Percentage of Correct Answers on the Comprehension Test by Item Indicator (n = 66)

Subtopic	Test Indicator	Correct Answers	Percentage (%)
Acid–base theories	Brønsted–Lowry acid–base concept	31	47.0
Acid–base strength	Identification of a weak acid pair	37	56.1
Acid–base theories	Lewis theory (BF_3 + NH_3 reaction)	29	43.9
pH and pOH	pH calculation of a weak acid (Ka)	26	39.4
Acid–base strength	Kb concept (weak base)	29	43.9
Indicators	Analysis of pH range from data of 3 indicators	14	21.2
Indicators	pH range of the methyl red indicator	29	43.9
Acid–base theories	Scope of Arrhenius vs. Brønsted–Lowry theory	32	48.5
pH and pOH	pH calculation of a strong acid (HCl)	32	48.5
pH and pOH	Relationship between pH, pOH, and [OH^-]	20	30.3
Total correct answers		279	
Mean score (scale 0–100)		42.3	

Table 2 shows that no indicator was answered correctly by more than 56.1% of students. The three lowest percentages were on the analysis of pH ranges from three-indicator data (item 6; 21.2%), the relationship between pH, pOH, and [OH^-] (item 10; 30.3%), and weak-acid pH calculation (item 4; 39.4%); the remaining items ranged from 43.9% to 56.1%, including strong-acid pH calculation (48.5%) and the pH range of methyl red (43.9%). To see whether low performance was concentrated in particular subtopics, the items were pooled into the four subtopics used in the questionnaire (Table 3). Indicators and pH/pOH calculation were the two lowest-scoring subtopics and also the two subtopics that students most often reported as difficult, whereas the order of the other two subtopics differed between the instruments. Because each subtopic contains only two or three items, this is a descriptive convergence and not a ranking of difficulty.

Table 3. Test Performance Pooled by Subtopic and Questionnaire-Reported Difficulty (n = 66).

Subtopic	Test Items	Correct Answers	Percentage (%)	Students difficulty (%)
Acid–base theories	1, 3, 8	92 of 198	46.5	74.2
Acid–base strength	2, 5	66 of 132	50.0	78.8
pH and pOH	4, 9, 10	78 of 198	39.4	83.3
Indicators	6, 7	43 of 132	32.6	87.9

As shown in Table 3, there is a clear inverse relationship between students' test performance and their perceived difficulty across all acid–base subtopics. Subtopics with the highest reported difficulty—namely indicators (87.9%) and pH and pOH calculations (83.3%)—correspondingly yielded the lowest percentages of correct answers at 32.6% and 39.4%, respectively. Meanwhile, although acid–base strength (50.0%) and acid–base theories (46.5%) showed slightly better test results, overall mastery remained low. These findings confirm that students' perceived learning difficulties directly reflect their actual conceptual gaps, underscoring the urgent need for more engaging and supportive instructional media.

4. Integration of the Three Data Sources

The three instruments point in the same direction. The teacher estimated that about 60% of students had difficulty with acid–base material, 83.3–87.9% of students reported difficulty in pH/pOH calculation and pH range, and the comprehension test showed a low mean score (42.3 out of 100), with the lowest percentages on pH range analysis and the pH–pOH–[OH^-] relationship. The difficulty in pH calculation mentioned by the teacher and the questionnaire was partially confirmed by the test (item 4: 39.4%; item 9: 48.5%). The magnitudes differ between instruments because what is measured differs (teacher estimate, student perception, and test performance), so this consistency is interpreted as agreement in the direction of the findings, not equality of magnitude. None of the instruments identified the type of error behind the low scores, for example which incorrect options students chose, so the data show where students struggle but not why; possible explanations are therefore addressed in the Discussion as interpretations, not findings.

The findings show a mismatch between the demands of acid–base material, the teaching materials available, and the way students prefer to learn. This discussion examines why achievement was lowest on indicator analysis and pH calculation, how far the data can answer that, and what it implies for a TGT-based LKPD.

The lowest-scoring items share one feature: they require students to process much information at once. Analyzing pH ranges from three indicators (item 6; 21.2%) requires reading the given transition ranges and the color observed for each indicator, comparing them, and finding the range of pH consistent with all three. Because the ranges were provided, the low score cannot be attributed to forgetting them; it more plausibly reflects the difficulty of combining several ranges and colors at once, although this remains an interpretation. The pH–pOH–[OH^-] relationship (item 10; 30.3%) requires conversion between concentration and a logarithmic scale, and weak-acid pH calculation (item 4; 39.4%) typically adds writing the Ka expression and simplifying before taking the logarithm. According to cognitive load theory, the complexity of a task is determined by element interactivity, that is, the number of elements that must be processed simultaneously because they cannot be understood in isolation (Chen et al., 2023). This complexity depends on the schemas the learner already holds in long-term memory (Sweller et al., 1998). For novices, limited working memory is easily exceeded (Cowan, 2001), a demand long regarded as one reason chemistry is difficult to learn

(Johnstone, 1991). In salt hydrolysis, the cognitive complexity of problems correlated with lower performance and higher mental effort among chemistry undergraduates (Horvat et al., 2021).

The load also rises with shifts between levels of representation (Johnstone, 1991). Indicator analysis (items 6 and 7) links observed color (macroscopic) to pH values (symbolic), whereas pH/pOH calculation and work with ion concentrations (items 4, 9, and 10) are mainly symbolic, involving logarithmic and numerical operations, with a macroscopic referent in the measured pH. The submicroscopic level, which concerns particle behavior such as ionization and proton or electron-pair transfer, is involved more directly in the items on acid–base theories (items 1, 3, and 8), which were not among the lowest-scoring items. The lowest-scoring items therefore appear to involve mainly the macroscopic–symbolic link and symbolic manipulation, and the data cannot show whether linking them to the submicroscopic level would help students. Among undergraduate general chemistry students working on acid–base titration problems, reliance on memorized procedures, plugging values into equations, and calculators has been reported, together with difficulty visualizing what happens at the microscopic level (Salame et al., 2022). This suggests that connecting calculation with particle-level meaning is a separate demand that the LKPD may need to address (Salame et al., 2022). Mathematical prerequisites add to this load, as 83.3% of students reported difficulty calculating pH and pOH. When logarithmic operations are not yet automatic, thinking capacity is spent on the operation and little remains for chemical reasoning. This may explain why strong-acid pH calculation (item 9; 48.5%) was still answered correctly by fewer than half of the students, although its difference from item 4 is only six students and cannot be read as a reliable ranking.

The teaching materials may also contribute, since 95.5% of students stated that the LKPD contained only summaries and practice questions. For novices, practice without step-by-step worked solutions tends to add unproductive load because they must search for solution steps themselves (Sweller et al., 1998). The advantage of worked examples also shrinks as expertise grows (Chen et al., 2023). The teacher's statement that the LKPD is discovery- or inquiry-based cannot be confirmed because the LKPD documents were not analyzed.

This explanation is interpretive. Cognitive load was not measured, and the test was a single, non-diagnostic measurement taken after a gap since instruction, so low scores are compatible with incomplete schemas, forgetting, and the demands of the items themselves. Even a single-fact item such as the pH range of methyl red (item 7; 43.9%) was answered correctly by fewer than half of the students, so task complexity does not account for all of the results. The data show only that mastery remained low after instruction and that the items with the most interacting elements were the weakest, which is consistent with, but not evidence for, a load-based account.

Within these limits, the framework yields four design hypotheses for the prototyping stage: (1) LKPD activities break pH calculation into sequential steps and present indicator data in one integrated table; (2) team study begins with worked examples that are gradually faded (Renkl & Atkinson, 2003), with load sharing among members, which is most useful for complex tasks (Kirschner et al., 2009); (3) tournament cards are tiered by number of steps and repeated across sessions to support retention (Roediger & Karpicke, 2006), consistent with ability-homogeneous tournament tables; and (4) game rules are kept simple because time pressure may add load, a conjecture that needs testing.

Items 10–11 of the questionnaire indicate that students believe they can understand the material if it is presented engagingly (89.4%), but most did not report remaining enthusiastic when it felt difficult (only 30.3% remained enthusiastic). Because only one self-report item asks about this, the finding cannot be used to draw conclusions about the level of learning resilience or the causes of the

decline; it is used only as a consideration so that the LKPD provides stepwise support and tiered rewards that sustain engagement when students struggle, and the effectiveness of these features needs to be tested. Repeated failure on tasks that exceed novices' processing ability may also reduce effort, a reading that was likewise not tested and that concerns the fit between task structure and prior knowledge, not a deficit in students' ability.

The teacher linked a decline in student participation to mobile phone use and low interest in continuing to university. Ole and Kodina (2023) showed a relationship between gadget use and the learning process, but their results cannot be used to conclude that gadget use caused the decline at this school, so the interview finding is treated as contextual information for designing an engaging, active LKPD.

These findings have direct implications for LKPD development. All ten indicators were answered correctly by fewer than 57% of students, and the questionnaire shows difficulty with acid–base theory (74.2%), acid–base strength (78.8%), pH range (87.9%), and pH/pOH calculation (83.3%), so the LKPD needs to cover these four subtopics. Structured LKPD activities have been used in various chemistry teaching-material studies (Apriani et al., 2021), and LKPD can provide more directed learning experiences through particular learning models (Lusiana et al., 2021).

Students' preferences for group work (84.8%), games (84.8%), and inter-group competition (78.8%) are core components of TGT. In chemistry learning, TGT has been linked to motivation and learning outcomes (Amni et al., 2021), learning outcomes (Mandasini et al., 2021), learning interest (Tiring et al., 2023), and participation (Rivaldo et al., 2024), and a meta-analysis reported its effectiveness on learning outcomes across contexts (Maiti et al., 2021). The match between students' preferences, the teacher's view that this approach could make learning more active, and the literature supports TGT as the learning structure for the LKPD.

The teacher linked limited use of active learning to concerns about time management and large class sizes, so the activity syntax and time allocation need to be explicit. Needs analysis is an important stage before product development (Rohimat et al., 2022), and LKPD can support student activities in a more directed way (Sarita & Kurniawati, 2020). The LKPD therefore needs to attend to the feasibility of activities, group formation, and time allocation under school conditions.

Based on these findings, this study proposes a TGT-based LKPD covering the four acid–base subtopics mapped in this study (the three theories, acid–base strength, pH and pOH, and indicators) with: (1) team activities, academic games, and tiered tournaments in each subtopic; (2) a tiered reward mechanism, whose effectiveness needs testing, to maintain enthusiasm; (3) explicit syntax and time allocation for teachers inexperienced with cooperative learning; and (4) group formation and assessment mechanisms that ensure equitable participation. Because the mean test score is low, competition may reduce the motivation of low-ability students; TGT addresses this with heterogeneous teams and ability-homogeneous tournament tables, which the LKPD should state explicitly. These design hypotheses are linked to the Deep Learning principles as a single rationale. The mindful principle (Fatihah & Wiji, 2026) requires students to understand the reason for each step, so sequenced steps and worked examples are accompanied by prompts to explain the reasons (hypotheses 1 and 2). The meaningful principle requires schemas that are connected to prior knowledge and context, so worked examples are faded gradually and linked to everyday solutions (hypothesis 2). The joyful principle requires that games and competition do not add load that does not support learning (extraneous load; Sweller et al., 1998), so game rules are kept simple and tournaments follow guided practice (hypotheses 3 and 4). These are design hypotheses for the prototype stage, and their effectiveness has not been tested.

This study has several limitations. The data come from one school, one teacher, and 66 purposively selected students, so the findings are not intended to be generalized. The interview guide and questionnaire were reviewed by one expert but did not undergo statistical validity and reliability testing, and the comprehension test did not undergo formal validation, because this is an early-stage needs analysis, so the results are an initial picture, not a standardized measurement. The 10-item test had one item per indicator and was not designed as a diagnostic test that identifies the source of each difficulty, so it describes the level of difficulty but not its causes. Cognitive load was not measured, and the single-occasion design cannot show that the difficulties persist or distinguish incomplete learning from forgetting, so the cognitive-load explanations are interpretive. The test was administered in August 2026, after a gap since Grade XI, so the scores may reflect memory retention as well as understanding and describe current mastery, not difficulty during learning itself; the teacher's estimate and the questionnaire, which relate more directly to learning difficulty, point in the same direction, so this limitation is partially addressed. The Yes/No questionnaire measures perception, not performance, and some items (for example, items 9 and 16) contain cause-and-effect statements that may steer answers. Preferences for groups, games, and competition are therefore interpreted as preferences, not evidence of effectiveness.

Each subtopic was represented by only two or three test items, so the test does not cover every concept within a subtopic, and the subtopic-level percentages (Table 3) are descriptive and should not be read as precise estimates of mastery. Titration, buffer solutions, and salt hydrolysis, which are part of acid–base learning in Phase F but are taught in Grade XII according to the school's learning objective flow, were not mapped in this study; the needs analysis therefore covers only the Grade XI acid–base subtopics, and needs related to the Grade XII topics remain to be examined. The subjects of the analysis (Grade XII students who had completed the Grade XI material) are not the same as the target users of the LKPD (Phase F students who are learning the material in Grade XI), so the needs mapped here need to be confirmed with Grade XI students at the prototype development stage.

CONCLUSION

This study aimed to analyze the needs for developing a TGT-based LKPD on Phase F acid–base material. At a single school, students' mastery was low across all tested indicators and weakest on analyzing indicator pH ranges, the pH–pOH–[OH^-] relationship, and weak-acid pH calculation, tasks that, on a content analysis of the items, involve many interacting pieces of information; this fits a cognitive-load reading, although cognitive load was not measured. The teacher, the students, and the test pointed in the same direction, although the results are best read as an initial picture because the test was brief, non-diagnostic, and administered after a gap since instruction. According to students, the LKPD currently used mostly offers summaries and practice questions; because the LKPD documents were not analyzed, whether it supports multi-step tasks remains to be examined. Students showed a clear preference for group work, games, and team competition, and the teacher, who had not yet applied cooperative learning, recognized its potential.

These findings imply that a TGT-based LKPD should do more than add games to existing content. Its syntax should be built around reducing the processing load of multi-step tasks: a class presentation that sequences procedures and shows how the quantities relate before students calculate; team study that starts from worked examples and fades them; tournament items tiered by number of steps and repeated across sessions; simple game rules; and explicit time allocation and grouping rules, with heterogeneous teams and ability-homogeneous tournament tables, suited to large classes. These are design hypotheses, not demonstrated effects: students' preferences are

consistent with the components of TGT but do not show its effectiveness, and the load-based interpretation was not measured.

The contribution of this study is a needs mapping that links the profile of students' difficulties, the condition of teaching materials, and students' preferences to concrete decisions about the LKPD syntax, in an subtopic that, to the authors' knowledge, remains limited in the literature. Further research should test the validity and practicality of the prototype, measure its effectiveness with validated instruments that include measures of cognitive load, and analyze the LKPD documents used at the school.

REFERENCES

Amni, Z., Ningrat, H. K., & Raehanah. (2021). Pengaruh model pembelajaran kooperatif tipe Teams Games Tournament (Tgt) berbantuan media destinasi terhadap motivasi dan hasil belajar pada materi larutan penyangga. *Jurnal Inovasi Pendidikan Kimia*, *15*(2), 2840–2848.

Antoro, R. D., Jangi, M. D., & Danial, M. (2021). Pengembangan LKPD identifikasi asam basa model inkuiri menggunakan pendekatan SETS. Chemedu, 2(3). 25-35 https://doi.org/10.35580/chemedu.v2i3.26611

Apriani, A., Afgani, M. W., & Astuti, R. T. (2021). Pengembangan lembar kerja peserta didik (LKPD) berbasis inkuiri terbimbing pada materi hidrolisis garam untuk siswa SMA. jurnal riset pendidikan kimia, 11(2), 123–131. https://doi.org/10.21009/jrpk.112.09

Arikunto, S. (2013). Prosedur Penelitian: Suatu pendekatan praktik (Edisi revisi). Jakarta: Rineka Cipta.

Atika, M. D., & Latisma, L. (2022). Deskripsi kesulitan belajar kimia siswa pada materi asam basa kelas xi di SMA Negeri 7 Padang. *Entalpi Pendidikan Kimia*, 3(3), *18–26*. https://doi.org/10.24036/epk.v3i3.273

Badan Standar, Kurikulum, dan Asesmen Pendidikan. (2025). Capaian pembelajaran mata pelajaran kimia fase F (Keputusan Kepala BSKAP Nomor 046/H/KR/2025). Kementerian Pendidikan Dasar dan Menengah.

Chen, O., Paas, F., & Sweller, J. (2023). A cognitive load theory approach to defining and measuring task complexity through element interactivity. *Educational Psychology Review*, *35(2), Article 63*. https://doi.org/10.1007/s10648-023-09782-w

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral And Brain Sciences*, *24*(1), 87–114. https://doi.org/10.1017/s0140525x01003922

Fatihah, W., & Wiji. (2026). Implementasi deep learning pada pembelajaran kimia: Tantangan, urgensi dan transformasi pedagogik. *Jurnal Riset Dan Praktik Pendidikan Kimia*, *14*(1), 1–10. https://doi.org/10.17509/jrppk.v14i1.96009

Giawa, A. J., Sukemi, S., Rahmadani, A., & Lestari, I. (2026). Implementation of the Remap-CIRC learning model toward high school students' learning outcomes in acid-base topics. *Jurnal Zarah*, *14*(1), 39–45. https://doi.org/10.31629/zarah.v14i1.8136

Haetami, A., Astuti, N. S., & Maysara. (2022). Pengembangan lembar kerja peserta didik (LKPD) berbasis model discovery learning pada materi asam basa di SMA Negeri 1 Siompu Barat. *Jurnal Jurrimipa*, 1(1), 64–70. https: //doi.org/10.55606/jurrimipa.v1i1.205

Hanifa, A., & Andromeda. (2025). Pengembangan LKPD asam basa berbasis problem based learning terintegrasi culturally responsive teaching untuk fase F Sma Azka. *Jurnal Pendidikan Mipa*, *15*(1), 31–39. https://doi.org/10.37630/jpm.v15i1.2093

Herawati, S., Kurniawan, R. A., & Kurniasih, D. (2025). Efektivitas pembelajaran kooperatif tipe Teams Games Tournament Berbantuan Ludo Kimia terhadap minat dan hasil belajar siswa pada materi reaksi redoks. *Orbital: Jurnal Pendidikan Kimia*, *10*(1), 112–134. https://doi.org/10.36709/jpkim.v10i1.158

Horvat, S. A., Mihajlović, J., Rončević, T. N., & Rodić, D. D. (2021). Procedure for the assessment of cognitive complexity: Development and implementation in the topic "Hydrolysis Of Salts."

Macedonian Journal Of Chemistry And Chemical Engineering, *40*(1), 119–130. https://doi.org/10.20450/mjcce.2021.2240

Hsb, P. S., & Alizar. (2025). Pengembangan LKPD berbasis Team Game Tournament (TGT) pada materi ikatan kimia fase F SMA/MA. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *6(6)*, 1731–1739. https://doi.org/10.59698/afeksi.v6i6.717

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning, 7*(2), 75–83. https://doi.org/10.1111/j.1365-2729.1991.tb00230.x

Kirschner, F., Paas, F., & Kirschner, P. A. (2009). A cognitive load approach to collaborative learning: United brains for complex tasks. *Educational Psychology Review, 21*(1), 31–42. https://doi.org/10.1007/s10648-008-9095-2

Lusiana, L., Enawaty, E., & Rasmawan, R. (2021). Pengembangan lembar kerja peserta didik (LKPD) berbasis inkuiri terbimbing pada materi laju reaksi di SMA Indonesia Muda. *Jurnal Eksakta Pendidikan*, 5(1), 51–58. https://doi.org/10.24036/jep/vol5-iss1/569

Maiti, M., Ruhmayanti, H., Agustina, H., & Syaharuddin. (2021). Meta-analisis: Model pembelajaran kooperatif tipe Teams Games Tournament dalam meningkatkan hasil belajar siswa. Pendekar: *Jurnal Pendidikan Berkarakter*, 4(1), 7-13. https://journal.ummat.ac.id/index.php/pendekar/article/view/4378

Mandasini, A. A., Alimin, & Hardin. (2021). Pengaruh penggunaan media Quizlet pada materi pembelajaran kooperatif tipe Teams Games Tournament terhadap hasil belajar peserta didik kelas X SMK-PP Negeri Rea Timur pada materi pokok struktur atom, sistem periodik dan ikatan kimia. *Chemedu*, 2(3), 113-127. https://doi.org/10.35580/chemedu.v2i3.26625

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Ole, A. A., & Kodina, L. (2023). Tingkat penggunaan gadget (smartphone) dan prestasi belajar siswa. *Journal On Education*, *05*(02), 3160–3164. https://doi.org/10.31004/joe.v5i2.969

Plomp, T. (2013). Educational design research: An introduction. In T. Plomp & N. Nieveen (Eds.), *Educational design research – Part A: An introduction* (pp. 10–51). SLO.

Putri, N. N., & Alizar. (2025). Validitas LKPD berbasis Team Games Tournament pada materi struktur atom untuk kelas X fase E SMA. *Journal Of Global Research Education*, *2*(2), 111–117. https://doi.org/10.62194/wtww1849

Putriawati, W., & Chiani, S. H. (2025). Development of an instrument to map acid–base misconceptions among high-achieving senior high school students in Eastern Indonesia. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan Ipa Ikip Mataram*, *13*(4), 1186–1198. https://doi.org/10.33394/j-ps.v13i4.17646

Renkl, A., & Atkinson, R. K. (2003). Structuring the transition from example study to problem solving in cognitive skill acquisition: A cognitive load perspective. *Educational Psychologist, 38*(1), 15–22. https://doi.org/10.1207/S15326985EP3801_3

Rivaldo, I., Yunaz, L., & Yuhelman, N. (2024). PTK kolaboratif: Pembelajaran kooperatif TGT berbantuan permainan CTA dalam meningkatkan keaktifan peserta didik pada pembelajaran kimia.*Jurnal Pendidikan Mipa, 14*(4), 1161–1167. https://doi.org/10.37630/jpm.v14i4.2077

Rohimat, S., Meilina A., R. A., & Siallagan, A. (2022). Studi literatur pengembangan E-LKPD mata pelajaran kimia di SMA. *Prosiding Temu Ilmiah Nasional Guru*, 14(1), 341–352. https://doi.org/10.33830/ting.v14i1.575

Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, *17*(3), 249–255. http://www.jstor.org/stable/40064526

Salame, I. I., Montero, A., & Eschweiler, D. (2022). Examining some of the students challenges and alternative conceptions in learning about acid-base titrations. *International Journal Of Chemistry Education Research*, *6*(1), 1–10. https://doi.org/10.20885/ijcer.vol6.iss1.art1

Sarita, R., & Kurniawati, Y. (2020). Pengembangan lembar kerja peserta didik (LKPD) kimia berbasis keterampilan generik sains. *Journal Of The Indonesian Society Of Integrated Chemistry*, 12(1), 31–39. https://doi.org/10.22437/jisic.v12i1.7846

Suliastifah, E. (2023). Penerapan model pembelajaran Teams Games Tournament (TGT) untuk meningkatkan prestasi belajar laju reaksi dan kreativitas siswa kelas XI IPA SMA Negeri 3

Lamongan. *Karangan: Jurnal Kependidikan, Pembelajaran, Dan Pengembangan*, *05*(01), 36–42. https://doi.org/10.55273/karangan.v5i1.222

Sweller, J., van Merriënboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251–296. https://doi.org/10.1023/A:1022193728205

Tiring, S. S. N. D., Nirmalasari, Y., & Herci, N. (2023). Analisis minat belajar kimia peserta didik dengan strategi gamifikasi Team Games Tournament dan media kartu CLUP. *Jurnal Pendidikan Mipa*, 13(2), 335–343. https://doi.org/10.37630/jpm.v13i2.938

Widiastuti, N. L. G. K., & Priantini, D. A. M. M. O. (2022). Lembar kerja peserta didik berbasis kontekstual pada muatan pelajaran IPA. *Jurnal Ilmiah Pendidikan Profesi Guru*, *5*(1), 147–160. https://doi.org/10.23887/jippg.v5i1.45530